JOURNAL OF

Punjab Academy of Forensic Medicine & Toxicology

ISSN: 0972-5687

Volume: 20, Number: 02 July to December Publication: Half Yearly

2020

Editor-in-Chief
Dr. Parmod Kumar Goyal

A Peer Reviewed Journal on
Forensic Medicine, Toxicology, Analytical Toxicology, Forensic Science, Environmental Pollution, Forensic Pathology, Clinical Forensic Medicine, Identification, Legal Medicine, State Medicine, Medical Jurisprudence, Medical Ethics, Forensic Nursing, Forensic Odontology, Forensic Anthropology, Forensic Psychiatry and other Allied branches of Medicine and Science dedicated to administration of Justice.

OFFICIAL PUBLICATION OF
PUNJAB ACADEMY OF FORENSIC MEDICINE & TOXICOLOGY
Place of Publication: Bathinda (Punjab) India

• Indexed with Index Copernicus (Poland), Scopus (Elsevier Products), IndMed (ICMR New Delhi), Safetylit, Worldcat Library & WHO Hinari
• JPAFMAT is also having PubMed/NLM catalogue number (NLM Unique ID: 101232466).
• Available online at Indian Journals.com, pafmat.org and pafmat.com
• UGC Approved (as per UGC care list)

PUNJAB ACADEMY OF FORENSIC MEDICINE AND TOXICOLOGY

(Registration No. 139 / 1998-99, Chandigarh)

HO: Department of Forensic Medicine, Govt. Medical College Patiala (Punjab) 147001

GOVERNING COUNCIL (2019 - 2021)

President
Dr. D. S. Bhullar

General Secretary
Dr. Akashdeep Aggarwal

Joint Secretary
Dr. Didar Singh Walia

Finance Secretary
Dr. Shilekh Mittal

Vice President
Dr. Rajiv Joshi

Joint Editor
Dr. Amandeep Singh

Editor-in-Chief
Dr. Parmod Kumar Goyal

Executive Members

Dr. Ashok Chanana
Dr. Ishwar Tayal
Dr. Dasari Harish
Dr. Preetinder S. Chahal
Dr. Puneet Khurana
Dr. Ajay Kumar
Dr. Amit Singla
Dr. Ashwani Kumar
Dr. Deep Rattan Mittal

Advisors

Dr. O.P. Aggarwal
Dr. S.S. Oberoi
Dr. Balbir Kaur
Dr. Gurmanjit Singh
Dr. K.K. Aggarwal
Dr. R.K. Sharma
Dr. R.K. Gorea
Dr. Vijaypal Khanagwal

Special Invitee

Dr. Adish Goyal
Dr. Mukul Chopra

FOUNDER GOVERNING COUNCIL OF PAFMAT

Patron
Dr Jagdish Gargi

Advisors
Dr J. S. Dalal
Dr Harish Tuli
Dr Maj. Gen (Rtd.) Ajit Singh

President
Dr. R. K. Gorea

Vice President
Dr. D. S. Bhullar

Secretary
Dr. Sat Pal Garg

Treasurer
Dr. Nirmal Dass

Executive Members
Dr A S Thind,
Dr Jagjiv Sharma,
Dr Kuldeep Kumar,
Dr I. S. Bagga,
Dr Baljit Singh

From the Desk of Editor-in-Chief

I am pleased to present the second issue of the year 2020 of Journal of Punjab Academy of Forensic Medicine & Toxicology. First of all I apologize for delay release of this issue due to covid pandemic. I am thankful to the authors and contributors for the scientific articles and research papers which are being published in this issue. I am also thankful to the editorial team and the members of the Academy for supporting me in its publication. My special thanks to Joint Editor Dr Amandeep Singh and Assistant Editor Dr Satinder Pal Singh for their support and sincere efforts for publication and release of this issue.

The Journal publishes original research papers, review articles, case reports and review of books on Forensic Medicine and Toxicology. The Journal highlights the achievements of the academy and its members. This journal is meant for achieving the aims and goals of the academy to expand the academic activities, spread the knowledge and latest research in the field of Forensic Medicine and Toxicology.

Any suggestions and advice for further improving the standards and quality of the journal will be highly appreciated and may be sent to me through email or my whattsapp no. 9876005211.

ISSN Numbers:
ISSN-L: 0972-5687, p-ISSN: 0972-5687, e-ISSN: 0974-083X.

Indexed with:
IndexCopernicushttp://journals.indexcopernicus.com/karta.php?id=4715

Scopus (SCI):
http://www.scimagojr.com/journalsearch.php?q=19900194914&ip=sid&clean=0

Volume of Distribution:
300 copies.

Funding Bodies: Punjab Academy of Forensic Medicine & Toxicology, Donations from Philanthropists and manuscript handling charges

Address for submission of articles Online (Soft Copy):
drparmodgoyal@gmail.com, indianjournals.com

Dr Parmod Kumar Goyal
Professor & Head (Forensic Medicine)
Member Secretary,Ethics Committee,Adesh University
Controller of Examinations, Adesh University, Bathinda
Convener, BOS(PG) Adesh University, Bathinda
Coordinator, Body Donation Programme
FAIMER 2013, ACME 2015
Editor in Chief, Journal of Punjab Academy of Forensic Medicine and Toxicology (JPAFMAT)
Adesh Institute of Medical Sciences & Research, Bathinda

JOURNAL OF
Punjab Academy of Forensic Medicine & Toxicology
ISSN: 0972-5687

Volume: 20, Number: 02 **July to December** **Publication: Half Yearly**

Contents

JOURNAL OF
Punjab Academy of Forensic Medicine & Toxicology
ISSN: 0972-5687

Volume: 20, Number: 02 **July to December** **Publication: Half Yearly**

Contents

JOURNAL OF
Punjab Academy of Forensic Medicine & Toxicology
ISSN: 0972-5687

Volume: 20, Number: 02 **July to December** **Publication: Half Yearly**

Contents

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00088.6

Editorial

A shift towards Competency Based Medical Education in India: Challenges and Way ahead

1. **Ashim Mishra,** Associate Professor, Department of Forensic Medicine, Great Eastern Medical School & Hospital, Srikakulam, Andhra Pradesh
2. **Prateek Rastogi**, Professor and Head, Department of Forensic Medicine and Toxicology, Kasturba Medical College Mangalore, Manipal Academy of Higher Education Manipal, Karnataka.

ABSTRACT :

The Competency based Medical Education (CBME) had been introduced by Medical Council of India as an adaptive measure in 2019 curriculum to provide much relief to the stagnant medical education system. The advent of novel corona pandemic had played a devastating role in disrupting the planned system and had put few question marks on our preparedness and pointed the lacunae in our system. The authors had tried to bring about the structural changes and practical challenges which we shall be facing from a medical teacher point of view.

The required process is rather than being myopic in approach and focusing on a jump start mechanism, we must take a few steps to ponder and plan it in a systemic way since the outcomes are not short term. The outcome measures could have significant impact on future health care delivery system.

Corresponding Author :
Dr Prateek Rastogi,
Professor and Head,
Department of Forensic Medicine and Toxicology, Kasturba Medical College Mangalore, Manipal Academy of Higher Education Manipal, Karnataka.
Contact : +91 94485-01376
Email : rastogiprateek@rediffmail.com

Article History:
Received: 30 November 2020
Received in revised form: 3 December 2020
Accepted on: 3 December 2020
Available online: 30 April 2021

KEYWORDS : Competency Based Medical Education; challenges; system approach; health care delivery.

INTRODUCTION:

The recent introduction of new CBME by erstwhile MCI was a much-needed intervention from a subject centered vertical time bound approach to a broader competency-based approach keeping in account the societal needs and national needs bringing the focus on a learner centric approach in real life scenario.[1]

The introduction of soft skills in attitude, ethics and communication model was a welcomed decision by medical fraternity. Now the National Medical Commission has also taken a proactive step to maintain the standards of Graduate Medical Education . Competency is a broader concept where each competency comprises a subset of requisite number of addressed learning objectives from knowledge, skill, attitude and communication domain.

In fact this concept is not a new concept. Accreditation Council of Graduate Medical Education (ACGME) in USA already grouped patient care, medical knowledge, practice based learning and improvement, interpersonal and communications skills , professionalism and system based practice as six domains of general competency.[2]

Moreover during the corona pandemic the declaration of dedicated covid hospitals and students shifting to online mode of learning disrupted the very purpose of interactive learning and attainment of competency. There had been a time lag of around ten months for the new curriculum and had projected the lacunae in our system as well.

Problem Statement:

To address some grey areas we need to answer some fundamental questions.

1. Whether all faculty are aware of nature, focus and assessment of new CBME Curriculum?
2. Whether the modular program of curriculum implementation support programme (CISP) training is sufficient to meet the demand?
3. What is actual difference between perception and intended competency from a faculty point of view?
4. Whether alignment and integration of curriculum is at design stage or implementable stage?
5. Whether all faculty had clarity of tasks assigned or undertaking tasks towards fulfilment of their managerial roles only?
6. Whether the management and authorities have accepted

wholeheartedly the intended paradigm change or satiating to their organizational needs?

7. Whether the newer assessment methods are uniform across the country and system of benchmarking necessary?
8. Whether the soft skills training and assessment issues are addressed adequately?
9. Whether the intended product shall be a competent doctor or not?
10. Whether the present books and resource material are adequate to deal with demand?
11. Do we have infrastructure to meets demands of CBME curriculum?
12. Do we have human resources to meet demands of CBME Curriculum?

DISCUSSION:

The primary focus of CBME is on the series of learning opportunities for students primarily based on his assumption of a role as categorically defined in new CBME guidelines.

The elements of competence had been well defined by the document provided by revised curriculum 2019 and the table also provides a feasible structure that can be adopted uniformly across institutions but still their remains a question about the expected performance level during assessment. Some authors have rightly pointed that in a sudden shift from time bound and teacher driven curriculum may create a chaos in not so self-motivated students who may lose their pace of learning. They had also pointed that in an attempt of fine tuning competencies and subsets the real beauty of the subject may sometimes get eroded.[3]

In one article , the authors had cited that this new curriculum is going to be "an overhaul of the system; we all have been used to. This paradigm shift is going to be difficult, especially since it is an overnight change rather than a gradual transition."

The framework for integration provided by Ronald Harden in 2000 comprising of ladder steps: Isolation, Awareness, Harmonization, Nesting, Temporal co-ordination, Sharing, Correlation, Complementary and Multi-disciplinary to maintain mid-levels of integration in the present scenario had been adapted by new curriculum at some places but still are all faculty trained in adoption of this process and competent to address the intended learning outcome is a major issue.

Alignment and integration may run an inherent risk of mapping staff strengths to weightage and time management.

The capacity building as suggested by formation of committees and thus assigning managerial roles apart from teaching roles to a faculty is praise worthy but does it not outweigh the research output of a faculty.

The benchmarking for assessment system is variedly described by many authors and more stress on formative assessment had been given which is commendable but had the consideration given to medical colleges dealing with a low student to faculty ratio.

The proctored system of student learning during clinical teaching is also a proactive steps but have the authorities ear marked the resources and assigned the responsibilities.

The residency program and more importantly post graduate medical education is still an unchartered territory.

The way forward:

I. The medical education unit of each college shall play a pivotal role in bringing about a uniform change and establishing a centralized system of monitoring and implementation of process.
II. It shall not only establish training programs but also set up system for aligning the entire system of medical education in pursuant to larger goal setting.
III. The power differential set up in department by the previous vertical system needs to be abolished by a more inter and intra-collaborative departmental approach.
IV. The agents of change may face resistance at different levels which may be diminished to a greater extent by debate and focused discussion which in turn would provide more clarity on curriculum.
V. The change in mind set from teacher centric to student centric is very important since it opens scope for adoption of newer teaching learning methods.
VI. Regular monitoring and evaluation is required to maintain the uniformity in standards by different faculty and identifying the bottlenecks.
VII. Assessment system needs to be modified and upgraded to meet requirements.
VIII. Infrastructure and faculty strength needs to be upgraded to meet the demand.

CONCLUSION:

Small baby steps are required through activities that pose low risk for both faculty and students. Various modalities and techniques may be followed like the web based platforms have been adapted during this pandemic, moreover after students rejoin the classes interactive teaching learning methods might be the notion.

While a hybrid approach has been suggested by previous authors "wherein new curriculum should be inbuilt in the tenets of the conventional curriculum in the initial phases of the

change" before undergoing a major transition.[1]

While challenges may be many, but these can be overcome by commitment, dedication and most importantly with a will to change for the benefit of medical education.

REFERENCES:

1. Shah N, Desai C, Jorwekar G, Badyal D, Singh T. Competency-based medical education: An overview and application in pharmacology. Indian J Pharmacol. 2016 Oct; 48(Suppl 1): S5–S9.
2. Swing SR. The ACGME outcome project: Retrospective and prospective. Med Teach. 2007;29:648–54.
3. Frank JR, Snell LS, Cate OT, Holmboe ES, Carraccio C, Swing SR, et al. Competency-based medical education: Theory to practice. Med Teach. 2010;32:638–45.
4. Sharma R, Bakshi H, Kumar P. Competency-based undergraduate curriculum: A critical view. Indian J Community Med 2019;44:77-80

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00089.8

Original Research Paper

A Retrospective Mapping of Homicide Patterns at National Capital Region of India

1. **Asit Kumar Sikary,** Assistant Professor, ESIC Medical College Faridabad, Haryana
2. **Raghvendra Kumar,** Associate Professor, AIIMS Bhopal, Madhya Pradesh
3. **Parthasarathi Pramanik,** Consultant Forensic Pathologist, Government of Jamaica, Institute of Forensic Science and Legal Medicine, Kingston, Jamaica
4. **Chittaranjan Behera,** Additional Professor, AIIMS New Delhi

ABSTRACT :

Introduction: India is a significant host to the homicidal deaths of different ages persons due to various reasons. The autopsy based evaluation along with the available medico legal records, inquest papers and the crime scene reports have been always important in knowing the exact reasons behind such acts.

Objective: To know about the exact reasons behind the homicides and to find out the pattern of the homicide, the motive behind the act of homicide and the perpetrator-victim relationship.

Materials and Methods: A retrospective autopsy based evaluation of homicidal deaths was done at, All India Institute of Medical Sciences ,New Delhi for a total duration of 20 years between Jan. 1996 to Dec-2015.

Results: Out of a total of 32,310 cases in the study group in this duration, the homicide deaths were comprised of 1918(5.9%) cases. The maximum homicides were reported against the 4th decade age group and by ligature strangulation followed by throttling and most commonly at out of the home environment and commonly by neighbor and known perpetrators between 18-50 years of age with the personal dispute as the main motive.

Conclusion: In the study it was found that the age is no bar for the homicides and the cases have been reported from infant to old age persons. They constituted about 5.9% of all the autopsy cases with maximum number of cases in 4th decade age-group and throttling, head injury in infants, ligature strangulation, stabbing and firearm injuries as the common means. The main reason/motive of homicide against infant was suicidal-homicidal pact, kidnapping-ransom in 1st decade victims, sexual assault & family revenge in 2nd decade victims and for relatives as peer-altercation and for neighbour/known persons & strangers as personal dispute.

Corresponding Author:
Dr. Raghvendra Kumar,
Associate Professor,
AIIMS Bhopal
Contact :+91 7747010414
Email : raghvendra.fmt@aiimsbhopal.edu.in

Article History :
Received : 29 March 2020
Received in revised from : 30 March 2020
Accepted on : 30 March 2020
Available online : 30 April 2021

Key words : Homicide, Perpetrator, Victim, Means and Motives, Place

INTRODUCTION :

Homicide is killing of a human being by the other. It is not against a defined age-group but it encompasses all the age-group of society be it infants, children, young, adults or elderly, however, with varying rate of involvement[1]. A motive is present behind these homicides in most of the times, such as enmity, robbery, kidnapping, revenge, rape, jealousy or just at the heat of moment during an argument. Sometimes, there is no motive at all. The motive is different for different age-group & sex[1]. Perpetrator of a homicide may be a stranger but in most of the cases it is mainly known, relative or a known person who is involved[2].

In Indian society where the societal and familial relations are on priority with various social regulations, still the main currents of social, economic and political development and the resulting changes affected the magnitude and incidence of homicide[3]. Criminal homicide in India, as in western countries, usually involves interaction between kinsmen or close associates rather than strangers and between persons of the same sex, religion, and caste[4].

MATERIAL AND METHODS :

This study was performed at All India Institute of Medical Sciences, New Delhi. It receives the dead bodies for autopsy service from South and South-East Delhi, an urban settlement with dispersed slum areas and unauthorised colonies. This was a retrospective study of last 20 years (years 1996-2015), comprising of 32,310 autopsy cases. Post-mortem records, inquest papers and crime scene reports were analysed from

archive of department of Forensic Medicine of the Institute and all the details of homicidal cases were collected and studied. There were total 1,918 cases (1,472 males and 446 females). Cases were analysed to see the pattern of homicide, perpetrator-victim relationship and the method & motive/reason of the homicide in a part of national capital region for the duration of 20 years.

RESULT :

Prevalence: The total autopsy cases in the study duration were 32,310 and out of that the homicidal cases were 1,918 (1472 males and 446 females), constituting about 5.9% of all the autopsy cases.The minimum number of cases were seen in >80 year age-group and the maximum number of cases was seen in 4th decade age-group followed by 5th decade age group **[Table:1]**.

Method: Common methods of homicide was throttling and head injury in infants (cases of infanticide); ligature strangulation followed by head injury in 1st decade victims; stabbing followed by firearm wound in 2nd decade victims; ligature strangulation followed by throttling, head injury and stabbing in 3rd, 4th, 5th and 6th decade victims; stabbing followed by ligature strangulation in 7th and 8th decade victims; and ligature strangulation in age-group after 8th decade. Firearm injury was the least common method **[Table:2].**

Place: All the cases of homicide occurred outside the home environment, except 1st decade victims and victims of 7th decade and beyond that against where, the incidents occurred at their homes **[Table:3]**.

Table 1 : Age and gender wise distribution of autopsy cases

Age-group (in years)	Total Cases		Homicide Cases	
	Male	Female	Male %	Female %
0-1*	39	39	4 (10.3)	13 (33.3)
>1-10	439	319	35 (8.0)	29 (9.1)
11-20	2098	1678	44 (2.1)	20 (1.2)
21-30	6757	2397	302 (4.5)	80 (3.3)
31-40	5936	1076	392 (6.6)	92 (8.6)
41-50	4995	955	360 (7.2)	91 (9.5)
51-60	2154	754	285 (13.2)	83 (11)
61-70	793	313	39 (4.9)	22 (7.0)
71-80	632	232	8 (1.3)	14 (6.0)
>80	472	7995	3 (0.6)	2 (0.9)
Total	**24315**	**7995**	**1472 (6.1)**	**446 (5.6)**

Table 2 : Distribution of homicide cases as per the means used for killing purposes

Age-group (in years)	Ligature Strangulation		Throttling/ Smothering		Head Injury		Stabbing		Poisoning		Firearm Wound		Blunt Force Injury (other than head)	
	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)
0-1*	0	3 (23.1)	2 (50.0)	5 (38.5)	2 (50.0)	5 (38.5)	0	0	0	0	0	0	0	0
>1-10	14 (40)	9 (31.0)	5 (14.3)	6 (20.7)	5 (14.3)	6 (20.7)	3 (8.6)	2 (8.6)	2 (5.7)	1 (3.4)	1 (2.9)	0	2 (5.7)	1 (3.4)
11-20	11 (25.0)	6 (30.0)	1 (2.3)	1 (5)	4 (9.1)	5 (25.0)	13 (29.5)	5 (25.0)	0	0	12 (27.3)	2 (10.0)	3 (6.8)	1 (5.0)
21-30	72 (23.8)	35 (43.8)	52 (17.2)	32 (40.0)	72 (23.8)	0	68 (22.5)	10 (12.5)	0	0	28 (9.3)	0	10 (3.3)	3 (3.8)
31-40	102 (26.2)	38 (41.3)	75 (19.1)	34 (37.0)	91 (23.2)	5 (5.4)	63 (16.1)	11 (12.0)	0	0	37 (9.4)	2 (2.2)	24 (6.1)	2 (2.1)
41-50	101 (28.1)	33 (36.3)	69 (19.2)	37 (40.7)	88 (24.4)	2 (2.2)	60 (16.7)	13 (14.3)	0	0	36 (10.0)	1 (1.1)	6 (1.7)	5 (5.5)
51-60	84 (29.5)	36 (43.4)	52 (18.2)	33 (39.8)	72 (25.3)	2 (2.4)	45 (15.8)	11 (13.3)	0	0	28 (9.8)	1 (1.2)	4 (1.4)	0
61-70	9 (23.1)	4 (18.2)	1 (2.6)	5 (22.7)	5 (12.8)	6 (27.3)	9 (23.1)	7 (31.8)	0	0	12 (30.8)	0	3 (7.7)	0
71-80	1 (12.5)	5 (35.7)	0	2 (14.3)	4 (50.0)	1 (7.1)	3 (37.5)	5 (35.7)	0	0	0	1 (7.1)	0	0
>80	1 (33.3)	1 (50.0)	0	1 (50.0)	1 (33.3)	0	1 (33.3)	0	0	0	0	0	0	0
Total	395	170	257	156	347	36	265	64	2	1	154	7	52	12

Table 3 : Places of Occurrence of Homicides :

Age-group (in years)	Within Home Environment		Outside Home Environment	
	Male %	Female %	Male %	Female %
0-1*	4 (100)	13 (100.0)	0	0
>1-10	1 (2.9)	2 (6.9)	34 (97.1)	27 (93.1)
11-20	0	0	44 (100.0)	20 (100.0)
21-30	21 (6.6)	15 (18.7)	281 (93.4)	65 (81.3)
31-40	98 (25.0)	24 (26.1)	294 (75.0)	68 (73.9)
41-50	85 (23.6)	22 (24.2)	275 (76.4)	69 (75.8)
51-60	67 (23.5)	13 (15.7)	218 (76.5)	70 (84.3)
61-70	33 (84.6)	22 (100.0)	6 (15.4)	0
71-80	8 (100.0)	14 (100.0)	0	0
>80	3 (100.0)	2 (100.0)	0	0

Perpetrator: All the perpetrators were of between 18-50 years of age and were males, except in cases of infanticide and homicide-suicide where the perpetrators were females. All the Sexual offenders were of male sex and of the age-group of 18-40 years of age. The age-group of offenders was equally distributed against the age-groups of the victims**[Table:4]**.

Table 4 : Distribution of homicide cases as per the identity of perpetrator

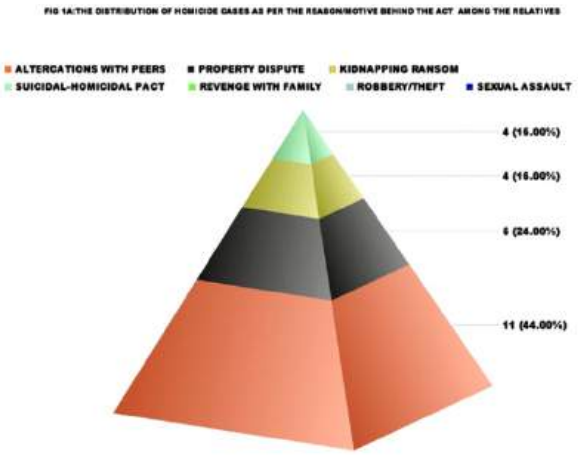
Age-group (in years)	Relative of Victims		Neighbour/ Known to Victims		Stranger to Victims		Accused Not Identified	
	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)
0-1*	4 (100.0)	13 (100.)	0	0	0	0	0	0
>1-10	2 (5.7)	4 (13.8)	21 (60.0)	11 (37.9)	8 (22.9)	7 (24.1)	4 (11.4)	7 (24.1)
11-20	0	1 (5.0)	27 (61.4)	7 (35.0)	14 (31.8)	5 (25.0)	3 (6.8)	7 (35.0)
21-30	11 (3.6)	0	191 (63.2)	39 (48.8)	66 (21.9)	38 (47.5)	33 (10.9)	3 (3.8)
31-40	0	0	357 (91.1)	74 (80.4)	10 (2.6)	8 (8.7)	25 (6.4)	10 (10.9)
41-50	0	0	320 (88.9)	72 (79.1)	5 (1.4)	3 (3.3)	35 (9.7)	16 (17.6)
51-60	6 (2.1)	0	244 (85.6)	73 (88.0)	0	0	35 (12.3)	10 (12.0)
61-70	0	0	23 (59.0)	10 (45.5)	14 (35.9)	10 (45.5)	2 (5.1)	2 (9.1)
71-80	0	0	5 (62.5)	6 (42.9)	1 (12.5)	7 (50.0)	2 (25.0)	1 (7.1)
>80	0	0	2 (66.7)	0	0	0	1 (33.3)	2 (100.0)
Total	23	18	1190	292	118	78	140	58

Perpetrator-victim relationship: The Perpetrators were mothers in all the cases of infanticide while neighbours and known persons were the most common against rest of the age-groups. Strangers were second to known persons as perpetrator for all the age-groups. In 198 cases (10.3%) the perpetrators were not identified which were mostly against 3rd to 6th decade victims.

Motive: Main reason/motive of homicide against infants was suicidal-homicidal pact (except infanticide), kidnapping-ransom followed by sexual assault were the reason/motives against 1st decade victims, sexual assault followed by family revenge, kidnapping-ransom and peer-altercation (heated arguments among peer groups) were the reason/motives against 2nd decade victims, personal dispute (heated arguments with stranger, bad business deal, road rage) followed by peer-altercations were the common reason/motives against 3rd, 4th, 5th and 6th decade victims, and robbery/theft was the reason/motive of homicide beyond that age-groups. In 198 cases (10.3%) the reason/motive was not known **[Table:5]**.

The most common reason/motive relatives had for homicide was peer-altercation followed by property dispute; the reasons/motives for neighbour/known persons for homicide were personal dispute followed by peer-altercation; and the reasons/motives for strangers was personal dispute followed by sexual assault. No relative had sexual assault as motive for homicide but the known person/neighbour had sexual assault as motive **[Figure 1a,1b,1c]**.

Sexual assault was reason/motive behind 13 male and 67 female homicides but ano-genital injury was found in 9 male and 35 female cases at autopsy (55%)**[Table:6]**.

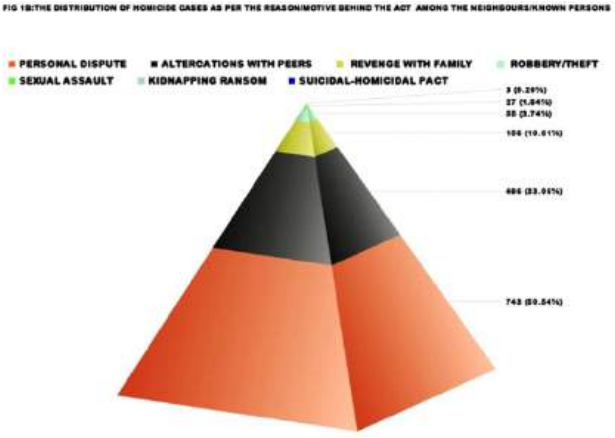


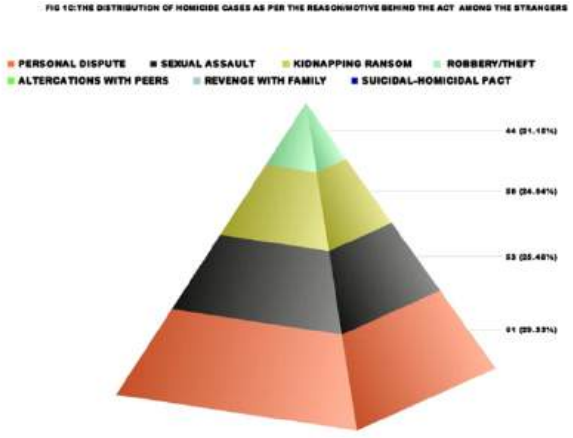
DISCUSSION :

During the study period, homicidal death cases comprised of

Table 5 : The distribution of homicide cases as per the reason/motive behind the act

Age-group (in years)	Sexual Assault		Revenge with Family		Kidnapping & Ransom		Personal Dispute		Altercations with Peers		Suicidal-Homicidal Pact		Robbery/ Theft		Reason/ motive Not Known	
	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)
0-1*	0	0	0	0	0	0	0	0	0	0	1 (25.0)	0	0	0	0	0
>1-10	4 (11.4)	14 (35.9)	12 (34.3)	2 (6.9)	15 (42.9)	4 (13.8)	0	0	0	0	0	2 (6.9)	0	0	4 (11.4)	7 (24.1)
11-20	9 (20.5)	11 (55.0)	10 (22.7)	1 (5.0)	10 (22.7)	1 (5.0)	0	0	11 (25.0)	0	1 (2.3)	0	0	0	3 (6.8)	7 (35.0)
21-30	0	22 (27.5)	30 (9.9)	0	21 (7.0)	0	108 (35.8)	54 (67.5)	110 (36.4)	0	0	1 (1.25)	0	0	33 (10.9)	3 (3.8)
31-40	0	12 (13.0)	63 (16.1)	2 (2.2)	6 (1.5)	0	154 (39.3)	68 (73.9)	132 (33.7)	0	0	0	12 (3.1)	0	25 (6.4)	10 (10.9)
41-50	0	8 (8.8)	22 (6.1)	3 (3.3)	0	0	165 (45.8)	64 (70.3)	122 (33.9)	0	0	0	16 (4.4)	0	35 (9.7)	16 (17.6)
51-60	0	0	11 (3.9)	0	0	0	114 (40.0)	73 (88.0)	122 (4.8)	0	0	0	3 (1.1)	0	35 (12.3)	10 (12.0)
61-70	0	0	0	0	0	0	10 (25.6)	0	0	0	0	0	27 (69.2)	20 (90.9)	2 (5.1)	2 (9.1)
71-80	0	0	0	0	0	0	0	0	0	0	0	0	6 (75.0)	13 (92.9)	2 (25.0)	1 (7.1)
>80	0	0	0	0	0	0	0	0	0	0	0	0	2 (66.7)	0	1 (33.3)	2 (100.0)
Total	13	67	148	8	52	5	551	259	497	0	2	3	66	33	140	58





about 6% of all the autopsy cases in contrast to 2.8% in another study done at the same institute 20 years back[5].The ligature strangulation was the most common method of homicide followed by throttling or manual smothering barring infanticide in which throttling or manual smothering was reported as the most common method. While in another study done in 1986, at the same place the blunt force was found as the most common method followed by stab wounds and firearms. While the Strangulation and burning was found as the least common method [5].

A known person but not a relative was the most common perpetrator, followed by a stranger. For the infanticide, the most common perpetrator was the mother of the infant. The relatives as well as strangers were mainly found as perpetrators against 1st to 3rd decade victims while known person were against 3rd to 6th decade victims. It seems that as the age increases, the perpetrator changes from mother to relative and known to strangers but again as a known person in the older age group. The same findings were concluded by Jason et al where they found that acquaintance homicides, not parental or familial, predominate at nearly all victims ages. The relationships between offenders and victims is shifted from

Table 6 : The distribution of homicide cases ast as per the attempted sexual assault injury and ano-genital injury present on the body

Age-group (in years)	Attempted Sexual Assault		Ano-genital Injury	
	Male (%)	Female (%)	Male (%)	Female (%)
0-1*	0	0	0	0
>1-10	4	14	3 (75%)	7 (50%)
11-20	9	11	3 (33%)	8 (73%)
21-30	0	22	0	15 (68%)
31-40	0	12	0	5 (4%)
41-50	0	8	0	0
51-60	0	0	0	0
61-70	0	0	0	0
71-80	0	0	0	0
>80	0	0	0	0
Total	**13**	**67**	**6 (46%)**	**35 (5%)**

parent to acquaintance with the rise of the age of the victim[6]. Similarly Abel found that as the children get older, the proportion of strangers, acquaintances, and unidentified perpetrators rise dramatically[7].

A detail study was done on homicide against children. In that study it was found that one-third of child homicides occurred within the first year of life, and two-third were within 2 years of age. Following this, the number of homicides has been decreased up to the 10-12 years, and then it was increased slightly among adolescents. The mothers were the more likely perpetrator than fathers against the children and almost always the offenders during the first week of a child's life. The most frequent weapons were the personal body parts (hands and feet) and the mode of death was the asphyxia, which have got decreased with increasing age. By the age of 16-18 years it was used in less than 2% of all child homicides. As the age of the victims got increased, the guns and knives were reported as the most common weapons[8]. In this study the infanticide was brought about most commonly by the mothers followed by the known person and strangers as the age increases. Only a few infanticide cases were caused by the family members, mainly mothers homicide-suicide pact. The smothering, throttling or strangulation were the most common methods adopted for the infanticides. However stabbing cases were seen with late teenagers.

In one study, intra familial homicide (homicide within the family) predominated against victims aged 0-3 years while extra familial homicide (homicide outside the family) predominated against victims of more than 12 years of age while a mix of these two patterns were seen between 3 and 12 years of age[9]. In the present study the intra familial homicide against the children was seen up to the age of 12 years and extra familial homicide was seen beyond that age-group.

The personal dispute, peer altercation and sexual assault were found as the common motives behind the homicide. The sexual assault was the motive mainly against 2nd decade victims and the peer altercation and personal dispute were the motives against 3rd to 6th decade victims. The motive for homicide against the elderly people was robbery/theft. A study done in Jamaican society found that the most common motive against children was dispute, drugs/gang was the motive against the adults, robbery was the motive against the victims beyond 3rd decades and rape was the motive against female children[10].

Sexual homicide is defined as murders with the associated evidences or observations sexual assault and it contains elements of power, sexuality, and brutality. It's occurrence may be indicated by signs such as removal of the victim's clothing, exposure of the victim's sexual organs, sexual positioning of the body, evidence of penile penetration of the victim's oral, vaginal, or anal orifices, placement of foreign objects into the victim's body cavities, or any other evidence to suggest sexual interest or sadistic fantasy[11]. In this study, sexual assault was the main motive of homicide in late 1st, 2nd 3rd and 4th decade victims. Most of them were females sex while it was also reported in some of the male members of 2nd decade and late 1st decade age. There were a total of 80 cases of sexual murder and out of this the ano-genital injuries were seen in half of the cases.

The relatives have peer-altercation and property dispute as the common motive for homicide while other known persons and strangers have personal dispute as the most common motive for the homicide. The strangers also have sexual assault as other motives. Most common motive of the relatives for homicide was property dispute. In a nationwide sample of Canada, the motive of homicide for strangers was robbery, followed by sexual assault while heated argument followed by anger for the acquaintances[12].

Elderly are less capable of fleeing or resisting a physical attack than a younger person[13,14] because age-related changes reduced their abilities to escape or defend themselves against

an assailant[15,16]. The same facts can explain elderly homicide in this study too. The elderly victims Compared to the young victims were killed in their own homes. Social isolation and physical weakness are significant risk factors for their homicides[17]. The perpetrators of elderly homicide were more likely found as the dependent on their victims for financial assistance[18], as in this study where the perpetrators were their victim's employee, directly or indirectly in most of the cases and were well known to them.

All the cases of homicide occurred outside home environment, except within the home for the 1st decade victims and victims of 7th decade. In a study in Australia it was found that the most homicides occur in residential premises but those involving youth often occurs on the street or other open areas [2].

The perpetrators were found as male in most of the cases while as female mainly against the children. A study done by Driver in the 70s among Indian population about criminal homicide had come up with the same findings of female murderers, that too mainly against children and involving the interaction between known persons rather than strangers[19].

CONCLUSION: In the study it was found that the age is no bar for the homicides and the cases have been reported from infant to old age persons. They constituted about 5.9% of all the autopsy cases in the study period. The maximum number of cases was seen in 4th decade age-group followed by 5th decade and the common methods of homicide were throttling, head injury in infants (cases of infanticide); ligature strangulation, stabbing and firearm injuries. All the perpetrators were of between 18-50 years of age and were males, except in cases of infanticide and homicide-suicide pact where the perpetrators were females. All the sexual offenders were of male sex and of the age-group of 18-40 years of age. The Perpetrators were mothers in all the cases of infanticide while neighbours and known persons were the most common against rest of the age-groups. The main reason/motive of homicide against infant was suicidal-homicidal pact (except infanticide), kidnapping-ransom in 1st decade victims, sexual assault followed by family revenge in 2nd decade victims, personal followed by peer-altercations were the common reason/motives against 3rd to 6th decade victims, and robbery/theft was the reason/motive of homicide in the older than the 6th decade age-group victims. The most common reason/motive relatives had for homicide was peer-altercation followed by property dispute; for neighbour/known persons and strangers as personal dispute.

REFERENCES :

1. Gupta A, Rani M, Mittal AK, Dikshit PC. A study of homicidal deaths in Delhi. Med Sci Law 2004;44(2):127-32.
2. Carlos Carcach. Youth as victims and offenders of homicide. Australian Institute of Criminology- trends & issues in crime and criminal justice 1997;73.
3. Nagpaul H. Patterns of homicide in north india: some sociological hypotheses. International Journal of Offender Therapy and Comparative Criminology 1985;29(2):147-58.
4. Driver ED. Interaction and criminal homicide in India. Social Forces 1961;40(2):153-8.
5. Dikshit PC, Togra TD, Chandra J. Comprehensive Study of Homicides in South Delhi, 1969-79. Med Sci Law 1986;26(3):230-4.
6. Jason J, Flock M, Tyler C. Epidemiologic characteristics of Primary homicide in the United States. Am J Epidemiol 1983;117 (4):419-28.
7. Abel EL. Childhood homicide in Erie County, New York. Pediatrics 1986;77(5):709-713.
8. Kaunz J, Bahr SJ. A Profile of Parental Homicide against Children. Journal of Family Violence 1996;1(4):347-362.
9. Jason J. Child homicide spectrum. American Journal of Diseases of Children 1983;137:578-581.
10. Lemard G, Hemenway D. Violence in Jamaica: an analysis of homicides 1998-2002. Injury Prevention 2006;12:15-18.
11. Ressler RK, Burgess AW, Douglas JE. Sexual Homicide. Lexington, MA: Lexington Books. 1988.
12. Langevin R. Stranger Homicide in Canada: A National Sample and a Psychiatric Sample 1987;78(2):398-429.
13. Taeuber CM, Allen J. Women in our aging society: The demographic outlook. In: Allen J, Pifer AJ (Eds). Women on the front lines: Meeting the challenge of an aging America. Washington DC: Urban Institute. 1990:pp 11-46.
14. Nelson C, Huff-Corzine L. Strangers in the night: An application of the lifestyle routine activities approach to elderly homicide victimization. Homicide Studies 1998; 2(2):130-159.
15. Safarik ME, Jarvis JP, Nussbaum KE. Sexual homicide of elderly females: Linking offender characteristics to victim and crime scene attributes. Journal of Interpersonal Violence2002;17(5):500-25.
16. Moen P. Gender, age, and the life course. In: Binstock R, George L (Eds). Handbook of aging and the social sciences. San Diego: Academic Press. 1996: pp 171-87.
17. Falzon AL, Davis GG. A 15-year retrospective review of homicide in the elderly, J Forensic Sci 1998;43:371-74.
18. Ahmed AG, Menzies RPD. Homicide in the Canadian Prairies: Elderly and nonelderly killings. Can J Psychiatry 2002;47(9):875-79.
19. Driver ED. Interaction and criminal homicide in India. Social Forces 1961;40(2):153-58.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00090.4

Original Research Paper

Sex Determination by Maxillary Sinus: A CT Scan Based Craniometric Study

1. **Kishan Dhanak,** Professor, Department of Forensic Medicine , R.N.T. Medical College, Udaipur, Rajasthan
2. **Sundeep Ingale,** PG Resident, Department of Forensic Medicine , R.N.T. Medical College, Udaipur, Rajasthan
3. **Akhilesh Pathak,** Professor & Head, Department of Forensic Medicine , AIIMS Bathinda

ABSTRACT :

Introduction : The present study was undertaken with the aim to determine the sex by evaluating dimensions of the maxillary sinuses and its use for forensic application.

Materials and Methods : In this study, 60 human skulls were examined with the help of a high-resolution 3D-CT scanner and the craniometric examination of both maxillary sinuses was done for determination of the sex of the individual. The height, width, depth and volume of both right and left maxillary sinuses found more in male than female, which were statistically significant.

Results : The mean volume of the right maxillary sinus in male was 15.79± 4.55 cc and in female was 12.65± 4.38 cc, while the mean volume of the left maxillary sinus in male was 15.68±6.21 and in females was 12.68±5.09. In our study, we observed that the skull with a volume range of 15.68±6.21 cc to 15.79±4.55 cc for right maxillary sinus was indicating the male gender, while the volume range of 12.65±4.38 cc to 12.68±5.09 cc for left maxillary sinus was indicating female gender.

Conclusions : It can be concluded that craniometric measurements of maxillary sinuses with the help of a high-resolution 3D-CT scanner can be used to determine the sex of the skull for forensic identification.

Corresponding Author:
Dr. Akhilesh Pathak,
Professor & Head,
Department of Forensic Medicine, AIIMS Bathinda
Contact : +91-9023360876
Email : dr.akhilesh_pathak@yahoo.co.in

Article History :
Received : 19 October 2019
Received in revised from : 2 March 2020
Accepted on :2 March 2020
Available online : 30 April 2021

Key words: Forensic Identification, Anthropology, Sex Determination, Maxillary Sinus, Craniometric measurements.

INTRODUCTION:

Forensic anthropology is the study of human remains to solving criminal cases and to establish the identification of the victim. The sex determination in adult skeletons is often the first step in this identification process, associated with the age and stature estimation methods.[1] Different methods can be used to sex determination[2] and the reliability of the sex determination depends on the skeletal remains and the degree of inherent sexual dimorphism in the population.[3] The studies done in the past shows that the pelvis is the most reliable bone for sex determination followed by skull.[4-7] There are many occasions when we do not receive a complete skull bone due to breakage or post-mortem destruction and in these cases, sex determination can be done by examining the parts of skull including various sinuses.[8-9] Examination of the paranasal sinuses for sex determination has been done by various methods but the recent diagnostic methods like Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) are used as a gold standard to evaluate the true anatomy of sinuses.[10-11]

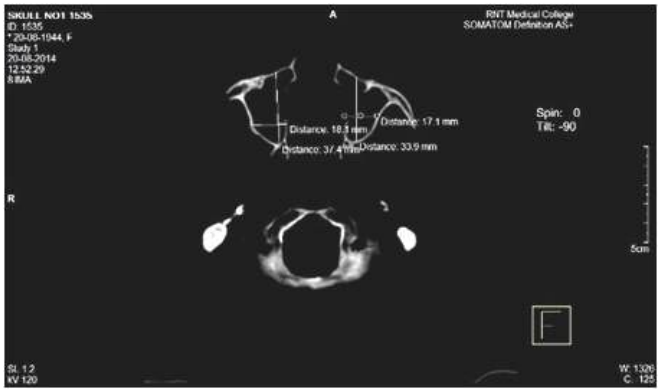
For the forensic casework, only specific focused studies on individual paranasal sinuses like frontal, maxillary, sphenoid, mastoid air cells have been conducted on living persons and skeletal remains. In the present study, the craniomatric examination of the maxillary sinuses was done with the help of a high-resolution 3D-CT scanner and the data were used to determine the sex of the individual for forensic identification.

MATERIAL & METHODS:

The present study was conducted in the department of forensic medicine, RNT Medical College, Udaipur, Rajasthan during the period of July 2014 to Nov. 2015. The ethical clearance was taken from the ethical committee of the Institute before the commencement of this study. Sixty dry human skulls were collected from the forensic medicine and anatomy departments and subjected to the high-resolution 3D-CT Scanning to evaluate the width, length, height and volume of the bilateral (right and left) maxillary sinuses. The maxillary sinus reaches their mature sizes at the age of about 20 years when permanent teeth are fully developed, and hence we have selected only those skulls, which are above 25 years on a gross anatomical basis. The length and width of maxillary sinuses were measured in the axial section **[Figure 1]** whereas, the height was measured in coronal cross-section **[Figure 2]** and the volume was calculated manually for each maxillary sinus. The procedure was carried out twice to enhance the accuracy

and to reduce the bias. The volume was calculated as the product of the three axis measurements i.e. Height (in mm) X Length (in mm) X Width (in mm) X .0001.[12] The data thus collected were tabulated in Microsoft Excel worksheet and SPSS software was used for statistical assessment. Statistical analysis was done by calculating the mean and standard deviation of both maxillary sinuses measurements, which were calculated and compared.

Figure 1: CT Scan image of the skull depicting depth and width of right & left maxillary sinuses



RESULTS :

In the present study, sixty dry human skulls were analyzed and results of comparison of different parameters of maxillary sinuses between males and females are done. The height, width, depth, and volume of the right maxillary sinus are more in male than in female skull. **(Table 1)** The p-value of height, depth and volume was significant. The mean volume of the male right maxillary sinus is 15.79± 4.55 cc and means the volume of the female right maxillary sinus is 12.65± 4.38 cc.

Table 2 shows the gender-wise distribution of various parameters of the left maxillary sinus by 3D-CT Scan. The height, depth, and volume of the left maxillary sinus are more in male than in female dry crania. The p-value of height and volume is significant. The mean volume of the left maxillary sinus in male dry crania is 15.68± 6.21 cc and in female dry crania is 12.68± 5.09.

Figure 2: CT Scan image of the skull depicting height of right & left maxillary sinuses

DISCUSSION:

The maxillary sinus reaches its mature sizes at the age of about 20 years, when permanent teeth are fully developed[13] and hence we have selected the specimens of dry skulls in this study, which are above 25 years on gross anatomical basis. The maxillary sinuses were chosen for this a study due to the fact that they are having unique features suggesting the sex and can be used for forensic identification.[14] The volumetric measurements of maxillary sinuses with the help of CT scan is a highly effective technique for sex determination because it gives a clear three-dimensional image of the sinuses,[15-16] but due to its high cost it is not available in forensic investigations in India and other developing countries.

The comparison of different parameters of right and left maxillary sinuses have been shown in Table-1&2, and almost similar findings were observed by Kanthem et al[8] in a study done in Andhra Pradesh. In our study, we observed that different parameters like height, width, depth, and volume of

Table-1: Comparison of different parameters of right maxillary sinus between male and female

Gender	Number of Skull	Height (mm)	Width (mm)	Volume (cc)	Depth (mm)
Male	33	30.59±2.78	20.95±3.29	24.54±3.01	15.79±4.55
Female	27	27.43±3.57	19.98±3.03	22.78±2.46	12.65±4.38
P value		0.004	0.241	0.017	0.009

Table-2: Comparison of different parameters of left maxillary sinus between male and female

Gender	Number of Skull	Height (mm)	Width (mm)	Volume (cc)	Depth (mm)
Male	36	30.21±4.30	22.31±5.66	23.33±4.05	15.68±6.21
Female	26	27.23±3.50	20.68±5.14	22.19±4.26	12.68±5.09
P value		0.005	0.248	0.287	0.047

both maxillary sinuses are higher in males as compared to the females. It shows that the perimeter and volume are higher in males and almost similar observations were noticed by Kanthem et al,[8] Sidhu et al[17] and Khaitan et al[18] in their studies done in various parts of India.

In the present study, the p-value of height, depth, and volume were significant for right maxillary sinus while it was significant for height and volume for left maxillary sinus, which is similar to the observations of Kanthem et al.[8] The width of maxillary sinuses were found statistically significant in the study done by Urooge and Patil[11] at Karnataka. Khaitan et al[18] has done a study in West Bengal using lateral cephalogram of maxillary sinuses to determine the gender and observed that the height of maxillary sinuses was statistically significant. In our study, we observed that the skull with a volume range of 15.68±6.21 cc to 15.79±4.55 cc for right maxillary sinus was indicating the male gender, while the volume range of 12.65±4.38 cc to 12.68±5.09 cc for left maxillary sinus was indicating female gender.

CONCLUSION: The present study shows that the measurements of various parameters of the maxillary sinuses by CT scan can be used for the sex differentiation in forensic practice, especially when the complete the skull is not available.

REFERENCES:

1. Queiroz CL, Terada ASSD, Dezem TU, Araújo LG, Galo R, Santos CO, Alves da Silva RH. Sex Determination of Adult Human Maxillary Sinuses on Panoramic Radiographs. Acta Stomatol Croat. 2016 Sep; 50(3): 215-221.
2. Staka G, Bimbashi V, Disha M, Dragidella F. Sexual Dimorphism in the Permanent Mandibular Canines: A study in Albanian Population of Kosovo. Acta Stomatol Croat. 2013;47(1):39-44.
3. Scheuer L. Application of osteology to forensic medicine. Clin Anat. 2002. Jun;15(4):297-312.
4. Bass WM. Human Osteology: A Laboratory and Field Manual. 5th edition. Missouri Archaeological Society Columbia; 2005.
5. France DL. Observation and metric analysis of sex in the skeleton. In: Reichs KJ, editor. Forensic Osteology: Advances in the Identification of Human Remains. Springfield, Ill, USA: Charles C. Thomas; 1998. pp. 163-186.
6. Pickering RB, Bachman DC. The Use of Forensic Anthropology. Boca Raton, Fla, USA: CRC Press; 1997.
7. Ubelaker DH, Volk CG. A test of the Phenice method for the estimation of sex. Journal of Forensic Sciences. 2002;47(1):19-24.
8. Kanthem RK, Guttikonda VR, Yeluri S, Kumari G. Sex determination using maxillary sinus. J Forensic Dent Sci. 2015 May-Aug; 7(2): 163-67.
9. Kiran SC, Ramaswamy P, Khaitan T. Frontal sinus index A new tool for sex determination. Journal of Forensic Radiology and Imaging. April 2014; 2(2): 77-79.
10. Saccucci M, Cipriani F, Carderi S, Di Carlo G, D'Attilio M, Rodolfino D, et al. Gender assessment through three-dimensional analysis of maxillary sinuses by means of Cone Beam Computed Tomography. Eur Rev Med Pharmacol Sci. 2015;19:185-93.
11. Urooge A, Patil BA. Sexual Dimorphism of Maxillary Sinus: A Morphometric Analysis using Cone Beam Computed Tomography. J Clin Diagn Res. 2017 Mar; 11(3): ZC67-ZC70.
12. Ariji Y, Ariji E, Yoshiura K, Kanda S. Computed tomographic indices for maxillary sinus size in comparison with the sinus volume. Dentomaxillofac. Radiol 1996;25(1):19-24.
13. Ikeda A, Ikeda M, Komatsuzaki A. A study of the distribution pattern and correlation between Maxillary, Frontal and Sphenoid sinus volume.PracticaOto-Rhino-Laryngologica. 1997; 90(11): 1235-9.
14. Kinsui MM, Guilherme A, Yamashita HK. Variações anatômicas e sinusopatias: estudo por tomografia computadorizada. Rev Bras Otorrinolaringol. 2002;68:645-52.
15. Cameriere R, Ferrante L, Mirtella D, Rollo FU, Cingolani M. Frontal sinuses for identification: quality of classifications, possible error and potential corrections. J Forensic Sci. 2005. Jul;50(4):770-3.
16. Reichs KJ. Quantified comparison of frontal sinus patterns by means of computed tomography.Forensic Sci Int. 1993. Oct;61(2-3):141-68.
17. Sidhu R, Chandra S, Devi P, Taneja N, Sah K, Kaur N. Forensic importance of maxillary sinus in gender determination: A morphometric analysis from Western Uttar Pradesh, India. 2014;3(1):53-56.
18. Khaitan T, Kabiraj A, Ginjupally U, Jain R. Cephalometric Analysis for Gender Determination Using Maxillary Sinus Index: A Novel Dimension in Personal Identification. International Journal of Dentistry. 2017;1:1-4.
19. Uthman AT, Al-Rawi NH, Al-Naaimi AS, Al-Timimi JF. Evaluation of Maxillary Sinus Dimensions in Gender Determination Using Helical CT Scanning. March 2011; 56(2):403-408.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00091.6

Original Research Paper

A Two Years Study of Various Factors Affecting the Age of Abrasion

1. **Guriqbal Singh,** Assistant Professor, Department of Forensic Medicine, Punjab Institute of Medical Sciences, Jalandhar

ABSTRACT :

Introduction : Determination of age of injuries is one of the most important aspect of clinical forensic medicine. Vital reaction i.e. redness, oedema and swelling of the edges of the wound help in age determination of abrasion. Medico-legally Abrasions are simple, superficial, lie at point of impact of blunt force, may be dangerous when involving vital organs, commonly accidental, But may be self inflicted. Imprint or patterned abrasion on the body tells of the weapon used.

Materials and Methods : Present 2 years clinical study of abrasion was conducted on 206 cases at emergency wing of Guru Nanak Dev Hospital and Sri Guru Teg Bahadur Hospital, Amritsar on cases which had no previous treatment and were having abrasion / abrasions on the body.

Results : Maximum case were 31-40 years and males with injury on immobile part.

Conclusion : No Difference was observed in the healing of abrasion on covered/uncovered part. Abrasion on mobile part took nine days to heal where as abrasion on immobile part took seven days.

Corresponding Author :
Dr. Guriqbal Singh,
Assistant Professor,
Department of Forensic Medicine, Punjab Institute of Medical Sciences, Jalandhar
Contact : +91 9915044296
Email : guriqbalsingh110000@gmail.com

Article History:
Received: 11 July 2019
Received in revised form: 11 August 2019
Accepted on: 11 March 2021
Available online: 30 April 2021

KEYWORDS : Abrasion, Covered Part, Mobile/immobile, Healing

INTRODUCTION :

Determination of age of injuries is one of the most important aspect of clinical forensic medicine. Vital reaction i.e. redness, oedema and swelling of the edges of the wound help in age determination of abrasion. Medico-legally Abrasions are simple, superficial, lie at point of impact of blunt force, may be dangerous when involving vital organs, commonly accidental, But may be self inflicted. Imprint or patterned abrasion on the body tells of the weapon used. linear or graze abrasion can tell the direction of application of force and the relative position of the victim and the assailant. Presence of mud, grit, coal dust, cement, sand, lime dust, pebbles or any vegetation etc. in and around abraded area will suggest the nature of surface or agent responsible for its causation.

Abrasions on private parts or over the breasts of a woman may be indicative of sex offence. Nail scratches on the neck of a dead body may be indicative of manual strangulation or throttling and scratches around the mouth and nose of a dead body may be indicative of killing by smothering.

Multiple brush or grazing abrasion over different parts of the body associated with lacerations, contusions fractures and rupture of internal organs usually suggest death due to automobile, rail or other accidents. Extensive brush burn abrasion over the back suggest dragging of the body over a hard and rough ground surface. Abrasion over the glans penis and prepuce usually indicate forcible intercourse through narrow vaginal introitus or sodomy or penetration of penis in narrow opening. Abrasion in or around the anus may be due to sodomy in a passive agent. Mark of ligature around the neck in the form of friction abrasion will indicate death due to hanging or strangulation. Teeth mark abrasion over exposed body parts of the assailant indicate that these might have been inflicted by the victim during struggle in self defense.

Abrasions may be produced on the vulnerable sites of the dead body during shifting of the body to the mortuary. These postmortem abrasion may be mistake for antemortem abrasion. Fabricated abrasions may be produced over accessible parts of the body to bring a false charge of assault or some other extraneous motive. The circumstances are self explanatory in such case and _ careful examination will solve the problem. [1-4]

A rough idea about their age can be gathered from the microscopic and naked eye Changes and same has been tried in present study.

MATERIAL AND METHOD :

Present 2 years clinical study of abrasion was conducted on 206 cases at emergency wing of Guru Nanak Dev Hospital and Sri Guru Teg Bahadur Hospital, Amritsar on cases which had

no previous treatment and were having abrasion / abrasions on the body. Time of infliction of injuries was recorded as alleged by the victim, attendants and corroborated by the statements recorded by the investigating police officer. Time of first examination was recorded and findings of abrasion / abrasions on the person were noted on subsequent examinations of each case after 12 hrs, 24 hrs, 48 hrs, 3 days, 4 days, 5 days, 6 days, 7 days, 7-10 days and 14th days.

Abrasion over mobile/immobile parts and covered and uncovered areas of bodies were studied. For mobile parts abrasions over elbow, wrist knee and ankle joints were taken. By covered abrasions we mean those abrasions which were present under the clothing. Equal distribution of abrasion over covered and uncovered areas of the body were observed.

RESULTS :

Table 1 : Age wise distribution of cases

S. No.	Age Group in Years	No. of Cases	%age
1.	0-10	1	0.48
2.	11-20	42	20.38
3.	21-30	57	27.66
4.	31-40	55	26.69
5.	41-50	18	8.73
6.	Above 50	33	16.01
	Total	**206**	**99.95**

Table 2 : Sex wise distribution of cases

S. No.	Male	Female	%age of male	%age of female
1.	191	15	92.71	7.29

Table 3 : Site of Abrasion

S. No.	Site of Abrasion	No. of Cases	%age
1.	Mobile Part	18	8.73
2.	immobile part	188	91.27
3.	**Total Cases**	**206**	**100**

Table 4 : Position of Abrasion

S. No.	Position	No. of Cases	%age
1.	Covered	103	50
2.	Uncovered	103	50
3.	**Total Cases**	**206**	**100**

In this study as depicted in table no. 5 out of 107 cases which reported at 12hrs interval 106 cases showed red abrasion and 1 case had red scab.

After 24hrs, 179 cases were seen of which 123 had red scab and 56 had reddish brown scab.

By 48hrs, 201 cases were seen of which 4 had red scab where as 191 showed reddish brown scab and the scab in 6 cases had turned brown in colour.

After 3 days out of 202 cases seen 144 had reddish brown scab and the scab had turned brown completely in 54 cases. In four cases the scab showed shedding from the periphery.

At interval of 4 days out of 205 cases the scab was reddish brown in 66 cases and brown in 64 cases. Two cases showed spongy scab due to oozing of blood beneath the scab. The scab showed shedding from the periphery in 73 cases,

After 5 days out of 205 cases seen 3 had reddish brown scab 7 had brown scab whereas 2 cases showed spongy scab. In 192 cases the scab was shedding from the periphery where as in one case the scab had totally shed off. After 6 days out of 205 cases, 2 cases showed Spongy scab whereas 185 cases showed shedding of scab from periphery. In 17 cases the scab had shed off on 6'" day whereas in 1 case the healing was complete.

At 7 days of 206 cases seen 56 showed shedding of scab, 130 showed complete shed off of scab and in 20 cases the healing was complete.

After 7 to 10 days out of the 206 cases seen one case showed spongy scab and in 7 cases the scab was shedding. In 36 cases the scab had completely shed off on 8" day, in 11 cases on 9t* day and in 4 cases on 10'" day. 147 cases showed complete

Table 5 : Various changes of healing of Abrasion at different time intervals

Time interval	Red abrasion	Red scab	Reddish brown scab	Brown scab	Scab Shedding	Spongy scab	Scab Shed off										Healing complete	Normal Skin
							5th day	6th day	7th day	8th day	9th day	10th day	11th day	12th day	13th day	14th day		
12 hrs	106	1																
24 hrs		123	56															
48 hrs		4	191	6														
3 days			144	54	4													
4 days			66	64	73	2												
5 days			3	7	192	2	1											
6 days					185	2		17									1	
7 days					56				130								20	
8-10 days					7	1				36	11	4					147	
14th day													6	2		1	22	175

healing.

At 14'" day of the 206 cases, 6 cases showed complete shed off on 11'° day. 2 cases showed complete shed off on 12' day and one case showed complete shed off on 14' day. 22 cases showed complete healing and 175 developed normal skin.

Medicolegal examination is delayed due to several reasons in some cases. As per the Study, of the 206 Studied, 107 reported at 12 hrs interval. 72 cases reported for medicolegal examination after 24hrs of injury. 22 cases were first seen after 48hrs of injury.

One case was seen after 3 days of injury and 3 more cases reported for medicolegal examination for the first time at 4 days. There was a single case which reported as late as 6 days for medicolegal examination.

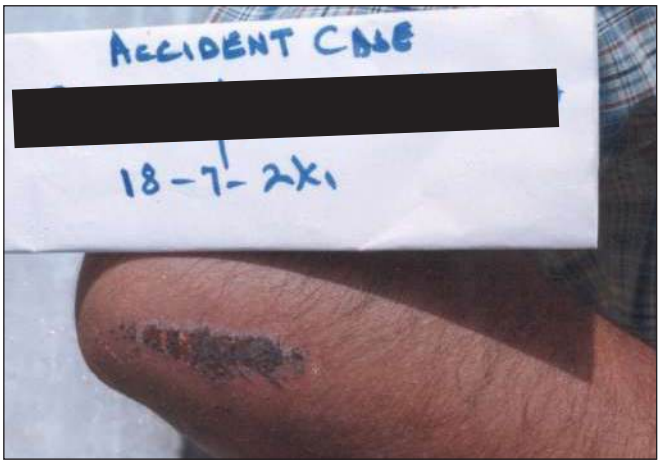


Figure 3 : Dark brown scab on 4th day of injury

Figure 1 : Reddish brown scab on 2nd day

Figure 4 : Partial Shedding of scab from periphery on 6th day.

Figure 2 : Reddish brown scab on 3rd day.

Figure 5 : Complete Shedding of scab with de-pigmented area on 9th day of injury

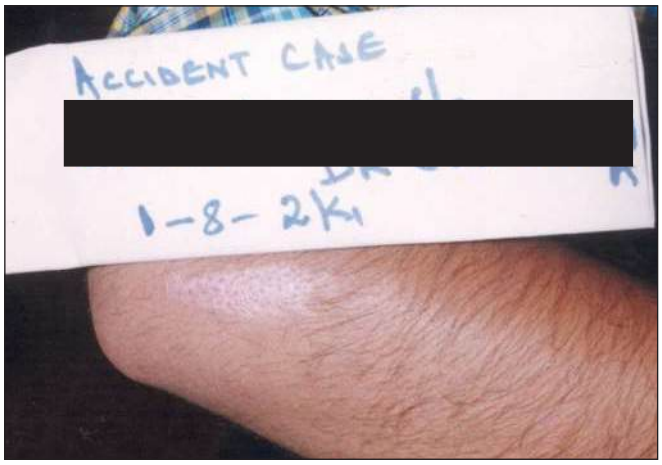


Figure 6 : Normal pigmentation on 17th day

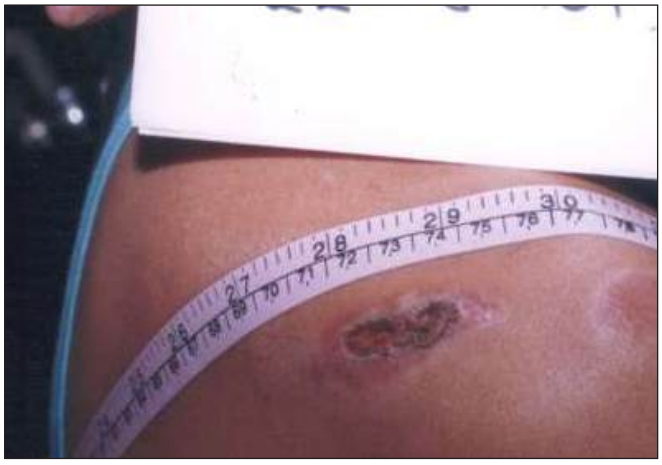


Figure 7 : Delayed healing due to repeated trauma of rubbing against hard surface.

DISCUSSION :

In this study majority of cases were between the age group of 21-40yrs (54.35%) as per **table no. 1**. This could be because this is the age group in which a person is entrusted with full responsibilities of family and beaming with energy. His nature is quite volatile and likely to clash with the people who surround him. Between 41-50 age group the number of cases fell to 8.73% and this is perhaps because his responsibilities either shared or taken of by his children and he is allowed to rest. Above 50yrs the number of cases again increased to 16.01% and this could be that this being the period of retirement from household responsibilities they are used as tools for settling personnel scores by younger members of the family.

In sex wise distribution of cases as per **Table No. 2**, we find that predominantly males (92.71%) come for medico legal examination. This is quite clear from the fact that males are involved in out door activities and Supposed to be the head of family are responsible for livelihood of the family in most of the cases.

As far as site of abrasion is concerned as per **table no. 3**, most of abrasions were on immobile parts 91.27%. This could be because of the fact that immobile parts form the maximum area of body and hence more likely to be hit during a scuffle.

As regards position of abrasion viz. over covered and uncovered areas, the incidence is almost the same as depicted in **table no. 4**.

According to Subrmanayam (1999) fresh abrasions appear as bleeding surfaces or scratches and are covered within a day or two with Reddish brown crust or scab. They generally heal in about 4 to 7 days.[4]

According to Parikh (2000)[5], Reddy (1999)[6] & Nandy (1998)[7] a fresh abrasion is bright red in color. In this study as shown in **(table no. 5)**, have seen that of the 107 cases which reported at 12hrs interval 106 cases (99.06%) presented with red abrasion. This finding is concurrent with above said authors.

As per Nandy (1998) by 8 to 24 hrs reddish scab is formed. But Parikh (2000) & Reddy (1999) described that by 12-24hrs a scab is formed which is red in color. In my study there is no case which presented with reddish scab in 8 to 12hrs period. By 24 hrs 179 cases were studied out of which 123 presented with red scab and 56 cases presented with reddish brown scab. This finding is different from the above authors who have not described about reddish brown scab in 12-24hrs, but my findings match with what Subramanayam (1999) says when he states that abrasions get covered within a day or two with reddish brown scab.

According to Nandy (1998) by second and third day the scab turns brownish in color. Parikh (2000), Reddy (1998) and Vij (2001)[8] mention that by 2 to 3 days the scab turns reddish brown in color whereas Subramanayam (1999) describes that within a day or two the abrasion gets covered with reddish brown scab. But in my study at 48hrs out of 201 cases studied 4 cases showed red scab, 191 had reddish brown scab and six cases had brown scab. So we see that the cases which presented with red scab are not in line with the above said authors had described. 95% of the cases studied by me at 48hrs fall in line with the views of the authors whereas six cases which presented with brown scab tally with findings of Nandy (1998).

At 3 days of 202 cases studied 144 showed reddish brown scab 54 had brown scab and in 4 cases the scab had started shedding from the periphery. So we see that the cases that showed

reddish brown scab are according to the findings mentioned by Parikh (2000), Reddy (1998) and Vij (2001) whereas the cases which showed brown scab tally with the findings of Nandy. But 4 cases which showed shedding of scab from the periphery are not in line with findings of the above said authors.

Parikh (2000) & Subramanayam (1999) mention that by 4 to 7 days the abrasion heals from the periphery by new growth of epithelium by which time the scab falls off. Reddy (1998) mention that by 4 to 7 days epithelium grows and covers the defect under the scab. Nandy (1999) and Vij (2001) have given a detailed day wise changes in the healing process during this period of 4 to7 days. According to Nandy (1999) by 4" and 5'" day the scab turns dark brown and by 6'" day it turns blackish and starts falling off from the margins Vij (2001) also agrees with Nandy (1999) when he says that by 4 to 5 days the scab turns dark brown and by 5 to 7 days it turns brownish black and starts separating from the margin.

In this study at 4 days of the 205 cases studied 66 showed reddish brown scab 64 had brown scab, 2 cases showed spongy scab and in 73 cases the scab had started shedding from the margins. So we see that reddish brown cases have not been described by any of the above authors during this period. But we see that maximum no. of cases fall under the category of the scab shedding off from the margins.

At 5 days as per my study out of 205 cases 3 showed reddish brown scab 7 had brown scab 2 had spongy scab 192 cases showed shedding of scab and in one case the scab had completely shed off at 5 days. Here we see that the three cases which presented reddish brown scab are totally out of line of the findings of the authors. The majority of the cases 95% cases showed shedding of scab from the margin. This is different from what Vij (2001) and Nandy (1999) described in their day to day findings of 4 to 7 days time period. But this finding matches that of Parikh (2000) and Subramanayam (1999) who describe that scab falls off during the period of 4 to7 days. Reddy (1998) has not elaborated the period of 40 to 7 days and has only mentioned that epithelium grows and covers the defect under the scab during this period.

At 6 days of the 205 cases studied 2 showed spongy scab, 185 had scab shedding from the margin in 17 cases the scab had completely shed off whereas in 1 case the healing had completed.

At 7 days of the 206 cases studied 56 showed shedding of scab and 130 cases presented with the scab shed off completely by 7°'" day. 20 cases presented with complete healing. Now we see that at 7 days according to my study in 63% cases the scab had shed off. So by and large this is in line with what Parikh (2000) and Subramanayam (1999) describe. But Reddy (1998) and Vij (2001) that the period of shedding of scab is 7 to 10 days.

At 7 to 10 days of the 206 cases studied one showed spongy scab 7 showed shedding of scab from margins, 36 cases showed scab shed off on 8'" day in 11 cases the scab shed off on 9'" day in 4 cases the scab shed off on 10'" day. In 147 cases the healing was found complete. So we see that though there are cases in which the scab had shed off during the period of 7-10 days (24.76%) but in my study the maximum no. of cases showed shed off scab by 7'" day. By 14'" day of 206 cases studied in 6 cases the scab shed off on 11" day, in 2 cases on 12'" day and in one case on 14th day. 22 cases presented with complete healing and 175 cases (85%) presented with normal skin.

The study has concentrated on factors affecting healing of abrasion and whether the abrasion is covered by clothing or not. I have concentrated on the above specific factors which modify the process of healing and which have not been taken into account by various authors who have described the process of healing of abrasions in their books. Various authors who have described the process of healing of abrasion in various books have unanimity of opinion about healing of abrasion upto a particular stage. They agree that fresh abrasion is bright red. By 12-24 hrs a reddish scab is formed, which turns to reddish brown by 2-3 days. By 4-5 days the scab turns dark brown and obtaining a blackish tinge by 6'" day. Beyond this there is variation in time period of sheeding of-scab by various authors. According to Reddy (1999, Nandy Vij) the scab dries or shrinks and fall off after 7 days. As per Nandy (1999 Modi Parrikh) the scab is dark brown by 4^{th} to 5^{th} day and by 6^{th} it becomes blackish and starts falling off from the margins.

Vij (2001) has described that by 4 to 5 days the scab is dark brown in appearance and by 5 to 7 days the scab is brownish black in appearance and starts separating from the margins. By 7 to 10 days the scab shrinks and falls off. But according to Parikh (Year) the abrasion heals from the periphery by new growth of epithelium in 4 to 7 days by which time the scab falls off. Robertson and Hodge, (1972) studied the histopathology of healing of abrasions. They found that scab is well formed at 48 hrs. Completely epithelial covering of small abrasions occurs in 4 to 5 days. No specified time for shedding of scrab is mentioned. Till date their observations have formed the basis of healing of abrasion for the forensic scientist for finding age and hence deciding the time of crime or event. But my study the various time changes given by the above authors for healing of abrasions cannot be the basis of deciding the age of abrasions because The factors mentioned should be taken into consideration for deciding the age of abrasion and there should be no fixed universal criteria for this.

The study shows that a linear abrasion heals faster as compare

to the broad surface abrasion. Out of 68 cases of linear abrasions studied (table no. 4) it took an average of about 6 % days for healing. Here too some linear abrasions took only 5 days to heal where as some healed after more than 10 days. This variation too was because of size and site of abrasion. Small size linear abrasion on vascular parts of body healed faster.

Similarly out of 138 cases of broad surface abrasion (Table No. 4) it took an average of about 7 days for healing. Here too some of the abrasions healed as early as 6 days and some took more than 10 days to heal. This variation was effected by size and site of abrasion.

I found that abrasions over mobile parts of the body took longer time to heal. Of the 18 cases of mobile abrasions (Table No. 5) it took an average of about 9 days for healing, whereas out of 189 cases of immobile abrasions (Table No. 5) studied, it took an average of about 7 days for healing.

The abrasions present under covered parts of body are likely to be subjected to repeated trauma which should lead to earlier shedding of scab giving a false appearance of early healing and hence misleading the forensic expert. But in my study of equal number of cases of covered/uncovered abrasions (Table No. 6) | could not find any substantial difference in their period of healing.

So it is seen that this study is an improvement upon what was known about healing of abrasions so far as depicted by various authors in their books. It enlightens a forensic expert to be more specific in calculating the age of abrasion and hence time of occurrence of crime/event. It also explains the variation in time period of healing by various authors in their books. This discrepancy was quite confusing for a forensic expert so far, but it should now be understood in the right prospective.

SUMMARY AND CONCLUSION :

In this study, 206 cases were examined in the emergency ward of Guru Nanak Dev and SGTB Hospital, Amritsar. All the cases were followed up. A data was prepared, studied and analyzed. Summary and Conclusion of this study is as follows:-

1. Majority (54.35%) of cases studied were between the age group of 21-40 yrs.
2. Predominantly (92.71%) males came for medico legal examination. This was far more than the females (7.29%) who reported for medicolegal examination.
3. As far as residential status of persons who reported for medicolegal examination the distribution of cases from rural and urban areas was the same (i.e. 50%).
4. Broad surface abrasion (67%) are almost the double of linear abrasion (33%) which came for medicolegal examination.
5. Most 91.27% of the abrasions were on immobile parts whereas 8.73% of abrasions were on mobile parts.
6. Out of 206 cases studied there was an equal number of abrasions which were covered by the clothing's and those which were not covered by the clothing (i.e.50%).
7. As far as healing of abrasion is concerned out of 206 cases under study in (63%) cases shedding of scab was observed by 7'" day and in (25%) cases between 7-10 days. In rest (12%) of the cases shedding of scab was observed between 10-14 days.
8. Linear abrasion heals faster as compared to broad surface abrasion. Usually a liner abrasion takes about 6 % days to heal whereas broad surface abrasion usually takes about 7 days to heal.
9. Abrasion over mobile parts took longer time to heal as compared to abrasion over immobile parts. Abrasion on mobile parts took 9 days to heal whereas abrasion over immobile parts healed in 7 days.
10. No difference was observed in the healing period of abrasions which were covered / uncovered by clothings.
11. This study involves the importance of various factors which modify the process of healing and which should be taken into account for deciding the age of abrasion. It also explains the discrepancy in healing period of abrasion by various authors.

REFRENCES :

1. Kanan K. Modi A Text Book of Medical Jurisprudence and Toxicology, 25 Edition, Lexis Nexis.
2. Gordon I, Shapiro H.A. Forensic Medicine A guide to Principles.
3. Lyon Medical Jurisprudence and toxicology, 11th Edition.
4. Subrahmanyam BV. Medical Jurisprudence and Toxicology, 22" Edition, Butterworth India, New Delhi, 1999, pp. 337,338
5. Subrahmanyam BV. Parikh's Text book of Medical Jurisprudence, forensic medicine and Toxicology. 8th Edition.
6. Reddy K.S.N. Essentials of Forensic Medicine and Toxicology, Published by K. Suguna Devi, Hyderabad, 18" Edition, 1999, pp. 145-148.
7. Nandy A. Principles of Forensic Medicine, New Central Book Agency Pvt. Ltd. 1998, pp. 212-214.
8. Vij K. A Text Book of Forensic Medicine, B.1. Churchill Livingstone, New Delhi, 2001, pp. 433-437.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00092.8

Original Research Paper

Pattern of Pediatric Poisoning at a Tertiary Health Care Hospital in South India: A Perspective of Clinical Forensic Medicine Unit

1. **Vikram Palimar,** Professor, Department of Forensic Medicine*
2. **Chandni Gupta,** Additional Professor, Department of Anatomy*
3. **Swadha Arora,** Undergraduate MBBS Student*
4. **Hussain Vohra,** Undergraduate MBBS Student*

*Kasturba Medical College, Manipal, Manipal Academy of Higher Education, Manipal, India, 576104

ABSTRACT :

Introducion: Poisoning is the cause of substantial morbidity and mortality globally. Acute poisoning in children is an important pediatric emergency. It accounts for 0.33% to 7.6% of total admissions in pediatric wards at different hospitals across India. Most of the cases of poisoning in children are accidental and they are preventable. The profile and consequence of poisoned patients differ from place to place. So, the aim of this study was to study the profile and outcome of poisoning in Pediatric age group in tertiary care hospital in south India.

Materials and Methods: We retrospectively reviewed the last 1 year (August 2016-August 2017) cases of pediatric poisoning. We looked into the profile of all cases and noted their outcome. Later all the results were calculated using regular statistics methods.

Results: Most common age group involved was 1-5 year (38.82%). Most poisoning cases were seen in boys (56.47%). Poisoning was seen most commonly in rural children (70.58%) and mostly at home (49.41%). In 22.35% of cases 2-4 hours was the time interval between exposure and admission to Hospital. Most common poisoning seen was by snake bite in 27.05% of cases.

Conclusion: From our study it was clear that the leading causes of poisoning was snake bite and children under the age of <5 years are most vulnerable. Following measures may help in reduction of Pediatric poisoning: educating the parents, storage of poisonous substances at a safe place and their proper disposal, providing basic health education to children.

Corresponding Author :
Dr. Chandni Gupta,
Additional Professor, Department of Anatomy,
Kasturba Medical College, Manipal, Manipal Academy of Higher Education, Manipal, India, 576104
Contact : +91 98867-385555
Email : chandnipalimar@gmail.com

Article History:
Received: 19 May 2020
Received in revised form: 24 May 2020
Accepted on: 24 May 2020
Available online: 30 April 2021

KEYWORDS : Child, Snake bites, Tertiary care centers, Parents, Health education,

INTRODUCTION :

Poisoning is a chief emergency and it is a main problem in all age groups all over the world. The cause of poisoning and type of poisoning may differ in various portions of the world and it also differs inside the country because it all depend on various factors like patients education, their demographic location, their socioeconomic status, customs and local belief of the people.[1] Death and injury in children due to poisoning can be prevented. It is the fourth primary reason of accidental damage subsequent to road traffic accident, burns and drowning.[2] Annually there are nearly 2 million children below 6 years who get admitted to emergency department due to poisoning.[3] Pattern of Poisoning depends on many factors and it differs according to age of the child, the nature of poison and its amount which is ingested and how it is taken.[4] At home when parents and guardians are not attentive to their child during that time most cases of poisoning are seen. Agents which are most commonly involved in poisoning are over-the-counter (OTC) drugs, tablets which are prescribed, household stuffs, insecticides, kerosene, venomous plants and animal or insect bites.[5] Most frequently 1-2 year age of children get admitted to emergency departments when they consume medications and this is the reason why 68% of visits among young children are medication-related.[6] About 9 out of 10 poisoning happens at home in children.[7] Most commonly poisoning in children are accidental as compared to adults and they can be prevented by some simple and quick interventions. Poisoning are most commonly intentional in grown-up children and adolescents and are mostly due to stress.[8] Deadly consequences can happen if there is improper storage of toxic materials and there is inadequate supervision of children by the parent or guardians at home.[9] So, the aim of this study was to study the profile and pattern of poisoning in Pediatric age group in tertiary care hospital in south India so that it can be prevented by doing early and proper interventions.

MATERIALAND METHODS :

Present retrospective study conducted on 85 cases of pediatric poisoning admitted during August 2016 to August 2017. Data was collected from the accident register maintained by clinical forensic medicine unit in pediatric ICU. Age, sex, patients residential area, place, route of ingestion, time interval between exposure and admission to Hospital and type of poison ingested were noted. Age group was divided into 4 categories 1-5 yrs, 6-10 yrs, 11-14 yrs and 15-18 yrs.

RESULTS :

Most poisoning cases were seen in boys (56.47%) than girls (43.52%). Poisoning was seen most commonly in rural children (70.58%) than urban (29.41%). The most common time interval between exposure to poison and admission to hospital was 2-4hrs.

Poisoning in various age group, place of poisoning, route how the poison was consumed by children and various types of poison consumed by children is shown in **Table 1**.

Table 1. Showing consumption of poison in various age groups, place of consumption, route of consumption and type of poison consumed.

PARAMETERS	PRESENT STUDY
AGE	
• **1-5 year**	38.82
• **6-10 year**	9.41
• **11-14 year**	16.47
• **15-18 year**	35.29
PLACE	
• **Home**	49.41
• **Outside**	20
• **Unknown**	30.58
ROUTE	
• **Oral**	65.58
• **Snake bite**	28.23
• **Unknown**	5.88
Type of POISON	
• **Chemicals**	24.7
• **Snake bite**	27.05
• **Household products**	17.6
• **Tablet overdose**	10.58
• **Unknown**	20.07

DISCUSSION :

Poisoning is defined as a damage that happens when somebody is exposed to an exogenous material which can lead to cellular damage or death.[10] Poisoning can occur in any way either by inhalation, swallowing, injection or by absorption. The exposure to poisoning can either be acute or chronic and the clinical presentation will differ according to it.[9]

Soren C and Paike K have studied total 203 cases. They found that (81%) were between 1 to 6 years of age but in our study it was 38.82% and it was the most common age group involved. In their study males outnumbered females (57.63%) which was also seen in our study (56.47%). Cases in their study were mostly from rural areas (68.96%) in our study also it was mainly rural population (70.58%). In their study the place of poisoning was home in 84.23% cases and outside the home in 15.76% cases in our study also most common place of poisoning was home in 49.41% of cases and outside the house was 20% of cases. The routes of exposure in their study were oral in 97.54% cases and 2.46% cases were exposed through inhalation in our study also 65.58% were oral and 28.23% were because of Snake bite. The time interval between exposure to poison and admission to hospital was less than 3 hours in 35.96% cases. In ours most common time interval between exposure to poison and admission to hospital was 2-4hrs. In their study most common product involved was Household products (50.24%), drugs (28.07%), and pesticides and rodenticides (13.30%) but in our study most common product involved was snake bite (27.05%) followed by chemicals (pesticides and rodenticides) (24.7%) then household products (17.6%) and then tablets overdose (10.58%).[9]

Kohli U et al studied 111 children. They also found that (63.9%) of children were in the 1-3 yr age group. In our study it was 38.82% in the age group of 1-5 yrs. In their study also male's outnumbered females (67.56%) in our study also male's outnumbered females (56.47%). Median time of presentation to the pediatric emergency for their patients was 1hr while in our study most common time interval between exposure to poison and admission to hospital was 2-4hrs. Majority of their patients were residing in urban areas (77.4%) but in our study most of the patients were from rural areas (70.58%). In their study Kerosene (27.9%), drugs (19.8%) and insecticides (11.7%) were the agents most frequently implicated while in our study most common product involved was snake bite (27.05%) followed by chemicals (pesticides and rodenticides) (24.7%) then household products (17.6%) and then tablets overdose (10.58%).[11]

Devaranavadagi RA et al studied 38 poisoning cases admitted to Pediatric intensive care unit. They found that out of 42% are males but in our study male's outnumbered females (56.47%).

In their study 34% cases are <5years of age which was similar to our study <5yrs are 38.82%, 5% cases are between 5-10 year and in our study they are 9.41% and in their study 61% cases are above 10 years in our study they are 51.76%. Among all, 34% cases of drugs consumption in our study drug consumption was seen in 10.58% of cases. They found 49% of poisoning were due to household products in our study 17.6% were due to household products. 22% cases were because of chemicals poisoning which was similar to our study 24.7% of cases. In their study the time interval between exposure to poison and admission to hospital was between 1-4 hrs in 47.3% of cases.[12] In our study also most common time interval between exposure to poison and admission to hospital was 2-4hrs.

Ram P et al studied the medical records of 81 children aged below 15 years. They found that 50.6% were boys and 49.4% girls which was similar to our study boys (56.47%) and girls (43.52%). In their study the maximum number of cases were observed below 5 years age group (55.55%). In our study it was 38.82% but it was the most common age group involved. Kerosene (28.4%) and organophosphate compounds (19.8%) were the most common agents responsible for poisoning in children. In our study most common product involved was snake bite (27.05%) followed by chemicals (pesticides and rodenticides) (24.7%) then household products (17.6%) and then tablets overdose (10.58%).The majority of the poisoning cases were reported to the hospital within 12 hours of the incident (83.3%).[13] In ours most common time interval between exposure to poison and admission to hospital was 2-4hrs.

Qazi M, Saqib N studied 227 children who were admitted to pediatric ICU due to poisoning. They found that 54.63% were males which was similar to our study (56.47%). Most of them arrived to the hospital in less than 2 h (42.29%) In our study also most common time interval between exposure to poison and admission to hospital was 2-4hrs. In their study majority of the patients 50.66% were in 13-18 years age group but in our study most common age group involved was 1-5yrs 38.82%. Organophosphorus poisoning was the commonest poisoning seen in 57.30% patients followed by snake bite 55.77%, insect bite 32.69%, Phenol 77.78%, kerosene 12.36% and rat poison 11.23%. Alcohol problem occurred in 24.32% cases. In our study most common product involved was snake bite (27.05%) followed by chemicals (pesticides and rodenticides) (24.7%) then household products (17.6%) and then tablets overdose (10.58%). Route of poisoning was ingestion in 76.21% cases followed by bites 23.35% and inhalation in 0.44% cases which was similar to our study 65.58% were oral and 28.23% were because of Snake bite.[14]

Reddy AB et al studies 98 cases which were admitted due to acute poisoning. In their study 53.1% were males and 46.9% were females which was similar to our study males 56.47% and females 43.52%. In their study the majority of the poisoning were found to be common in the age group of 0-5 years 70.4% but in our study it was 38.82% and it was the most common age group involved. In their study kerosene 40.8% was the most common poisoning agent, followed by household compounds 22.4% pesticides 14.2%, corrosives 12.2%, and drugs 10.2%.[15] In our study most common product involved was snake bite 27.05% followed by chemicals (pesticides and rodenticides) 24.7% then household products 17.6% and then tablets overdose 10.58%.

Kariyappa M et al studied 332 cases who were admitted due to poisoning. In their study house hold Products topped the list with 34% cases, followed by agricultural products 27%, animal bites and stings 21%, drugs 14% and industrial compounds 2%.[16] In our study most common product involved was snake bite 27.05% followed by chemicals (pesticides and rodenticides) 24.7% then household products 17.6% and then tablets overdose 10.58%.

Dayasiri MBKC et al studied 1621 children with acute poisoning. In their study the majority were in preschool age group but in our study most common age group involved was 1-5yrs 38.82%. Household chemicals were accountable for 30.2% of acute poisonings cases but in our study it was 17.6% of cases. Most events occurred within their own domestic premises.[17] In our study also most common place of poisoning was home in 49.41% of cases.

Bandyopadhyay A and Mandal PK studied 75 patients who presented with acute poisoning. They found majority of the children were between 12 to 18 years 60% but in our study most common age group involved was 1-5yrs 38.82%. In their study male and female were almost equal while in our study male outnumbered female 56.47%. In their study most of the patients were residents of urban areas while in our study also it was mainly rural population (70.58%). Most frequent agents were drugs (44%), hydrocarbon (21.33%) and insecticides (22.66%).[18] In our study most common product involved was snake bite 27.05% followed by chemicals (pesticides and rodenticides) 24.7% then household products 17.6% and then tablets overdose 10.58%.

Abhulimhen-Iyoha BI and Israel-Aina YT studied 55 patients who were admitted for accidental poisoning. In their study 70.9% were males while 29.1% were females. In our study males were 56.47% and females were 43.52% In their study the median and modal age at presentation was two years in our study also most common age group involved was 1-5yrs 38.82%. Route of poisoning was by ingestion in 98.2%

patients in our study also 65.58% were oral. The commonest agent of poisoning in their study was kerosene 32.7% followed by medicines 18.2%, insecticides 16.4% and caustic soda (12.7%).[19] In our study most common product involved was snake bite 27.05% followed by chemicals (pesticides and rodenticides) 24.7% then household products 17.6% and then tablets overdose 10.58%.

Roy MP et al studied 195 cases of acute poisoning among children in a tertiary hospital. They found 63% of them were males in our study also 56.47% were males. In their study 75% were below five years of age. In our study also most common age group involved was 1-5yrs 38.82%. In their study poisoning by medicines was most common 17% followed by ingestion of corrosives/detergents 16% and kerosene 14%.[20] In our study most common product involved was snake bite 27.05% followed by chemicals (pesticides and rodenticides) 24.7% then household products 17.6% and then tablets overdose 10.58%.

Edelu BO et al studied 65 cases of childhood poisoning. They found the mean age was 22.15 ± 11.7 months. In our study also most common age group involved was 1-5yrs 38.82%. In their study male outnumbered females 75%. In our study also males outnumbered females 56.47%. Kerosene poisoning was the most common agent in their study in our study it was snake bite.[21]

Ghosh VB et al studied 52 cases of accidental poisoning. They found 80.7 % children between 1-5 y of age with male preponderance. In our study also most common age group involved was 1-5yrs but it was 38.82% with males preponderance 56.47%. Kerosene oil poisoning remained the commonest accidental poisoning in this study. An interesting trend was concentrated HCL poisoning (now a common household product) as the second commonest poisoning (17.3 %). This was followed by poisoning with various drugs used by adults in the house.[22] In our study most common product involved was snake bite 27.05% followed by chemicals (pesticides and rodenticides) 24.7% then household products 17.6% and then tablets overdose 10.58%.

Abbas SK et al studied 43 cases of accidental poisoning. In their study 46.5% were less than 3 years of age. In our study also most common age group involved was 1-5yrs 38.82%. In their study pharmaceutical products 34.9% were the leading cause of ingestion followed by kerosene oil 25.6%, organophosphorous 16.3%, alkali 9.3% and acid 7%.[23] In our study most common product involved was snake bite 27.05% followed by chemicals (pesticides and rodenticides) 24.7% then household products 17.6% and then tablets overdose 10.58%.

From our study it was clear that the leading causes of poisoning was snake bite followed by chemicals and children under the age of <5 years are most vulner4ble. Following measures may help in reduction of Pediatric poisoning: educating the parents, storage of poisonous substances at a safe place and their proper disposal, providing basic health education to children.

CONCLUSION :

The study include 85 pediatric children who were admitted in pediatric ICU due to poisoning in 1 year. Age group 1-5 years was more commonly involved. Males outnumbered females. Oral ingestion of poison was predominately seen. Poisoning was seen most commonly in rural children. Poison was ingested mostly at home. Most common time interval between exposure and admission to Hospital was 2-4 hours. Most common poisoning seen was by snake bite.

Acknowledgement Section:

We acknowledge the Medical superintendent of Kasturba Hospital for allowing us to go through the accident register which was maintained in pediatric ICU under the clinical forensic medicine unit.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declarations of interest: None

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

We state that all authors have read and approved the final version of the article. There is no conflict of interest between the authors.

REFERENCES :

1. Narayan Reddy KS. The essential of Forensic Medicine and Toxicology, 27th edition, Medical Book Company. 2008; 95:440-456.
2. Hyder AA, Wali S, Fishman S, Schenk E. The burden of unintentional injuries among the under-fi ve population in South Asia. Acta Paediatrica. 2008; 97:267-75.
3. American Academy of Pediatrics. Poison Prevention and Treatment Tips National Poison Prevention Week, 2017; March: 19-25.
4. WHO-UNICEF. Children and poisoning: world report on child injury prevention. World Health Organization. 2008.
5. Lam LT. Childhood and adolescence poisoning in NSW, Australia: an analysis of age, sex, geographic, and poison types. Inj Prev. 2003; 9:338-42.
6. Ferguson RW, Mickalide AD. An In-Depth Look at

Keeping Young Children Safe around Medicine. Washington, DC: Safe Kids Worldwide, March 2013.

7. Juris E. Personal communication. Washington, DC: American Association of Poison Control Centers; 2006.
8. Dutta AK, Seth A, Goyal PK, Agarwal V, Mittal SK, Sharma R et al. Poisoning in children, Indian scenario. Indian J Pediatr. 1998; 65:365-70.
9. Soren C, Paike K. Patterns of acute poisoning in children: an epidemiological study from a tertiary care centre. Pediatr Rev: Int J Pediatr Res. 2015; 2(4):169-173.
10. Margie Peden, Kayode Oyegbite et. al. World Report on Child Injury. World Health Organisation 2008.
11. Kohli U, Kuttiat VS, Lodha R and. Kabra SK. Profile of Childhood Poisoning at a Tertiary Care Centre in North India. Indian J Pediatr 2008; 75 (8): 791-794.
12. Devaranavadagi RA, Patel S, Shankar P. A study on profile of poisoning in pediatric population. Int J Contemp Pediatr. 2017; 4(3):810-815.
13. Ram P, Kanchan T, Unnikrishnan B. Pattern of acute poisonings in children below 15 years – A study from Mangalore, South India. Journal of Forensic and Legal Medicine. 2014; 25:26-9.
14. Qazi M and Saqib N. Clinical profile and outcome of children presenting with poisoning or intoxication: a hospital-based study. Int J Contemp Pediatr. 2018; 5(5):1844-1850.
15. Reddy AB, Reddy KV, Soren C, Eluzai Z, Srikanth M. Epidemiological profile and outcome of pediatric poisoning: a prospective observational study from a tertiary care center. Int J Contemp Pediatr. 2018; 5:963-6.
16. Kariyappa M, Benakappa A, Kejjaiah AK, Ramachandrappa RS. Spectrum of poisoning in children: study from tertiary care hospital in south India. Journal of Evidence based Medicine and Healthcare. 2015; 2(33):4989-4999.
17. Dayasiri MBKC, Jayamanne SF, Jayasinghe CY. Patterns and outcome of acute poisoning among children in rural Sri Lanka. BMC Pediatric. 2018; 18 (1): 274.
18. Bandyopadhyay A and Mandal PK. Clinical profile and outcome of acute poisoning in children and adolescent in a tertiary care center. Asian Journal of Medical Sciences. 2017; 8(3): 76-80.
19. Abhulimhen-Iyoha BI and Israel-Aina YT. Pattern of Accidental Childhood Poisoning at the Children Emergency Room of the University of Benin Teaching Hospital, Benin City, Nigeria. West African Journal of Medicine. 2018, 35 (2): 85-89.
20. Roy MP, Gupta R, Bhatt M, Aggarwal KC. Profile of Children Hospitalized with Acute Poisoning in New Delhi. Indian Pediatrics. 2017; 54 (3): 246-247.
21. Edelu BO, Odetunde OI, Eke CB, Uwaezuoke NA, Oguonu T. Accidental Childhood Poisoning in Enugu, South-East, Nigeria. Annals of Medical and Health Sciences Research. 2016, 6 (3): 168-71.
22. Ghosh VB, Jhamb U, Singhal R, Krishnan R. Common childhood poisonings and their outcome in a tertiary care center in Delhi. Indian Journal of Pediatrics 2013, 80 (6): 516-8.
23. Abbas SK, Tikmani SS, Siddiqui NT. Accidental poisoning in children. Journal of the Pakistan Medical Association. 2012, 62 (4): 331-4.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00093.X

Original Research Paper

Forensic Study on Inheritance and Variability of Handwriting Features amongst English Language Writers

1. **Manju Tobria,** MSc. Student, Department of Genetics, MDU Rohtak
2. **Kusum Singal,** Senior Research Fellow, Department of Genetics, MDU Rohtak
3. **Vikas Kumar,** Senior Research Fellow, Department of Genetics, MDU Rohtak
4. **Neelkamal Sharma,** Assistant Professor, Department of Genetics, MDU Rohtak
5. **Permila Singh,** Assistant Professor, Department of Statistics, G.C.W, Rohtak

ABSTRACT :

Introduction: Handwriting is a complex process. It needs a lot of efforts and practice to learn. It is executed by fingers, hand, wrist, forearm, arm, and brain. No two people can compose precisely the same.

Aims and Objectives: To check the influence of heredity on handwriting characteristics.

Materials and Methods: Study comprises of english handwriting samples collected from 4 members (father, mother, daughter, and son) of 50 families. Samples were analyzed on the basis of 12 characteristics of handwriting. Some peculiar letters such as "i", "o", "g", "e", "s", "r", "t" were examined in the handwriting sample. The analysis part was done by manual methods.

Results: The maximum similarities in the pattern of handedness were found among father-son (100%) followed by mother-son (98%), mother-daughter (98%), siblings (96%) and father-daughter (96%).

Conclusion: Present study concluded that father-son relationship has the majority of the similarities in handwriting.

Corresponding Author :
Dr. Neelkamal Sharma,
MSc.Ph.D, Assistant Professor,
Department of Genetics, MDU Rohtak
Contact : +91 97285-34170
Email : neelforensics@gmail.com

Article History:
Received: 17 April 2020
Received in revised form: 30 April 2020
Accepted on: 30 April 2020
Available online: 30 April 2021

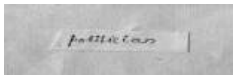
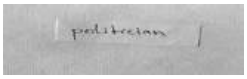
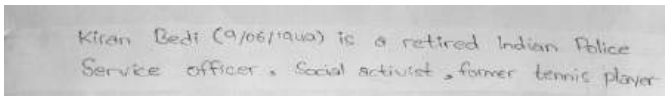
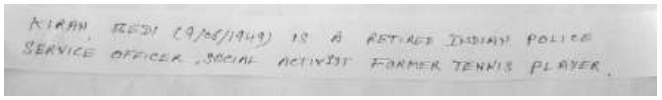
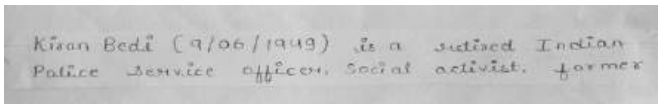
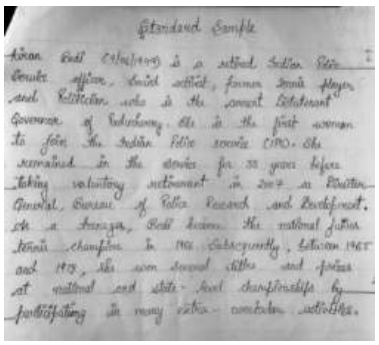
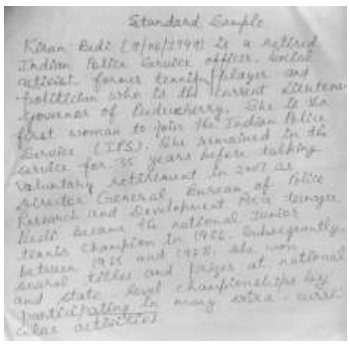
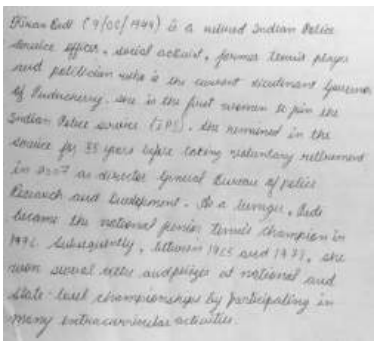
KEYWORDS : Forensic Science, Handwriting, Questioned document, Inheritance, Variability etc.

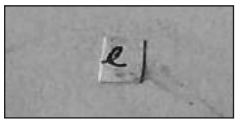
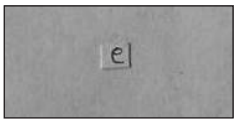
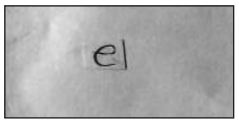
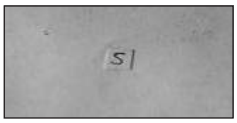
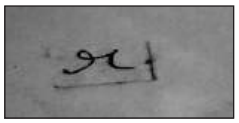
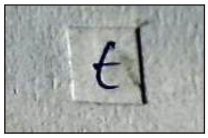
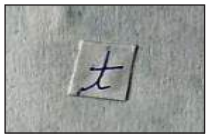
INTRODUCTION : Handwriting is a visible speech which is not spoken, but is written with the help of pen or any writing instrument and comprise of signs, symbols, lines etc[1,2,3]. The handwriting of a person is the pictorial expression of his/her personality. No two people can compose precisely indistinguishable**.** It's not possible for anyone to copy the handwriting of someone else, not even of his/her near ones (father, mother, brother, sister, son & daughter), nor of his/her teacher who taught him/her the art of handwriting[3]. Hence the handwriting of a person is unique. There are numerous peculiarities in handwriting e.g. roundness of the words, the spacing between letters, slopes, pressure, size of letters, line quality, spacing, pen-lifts etc[4]. In handwriting forensics "only the likes can be compared with likes in a corrected manner[1,4,5]. It has been observed that numerous studies have been led on the Handwriting identification and recognition[6-10]. But a very few studies have been done on the impact of heredity on handwriting pattern. Parents are the children's learning models. Children learn to write letters by copying the letters formed by parents[5]. The present research examines the handwritings of genotypic familial relatives i.e. parents-off springs, to determine the resemblances in handwriting influenced by heredity.

MATERIALS AND METHODS : Samples were collected from members of 50 families with purpose to check the similarities in handwriting among parents and their off springs. Study subjects include parents as well as their siblings i.e son and daughter skilled in writing in English scripts. Samples were collected only after getting their signed consent. Subjects having physical illness were excluded from the study. The Standard English typed text was given to the writers to copy.

Standard document : A standard archieve in English language, which was to be replicated by subject, was set up for examination. The standard document contained all 26 English letters, all numerals, punctuation marks like comma, sections, and semi-colon. Every writer was requested to compose the given content in their natural handwriting on plain A4 size paper with a blue ballpoint pen ELKOS (0.6mm). Some class and individual characteristics were compared. These were handedness, pen position, body posture, margin, size, slant, style, alignment, no. of words per line, spacing, commencing and terminal strokes **(Figure 1)**. Some exceptional letters were additionally examined in this handwriting sample. These were –"i", "o", "g", "e", "s", "r", "t". The examination was carried out manually utilizing a hand magnifier. The photographs of specific observations were taken.

Figure 1: Showing various handwriting characteristics and peculiar features of few letters examined in the present study

Slant	 Vertically straight	 Towards right side	 Towards left side
Style	Cursive 		
	Manuscript 		
	Handlettering 		
	Composite 		
Alignment	 Straight	 Ascending	 Descending
Commencing and Terminal Strokes	Blunt 		Smooth 
Letter "I"	 Left smudged	 Center smudged	 Right smudged
	 Left circle	 Center circle	 Right circle
Letter "O"	 Closed at top with loop	 Closed at top without loop	 Open at top with loop	 Open at top without loop

Letter "G"	 Closed and broad loop	 Closed and normal loop	 Closed and narrow loop	 Open and broad loop	 Open and normal loop	 Open and narrow loop
Letter "E"	 Narrow loop	 Normal loop	 Broad loop	 Without loop		
Letter "S"	 "s" with loop	 "s" without loop	 "ऽ" with loop	 "ऽ" without loop		
Letter "R"	 "r" with loop	 "r" without loop	 "ऋ" with loop	 "ऋ" without loop		
Letter "T"	Simple "t" 	Retraced "t" 	Looped "t" 			

RESULTS :

Sibling observations were compared with their respective parental observations to determine specificity in features. All observations were recorded in Excel sheets and the observed data was then evaluated and interpreted **(Table 1-2)**. The maximum similarities in the pattern of handedness were found among father-son (100%) followed by mother-son (98%), mother-daughter (98%), siblings (96%) and father-daughter (96%) (Table 1).While writing, similarities in the posture of the body found maximum among father-son (82%) followed by siblings (68%), father-daughter (66%), mother-daughter (46%), mother-son (42%). All the selected parameters were analyzed and similarities found were reported **(Table 1-2)**

DISCUSSION :

The earliest published remark regarding the likelihood of composing similarities because of familial relationship was one in the December 2, 1911 issue of Scientific American that reports an article by R.H. Chandler. The article demonstrates three cases in which some broad similarity was noted between brothers, sisters or fathers and children, but the similarity was not all that good in another study conducted by Saini et al.[5]. Stevens directed a correlation of the written work from three control groups in which instead of compositions of eight individuals (seven females) of one family, every one of whom was dextral writers, educated in similar schools by same teachers and with the Palmer writing system.

In the present study, father-son similarities were found in many handwriting characteristics [handedness (100%), pen position (82%), body posture (82%), style (72%), line spacing (58%), commencing & terminal strokes (70%), peculiar letters "i" (54%) and "t" (54%)] followed by siblings, similarities were found in characteristics [left margin (46%), size (48%), word spacing (54%), peculiar letters "o" (66%) and "g" (40%)] followed by father-daughter, similarities were found in characteristics [Style (72%), Alignment (48%), Peculiar letters "e" (90%) and "s" (52%) and "r" (68%)] followed by mother-daughter, similarities were found in characteristics [right margin (44%), slant (82%) and no. of words per line (50%)] followed by mother-son, similarities were found in characteristics [letter spacing (56%)] which is in accordance with previous studies conducted by other researchers. **(Table 1-2)**

In an investigation performed by Saini et al, similarities were found in one case in the handwriting compositions of a mother and daughter[4,5]. They observed a greater degree of resemblance in older individuals. Kaur et al also performed a study on handwriting samples collected from 40 individuals skilled in writing in three scripts (Hindi, English, and

Table 1: Showing the similarities in various handwriting parameters among the parents and their offspring

Characteristics	Sub-types of Characters	Relationships				
		Father-Son	Father-Daughter	Mother-Son	Mother-Daughter	Siblings
Handed Ness	Sinister	2%	-	-	-	-
	Dexterous	98%	96%	98%	98%	96%
	Ambidextrous	-	-	-	-	-
Pen Position	Tip of the pen	10%	10%	8%	12%	14%
	Slightly above from tip	70%	50%	30%	28%	50%
	Grip of the pen	2%	6%	4%	6%	4%
Body Posture	Near to the paper	10%	8%	6%	10%	16%
	Normal distance from the paper	68%	44%	30%	32%	52%
	Far from the paper	4%	6%	6%	8%	6%
Margin Left Margin	Wide to narrow	6%	6%	10%	6%	6%
	Narrow to wide	12%	16%	2%	6%	20%
	Even margins all around	-	-	-	-	-
	Irregular margin	6%	10%	16%	18%	18%
	No margin	-	-	-	-	2%
Right Margin	Wide to narrow	6%	6%	-	-	2%
	Narrow to wide	4%	2%	6%	4%	2%
	Even margins all around	-	-	-	-	-
	Irregular margins	26%	32%	24%	40%	34%
	No margins	4%	-	4%	-	4%
Size	Small	28%	18%	16%	8%	18%
	Medium	12%	10%	16%	20%	20%
	Large	4%	2%	12%	12%	10%
Slant	Straight	68%	72%	74%	80%	76%
	Towards left	-	-	-	-	-
	Towards right	10%	6%	6%	2%	4%
Style	Cursive	-	-	-	2%	10%
	Composite	70%	72%	62%	64%	60%
	Manuscript	2%	-	4%	-	2%
	Hand-Lettering	-	-	-	-	-
Alignment	Straight	10%	16%	10%	20%	22%
	Ascending	16%	16%	4%	6%	10%
	Descending	20%	16%	16%	16%	12%
No. of words per line	6	6%	-	2%	4%	-
	7	14%	16%	16%	22%	16%
	8	16%	16%	14%	22%	14%
	9	4%	4%	2%	2%	4%
	10	-	-	-	-	4%
	11	-	-	-	-	2%
Line spacing	Small	12%	8%	12%	12%	18%
	Medium	-	2%	-	4%	4%
	Large	46%	38%	40%	36%	24%
Word spacing	Small	16%	10%	8%	4%	12%
	Medium	4%	2%	-	4%	2%
	Large	26%	30%	24%	28%	40%
Letter spacing	No spacing	12%	30%	24%	32%	32%
	Spacing	28%	14%	28%	18%	16%
	More spacing	85%	-	4%	-	-
Commencing and terminal strokes	Blunt	58%	60%	32%	36%	68%
	Smooth	12%	6%	10%	6%	0

Table 2: Showing the similarities in characteristics of various letters among the parents and their offspring

Characteristics	Sub-types of Characters	Relationships				
		Father-Son	Father-Daughter	Mother-Son	Mother-Daughter	Siblings
	Centre placed smudged dot	30%	14%	30%	18%	14%
	Right placed smudged dot	22%	14%	18%	8%	8%
	Left placed smudged dot	-	-	-	-	-
	Centre placed circle dot	2%	2%	-	-	6%
	Right placed circle dot	-	-	-	-	-
	Left placed circle dot	-	-	-	-	-
	Closed at top with loop	10%	8%	6%	10%	20%
	Closed at top without loop	52%	32%	58%	46%	46%
	Open at top with loop	-	-	-	-	-
	Open at top without loop	2%	-	2%	-	-
	Closed and normal loop	8%	4%	24%	20%	20%
	Closed and broad loop	6%	4%	2%	2%	10%
	Closed and narrow loop	-	2%	8%	8%	2%
	Open and normal loop	2%	2%	2%	2%	2%
	Open and broad loop	8%	4%	2%	2%	6%
	Open and narrow loop	-	-	-	-	-
	Narrow	-	-	-	-	-
	Normal	82%	88%	84%	78%	80%
	Broad	2%	-	2%	-	-
	Without loop	-	2%	-	-	-
	“S” with loop	2%	-	-	-	-
	“S” without loop	6%	2%	4%	4%	4%
	“S” with loop	26%	28%	36%	34%	28%
	“S” without loop	16%	22%	4%	6%	12%
	“R” with loop	-	-	2%	-	-
	“R” without loop	8%	-	2%	-	-
	“R” with loop	36%	40%	44%	54%	28%
	“R” without loop	20%	28%	2%	6%	6%
	Simple “t”	34%	24%	24%	20%	18%
	Retraced “t”	14%	14%	18%	18%	18%
	Looped “t”	6%	8%	2%	6%	8%

Punjabi)[11-14]. In the present study, father-son similarities were found in various parameters (handedness, pen position, body posture, style, line spacing, commencing & terminal strokes, peculiar letters “i” and “t”) which are similar with other studies performed previously by different researchers[15-18].

CONCLUSION :

The aim of the study was to discover the impact of inheritance on handwriting. The likenesses in the conduct and life structures of a man are reliant on the acquired characters which in another way impact the handwriting. In the present examination, father-son relationship has the majority of the similarities in handwriting that might be because of a similar sex impact and male quality strength. Likenesses acquired in handwriting highlights the transmission of handwriting characteristics from one generation to the next generation and within the same generation.

Ethical Clearance: Not required.

REFERENCES :

1. Huber RA, Headrick AM. Handwriting identification, Facts & Fundamental. CRC press Boco Raton. 1999; (1): 91-31.
2. Lal B, Chandra R. Cross-examination of handwriting expert. Selective and Scientific Books. 2010; 1:09-20.
3. Sharma BR. “Forensic Science in Criminal Investigation and Trials”. Universal Law Publishing Co. Pvt. Ltd. 2005; (4): 85-21.
4. Saini M, Kapoor A. Variability in handwriting patterns among ethnic group of India. International Academy of Science, Engineering and Technology. 2014; 3(1):04-60.
5. Saini M, Srinivasan A, Kapoor A. Inheritance of handwriting features. International Refereed Journal of Engineering and Science (IRJES). 2015; 4 (4): 01-05.
6. Zhang B, Srihari S. Binary vector dissimilarity measures

for handwriting identification. Proceedings of the SPIE 5010, Document Recognition and Retrieval X; Santa Clara, CA. 2003; 50(10): 28-37.

7. Schlapbach A, Bunke H. Offline handwriting identification using HMM based recognizers. Pattern Recognition, ICPR. 2004; 2:654-58.
8. Zheng Y, Li H, Doermann D. Machine printed text and handwriting identification in noisy document images. IEEE Transactions on pattern analysis and machine intelligence. 2004; 26(3):337-53.
9. Plamondon R, Srihari S. On-line and off-line handwriting recognition: A comprehensive survey. IEEE Transactions on pattern analysis and machine intelligence.2000; 22(1):63-84.
10. Marti UV, Bunke H. The IAM-database: An english sentence database for off-line handwriting recognition. International Journal of Document Analysis and Recognition. 2002; 5(1):39-46.
11. Kaur A, Singh M, Jasuja OP. Inter-script comparison of handwriting features leading to their identification and authorship. Nowa kodyfiacja prawa karnego. 2017; 45:15-26.
12. Choudhary SK, Mathur S, Sharma P. Discrimination of tremors in illiterate and fraud handwritings. J Forensic Sci & amp; Criminal Invest. 2018; 7(1):1-4.
13. Desai B, Kalyan J. Forensic examination of handwriting and signatures. International Journal of Innovative Research and Development. 2018; 2(5):514-27.
14. Hilton O. Scientific examination of questioned documents. Elsevier, New York, USA, pp. 1982; 153-57.
15. Jain J, Singh M, Ahuja P, Dahiya MS. Correlation between the authorship and occupation of writer. J Forensic Sci & Criminal Invest. 2018; 7(4):1-8.
16. James & Nordby. “Forensic science: An introduction to scientific and investigative Techniques”. CRC Press, London. 2003;1:357-75.
17. Kelly JS, Lindblom BS. Scientific examination of questioned documents. CRC press. Taylor and Francis group. 2006; 2:47-75.
18. Kriti N, Vaibhav S, Ankit S, Syeed A, Gupta AK. Automated tool based on statistical study for predicting probable dextrality of writers. J Forensic Sci. & Criminal Invest. 2018; 7(1): 555703.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00094.1

Original Research Paper

Radiographic Study of Fusion of Coronal Sutures in Females for Age Estimation

1. **Ishita Manral,** Assistant Professor**,** Department of Forensic Medicine and Toxicology, Command Hospital Kolkata
2. **Rashid Nehal Khan,** Associate Professor***,**
3. **Abhijit Rudra,** Professor*,
*Department of Forensic Medicine and Toxicology, Armed Forced Medical College, Pune

ABSTRACT :

Introduction : Age estimation of individuals is a usual case faced by Forensic Practitioners. Establishment of the individuality of a person can be absolute or partial. Every age has medico-legal importance in this era. Age estimation as seen in the courts of law can be for age confirmation as in pension, benefits of senior citizen or in dementia cases. Cranial sutures with other criteria are helpful for age estimation.

Materials and Methods : We studied skull roentgenogram of patients who had been advised roentgenogram for diagnostic and therapeutic purpose from clinical departments. We studied the fusion of coronal sutures in those roentgenograms where age was known after match with a relevant identity document. The suture was divided into upper half and lower half and stage of fusion was documented. We followed the Key et al stage of fusion of sutures.

Results : We found the earliest beginning of fusion occurred in coronal suture at 40 years and 31 years in its upper half and lower half respectively. The earliest complete fusion occurred at 56 years in upper half and 50 years at lower half.

Corresponding Author:
Dr. Ishita Manral,
Assistant Professor**,**
Department of Forensic Medicine and Toxicology, Command Hospital Kolkata, West Bengal
Contact : +91 7726307790
Email : atihsi532@gmail.com

Article History :
Received : 8 April 2019
Received in revised from : 3 July 2020
Accepted on : 3 July 2020
Available online : 30 April 2021

Key words : Coronal Suture; Roentgenogram; Skull; Female; Fusion; stage

INTRODUCTION :

Forensic Practitioners typically face cases of age estimation. [1,2]. Identification is the establishment of the individuality of a person. It may be complete where all facts are ascertained or incomplete in which certain facts are ascertained and others are unknown[3,4,5]. Race, age, sex and stature are considered the main four criteria in forensic identification[4,5]. The present study is an attempt to correlate the documented age of an individual with the skull radiographs using coronal suture of the skull in female population.

The aim of the study is to study the pattern of fusion of coronal suture using skull radiographs and its association with documented age. The objectives is to study the stages of progression of closure of coronal sutures and compare with the available standards in female.

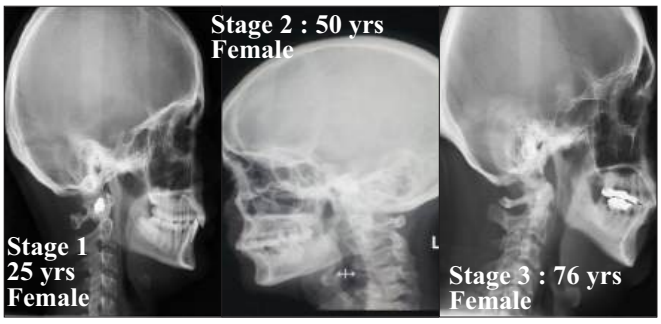
MATERIALS AND METHODS :

The present study was conducted in Department of Forensic Medicine and Toxicology at Armed Forces Medical College, Pune from November 2015 to November 2017. Cases included for the study were those who have been advised a radiograph of the skull (AP view or PA view or Lateral view) for diagnosis. Such roentgenograms were studied and interpreted in terms of closure of suture with the documented age in correlation with the Birth certificate/Aadhaar card/Driver's license/Voter's ID/ Ration card. The study was approved by the institutional ethics committee.

Coronal suture was divided into upper and lower half. Sample were then grouped in age groups of 20-25, 25-30, 30-35, 35-40 ,40-45, 45-50, 50-55, 55-60, 60-65, 65-70 and stage of fusion was documented.

Stage of fusion of the three sutures were as :

Stage 1: Not commenced, Stage 2: In process of fusion, Stage 3: Fused



RESULTS :

A total of 154 roentgenograms were studied.

Age group 20-25 years : Total cases were 19 (12%). In none of the case suture fusion had commenced.

Age group 26-30 years : Total cases were 16 (10%). In none of the case suture fusion had commenced.

Age group 31-35 years : Total cases were 15 (10%).In upper half, 1 cases (6 %) suture fusion had not commenced, 14 cases (94%) it was in process of fusion. In lower half, 15 cases (100 %) suture fusion had not commenced.

Age group 36-40 years : Total cases were 24 (17%). In upper half, 24 cases (100%) suture fusion had not commenced. In lower half, 5 cases (21%) suture fusion had not commenced, 19 cases (79%) it was in process of fusion.

Age group 41-45 years : Total Cases were 12 (8%). In upper half, 12 cases(100%) suture fusion had not commenced. In lower half, 6 cases (50 %) suture fusion had not commenced, 6 cases (50 %) suture fusion was in the process.

Age group 46-50 years : Total cases were 14 (9%). In upper half,14 cases(100%) suture fusion was in process of fusion. In lower half, 7 cases (50 %) it was in process of fusion, in 7 cases (50 %) sutures had fused.

Age group 51-55 years : Total cases were19(12%). In upper half,19 cases (100 %) it was in process of fusion. In lower half, in 19 cases (100 %) sutures had fused.

Age group 56-60 years : Total cases 10(6%). In upper half, 4 case (40 %) it was in process of fusion, 6 cases (60 %) sutures had fused. In lower half, in 10 cases (100 %) sutures had fused.

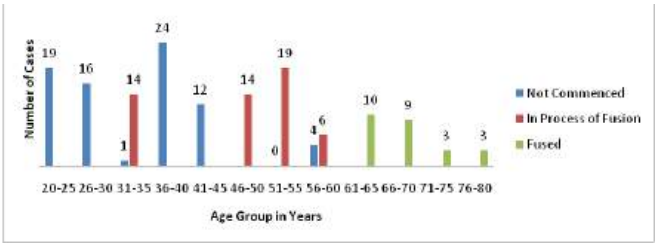
Age group 61-65 years : Total cases were 10 (6%). In upper half, in 10 cases (100 %) sutures had fused. In lower half, 10 cases (100%) sutures had fused.

Age group 66-70 years : Total cases were 9 (6%). In upper half, 9 case (100%) sutures had fused. In lower half,9 case (100 %) sutures had fused.

Age group 71-75 years : Total cases were 3(2%). In upper half, 3 cases (100 %) sutures had fused. In lower half, 3 cases(100 %) sutures had fused.

Age group 76-80 years : Total cases were 3(2%). In upper half, 3 cases(100 %) sutures had fused. In lower half, 3 cases(100 %) sutures had fused. **(Table 1, Graph 1-2)**

Graph 1: Fusion of Coronal suture in its upper half in female



Graph 2: Fusion of Coronal suture in its lower half in female

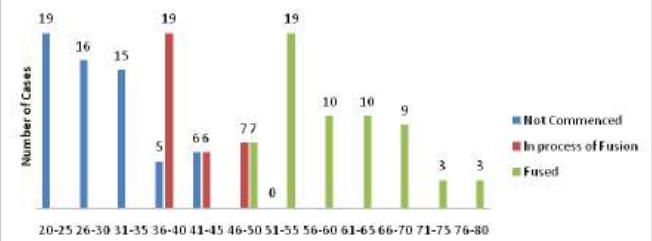


Table 1: Fusion of Coronal suture in Female

Age (in years)	Number of Cases		Upper Half						Lower Half					
			Not Commenced		In Process		Fused		Not Commenced		In Process		Fused	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
20-25	19	12	19	100	0	-	0	-	19	100	0	-	0	-
26-30	16	10	16	100	0	-	0	-	16	100	0	-	0	-
31-35	15	10	1	6	14	94	0	-	15	100	-	-	0	-
36-40	24	17	24	100	0	-	0	-	5	21	19	79	0	-
41-45	12	8	12	100	0	-	0	-	6	50	6	50	0	-
46-50	14	9	0	-	14	100	0	-	0	-	7	50	7	50
51-55	19	12	0	-	19	100	0	-	0	-	0	-	19	100
56-60	10	6	4	40	6	60	0	-	0	-	0	-	10	100
61-65	10	6	0	-	0	-	10	100	0	-	0	-	10	100
66-70	9	6	0	-	0	-	9	100	0	-	0	-	9	100
71-75	3	2	0	-	0	-	3	100	0	-	0	-	3	100
76-80	3	2	0	-	0	-	3	-	0	-	0	-	3	-
Total	154	100	-	-	0	-	-	-	-	-	-	-	-	-

P value for age versus upper half of Coronal suture in female is < 0.001as the age increases the trend is not commenced to fused.

P value for age versus lower half of Coronal suture in female is< 0.001as the age increases the trend is not commenced to fused.

Test used is Fisher's Exact test.

DISCUSSION :

Age estimation cannot be done using a single factor as it depends on many factors with time6.The age range in our study was 20 years to 80 years. A comparative analysis of methods used and age group of sample employed in various studies is given in **Table 2**.

Study	Method	Age groups used
Singh et al.[7]	Computed	40-70 years
	Tomography scan	
Verma et al.[8]	Roentgen ray	30-70 plus years
Parmar et al.[9]	Roentgen ray	15-70 years
Gaur et al.[10]	Roentgen ray	20-45 years above
Present study		20-80 years

Table 2: Comparative account of age groups and Method used in studies in the Indian Scenario.

Antero-posterior view of the skull shows Lambdoid sutures and a portion of the Sagittal suture, sometimes Coronal suture is also seen. The lateral view will showed the Lambdoid and Coronal sutures.[4, 5] Antero-posterior view of the skull could show all major sutures(Coronal, Lambdoid and Sagittal suture). [5]Postero-anterior roentgenograms of the skull is also useful to visualise the sutures and is advisable to use both views. [1]

The obliteration of cranial suture was found to occur earlier in males than in females.[11-12] In others however the obliteration of the skull sutures in females was found to be earlier[13]. In Indian scenario sutures of the skull closed earlier in females. [14]

Radiologically, in the younger age groups, sutures appear simple and straight. With advancing age, they acquire a complex anatomy of inter-digitations by process of growth.[15]

Comparison with other roentgenogram studies :

Verma *et al.*[8] studied radiological stage of fusion with physical findings of the patient. Gaur *et al.* [9] studied radiological obliteration of sutures with documented age of the individual. Parmar *et al.*[10]studied radiological stage of fusion of skull sutures with the documented age. It is not possible to comment on endocanial sutures in roentgenogram studies[8]. Please see **table 3** to compare the age of closure in different studies.

Table 3: Comparative account of suture closure

Author	Method	Coronal Suture Age of Fusion
Reddy[4]	Roentgen ray	50-60 years
Nandy[16]	Roentgen ray	50-60 years
Pradeep et al.[7]	Roentgen ray	45-50 years
Parmar et al.[9]	Roentgen ray	50-60 years
Masih et al.[17]	Morphology	46-50 years

CONCLUSION :

We studied the radiological stages of fusion of Coronal suture of the skull in females in association with the documented age and found a significant correlation between the two using a Scoring method, Key et al. Coronal suture was found to start fusion by 31 years and earliest completion was at 50 years. Ectocranial suture closure can be used for age estimation with other associated factors. In our study the trend of correlation is increasing with age which strengthen the view that there is a significant relationship between suture closure and age. It is important to refine the methods of scoring or quantifying these structures to make it an unbiased observation.

Ethical clearance : a prior approval was obtained from the institutional ethical committee IEC/AFMC/Nov2015

Conflict of interest: none to declare

Source of funding: none to declare

REFERENCES :

1. Aggrawal, A. Estimation of age in the living: in matters civil and criminal. Journal of Anatomy 2009.
2. Dogra TD, Rudra A. Identification. In: Lyon's Medical Jurisprudence & Toxicology. 11th ed, Delhi: Delhi Law House; 2004: 396-416.
3. Vij K. Identification. In:Textbook of Forensic Medicine and Toxicology Principles and Practices. 4th ed. New Delhi: Elsevier; 2008: 48-57.
4. Reddy KSN. Identification. In: The Essentials of Forensic Medicine and Toxicology. 24th ed. Hyderabad: K Sugna Devi; 2005: 47-68.
5. Aggrawal A. APC Textbook of Forensic Medicine and Toxicology-Avichal Publishing Company. Avichal publishing company; 2014:59-117
6. Meindl RS, Lovejoy CO. Ectocranial suture closure: a revised method for the determination of skeletal age at death based on the lateral anterior sutures. American Journal of Physical Anthropology 1985; 68(1): 57-66.
7. Singh P, Oberoi SS, Gorea RK, Kapila AK. Age estimation in old individuals by CT scan of skull. Journal of Indian Academy of Forensic Medicine.2004; 26(1):10-

13

8. Verma. RK, Goyal. MK, Kochar. S. Age Assessment from Radiological Cranial Suture closure in Fourth to Seventh decades (A Jaipur Based Study). Journal of Indian Academy of Forensic Medicicne, 2010; 32(2): 120-123.
9. Gaur VB, Sahay VB, Singh A, Determination of Age in living by closure of Cranial Sutures .A Radiological Examination.Journal of Indain Academy of Forensic Medicine, 2007-29 (1)
10. Parmar P, Rathod GB. Determination of age by study of skull sutures. International Journal of Current Research and Review. 2012 15;4(20):127
11. RentoulE,SmithH.In: Identification. Glaister`s Medical Jurisprudence and Toxicology.9th ed. E & S Livingstone.London.1942.80-83.
12. Begum S, Kataria G, Sharma N. Forensic Odontology v Radiology. International Journal of recent Scientific Research. 2017:8(7) 18338-343.
13. Hardlicka A. Anthropometry [Internet]. 1st ed. Philadelphia: Wistar Institute of Anatomy and Biology. Philadelphia; 1920 [cited 17 November 2017].
14. AG VK. Fusion of Skull Vault Sutures in Relation to AgeA Cross sectional Postmortem Study Done in 3rd , 4th& 5th Decades of Life at KLES Prabhakar Kore Hospital and MRC, Belgaum (Doctoral dissertation, KLE University, Belagavi, Karnataka.).
15. Sabini R C., Elkowitz DE. Significance of differences in patency among cranial sutures. Journal American Osteopathic Association 2006;106(10):600-604
16. Nandy A. Identification.In :Nandy A. Principles of Forensic Medicine,2nd ed.,2004; New Central Book Agency,2004 : 39-41
17. Masih WF, Gupta S, Jaiswal P, Chand AE, Saraswat PK. Morphological study of vault suture & its correlation with age in central Rajasthan. National Journal of Medical Research. 2014;4:19-22

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00095.3

Original Research Paper

The Toxic Effects of Some Heavy Elements in Shamiayah River (AL-Qadisiyah Province, Iraq)

1. **Ali Kadhim Kareem,** Researcher, University of AL-Qaadisiyah,College of Sciences, Iraq
2. **Haider Mashkoor Hussein,** Assistant Professor, University of AL-Qaadisiyah, College of Sciences, Iraq

ABSTRACT :

Introduction : The current study was conducted to find out the effect of heavy elements (cadmium, copper, cobalt, zinc and lead) on total chlorophyll and fats in *Ceratophyllum demorsum* in the Shamiyah River.

Material and Methods : The plant was collected from three sites of the Shamiyah River, which is the beginning of the river entrance, the city center, and the last site when the river exited the city, quarterly for a full year and by two months for each season. The study included measuring heavy metals (cadmium), Copper, cobalt, zinc and lead) and biochemical components (total chlorophyll and fats).

Results : The results of the study showed that the concentration of heavy metals (cadmium, copper, cobalt, zinc and lead) in the Ceratophyllumdemorsum plant ranged between (2.48-8.79), (8-72.23), (7.51-62.97), (289.6-4201), (31.4-80.23) Mg / g weight by dry weight, respectively, while the total chlorophyll was between (20-37.24) mg / 100 g and fat (20-38(%)..

Corresponding Author:
Dr. Haider Mashkoor Hussein,
Assistant Professor,
University of AL-Qaadisiyah,College of Sciences, Iraq
Contact : +91
Email : hussein.mahmoud85@yahoo.com

Article History :
Received : 23 March 2020
Received in revised from : 25 March 2020
Accepted on : 31 March 2020
Available online : 30 April 2021

Key words : Heavy elements, *Ceratophyllum demorsum*, Shamiyah River

INTRODUCTION :

Heavy elements are among the most dangerous pollutants that cause many damages to the plants and the environment in which they are present. Their seriousness lies in their cumulative nature in various environments and living organisms, including plants. Heavy elements and their relationship with various living and non-living components, including plants[1]. The movement and distribution of heavy elements in plant parts such as the root, stem, leaves and fruits depend on the type of heavy element[2].The plant roots act as filters for the heavy elements accumulating slowly, especially when they are present at high levels and thus will get inhibition partially for the transport of heavy elements to other plant parts [3]. Plants are very sensitive to the toxicity of heavy elements as they have the ability to detect heavy elements much better than other measures because of their ability to accumulate these elements within their tissues[4].The aquatic plants give a clear picture of the water environments in which they exist by detecting the stresses that Aquatic plants are exposed to it, such as chemical stress resulting from the accumulation of some chemical pollutants, such as trace elements. These elements are detected by measuring the concentrations of these elements within the tissues of the plants under study and knowing the effects of these elements on their biochemical components, such photosynthesis, chlorophyll content, and total fat ,this gives us a clear assessment of the severity of the impact of pollution on the aquatic environment[5].These effects are reflected a decrease is evident in the construction rates of photosynthesis and the content of chlorophyll total resulting from industrial and agricultural wastes put into river water[6]. The objectives of the study are to measure the concentrations of heavy elements (cadmium, copper, cobalt, zinc, lead) and the concentrations of biochemical components (total chlorophyll and fats) in the *Ceratophyllum demorsum* plant and to find the relationship between the concentrations of heavy elements and biochemical components.

MATERIALS AND METHODS :

Samples were collected with three replications and sites from the study sites quarterly and by two months for each season from the beginning of November 2018 to October 2019, the *Ceratophyllum demorsum* was washed with river water to remove the clays and impurities after that was put in Clean plastic bags and then, transferred to Lab to make the following tests: A method[7] was used to digest plant samples, by taking 0.5 g of dry vegetable sample and placing it in a glass tube, then adding 5 ml of HNO3 and left for 16 hours after it was placed on a heat plate at 100 ° C for one hour and then adding 3 ml Of the perchloric acid, its concentration is 70%, due to heat until the acid evaporates, then completes the volume to 50 ml by adding distilled water free of ions, then placed in plastic

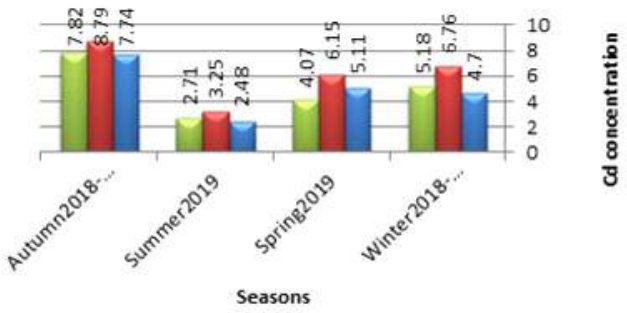
containers until the heavy metals are measured by the Flame Atomic Absorption Spectrophotometer Shimadzo AA-6300. To estimate the total chlorophyll content in plants, I followed the method described by[8-9], which is summarized by taking 1 g of fresh vegetable leaves and crushing them with 10 ml of acetone. Then, the process of centrifugation of the sample is carried out for 15 minutes. In the tissue of the sample, the absorbance is read using the Spectrophotometer and on the two lengths (645, 663) nm. As for estimating the fats, I followed the method set by[10] by adding 2 ml of chloroform and methanol solutions to 0.2 g of the previously dry and crushed vegetable sample. Then the precipitate was separated from the leachate by centrifugation and added 0.5 ml of calcium chloride solution after which the lower layer containing the fat was drawn and placed On a sponge in an aluminum container and dried in the oven to get rid of solutions, then calculate the weight difference, which represents the amount of fat in the tissue.

RESULTS :

Concentration of heavy elements in the *Ceratophyllum demorsum* plant:

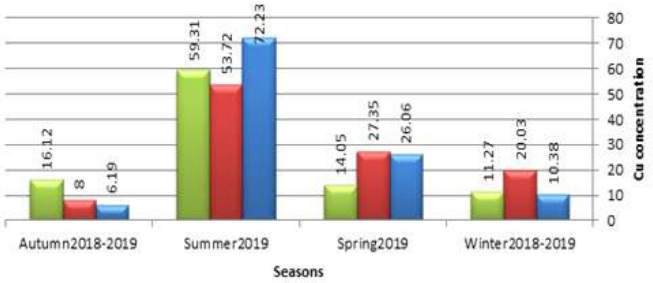
1. Cadmium: The results showed that the lowest concentration of cadmium in *the Ceratophyllum demorsum* plant was 2.48 during the summer in the first location, while the highest concentration was 8.79 during the autumn in the second location, at an annual rate (5.39), and the results of the statistical analysis showed a significant difference at the level of ($P \leq 0.05$) Between seasons except winter and spring, there is no significant difference between them **(Figure 1)**.

Figure 1 : the seasonal changes in the concentrations of cadmium in the *Ceratophyllumdemorsum* plant Mggm / gm and dry weight in the study sites.



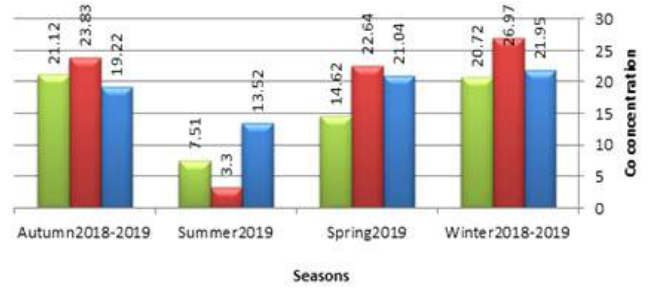
2. Copper: The lowest concentration of the copper element in the *Ceratophyllum demorsum* plant reached 8 mg / g weight by dry weight during the autumn season at the second site, while the highest concentration was 72.23 mg / g weight by dry weight during the summer season at the first site, with an annual average of (27.05) mg / g weight by dry weight. Statistical analysis: There was no significant difference between the seasons of the year except for the summer, and also between the study sites **(Figure 2)**.

Figure 2 : the seasonal changes in the concentrations of the copper element in the *Ceratophyllumdemorsum* plant mg / gm and dry weight in the study sites.



3. Cobalt: The results of the study showed that the lowest concentration of cobalt in the *Ceratophyllum demorsum* plant is 7.51 mg / g dry weight during the summer in the third location, while the highest concentration is 62.97 mg / g in dry weight during winter in the second location, and the annual average (18) mg / g weight in dry weight Statistically, it was found that there was no significant difference between the seasons of the year except for the summer **(Figure 3)**.

Figure 3 : the seasonal changes in the concentration of cobalt element in the*Ceratophyllumdemorsum*plant Mggm / gm dry weight in the study sites.



4. Zinc: The results of the study showed that the lowest concentration of the zinc component in the Ceratophyllumdemorsum plant was 289.6 mg / gm dry weight during the spring season in the first site and that its highest concentration was 4201 mg / gm dry weight during the summer in the first site and the annual average was (1229.6) mg / gm Java weight, the results of the statistical analysis showed that there was no significant difference between the seasons of the year except for the summer **(Figure 4)**.

5. Lead: Concentrations of lead element in the *Ceratophyllum demorsum* plant ranged between 31.4 mg / g dry weight as the lowest concentration during the summer in the second location and 80.23 mg / g dry weight as the highest concentration during

the fall season in the second location as well and with an annual rate of (49.35) mg / g Java weight, and from the results of the statistical analysis, we note the presence of a significant difference at the level (P≤0.05) between summer and autumn **(Figure 5-6)**.

Figure 4 : the seasonal changes in the concentrations of the zinc component in the *Ceratophyllumdemorsum* plant, mg / gm, and dry weight, in the study sites.

Figure 5 : the seasonal changes in the concentrations of the lead element in the *Ceratophyllumdemorsum* plant mg / gm and dry weight in the study sites.

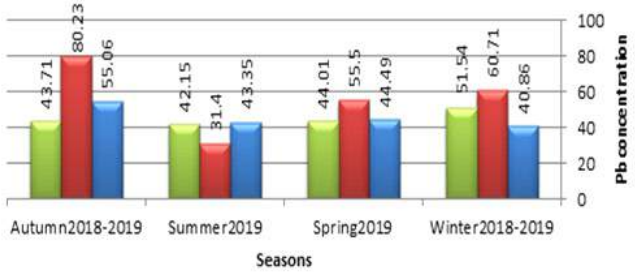
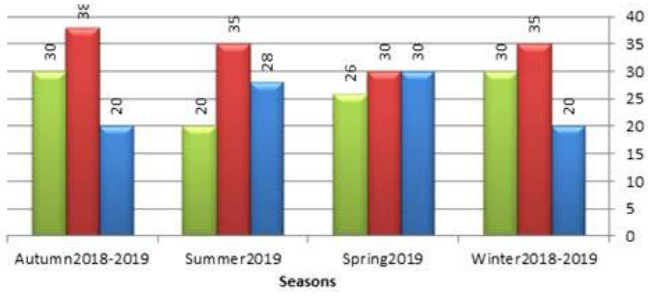


Figure 6 : concentration of fats (% dry weight) in the *Ceratophyllum* demorsum plant during the study period.



Biochemical Components :

1. Total Chlorophyll: The results of the study showed that the lowest concentration of total chlorophyll in the *Ceratophyllum demorsum* plant is 20 mg / 100 g during the autumn season at the second site and the highest concentration was 37.24 mg / 100 g during the winter season at the first site and at an annual rate () mg / 100 g figure (6), the results showed Statistical analysis, there was no significant difference at the probability level (P≤0.05) between the seasons of the year while between the sites, a significant difference was found, as we note an inverse correlation relationship with the cobalt element r = -0.614 and zinc r = -0.598 **(Table 1)**.

Table 1 : The relationship between the concentrations of heavy elements and the biochemical components of the *Ceratophyllumdemorsum* plant.

lead	zinc	cobalt	copper	Cadmium	Heavy metals / plant
-0.518	-0.598*	-0.614*	-0.039	-0.314	chlorophyll
-0.416	-0.627*	-0.591*	-0.418	-0.320	fat

DISCUSSION :

Concentration of heavy elements in the *Ceratophyllum demorsum* plant:

Aquatic plants are biologically important, because they represent the base of the food chain hierarchy, as they are an essential source of energy in the aquatic environment, and they also provide suitable grounds for aquatic organisms and living and feeding areas for fish[11]. Plants also have a high resistance against heavy concentrations of heavy metals, and the distribution of these minerals varies according to the type of plant, plant root, stem, and leaves[12]. The results of the current study showed a noticeable increase in the concentrations of the lead component during the fall season and the zinc component during the summer. The reason may be due to their rise in sediments during these two seasons, and this corresponds to what was stated[13].

1. Total Chlorophyll : When Brassica plant is exposed to large quantities of heavy metals, it will cause physiological damage that leads to the inhibition of chlorophyll and thus decrease photosynthesis. The results of the study showed a decrease in the concentrations of chlorophyll for the plant.[14] The results of the statistical analysis also showed an inverse correlation between the total chlorophyll of the *Ceratophyllum demorsum* plant and some heavy metals. This indicates the negative effect caused by the heavy metals of the plant, and this corresponds to[15].

2. Fat: All plant cells are surrounded by a membrane called the plasma membrane. One of the most important components of this membrane is fat. This membrane is the first target of heavy metal toxicity by oxidizing and linking thiol groups SH in proteins which leads to inhibition of plasma membrane proteins and thus a change in the composition of fats[16]. The results of the study showed a decrease in the total fat content in the *Ceratophyllum demorsum* plant, and the reason may be due to the effect of heavy metals on it. This confirms that there is a negative correlation between fats and some heavy elements. Heavy metals are high.

CONCLUSIONS :

1. The *Ceratophyllum demorsum* plant recorded a noticeable increase in the concentrations of the copper and zinc elements during the study period, and this poses a risk to aquatic organisms, reaching the human being through the food chain.

2. The study recorded a clear decrease in the concentrations of total chlorophyll and fats in the *Ceratophyllum demorsum* without the plant reaching death.

3. *Ceratophyllum demorsum* can be used as good life evidence to pollute the aqueous environment with heavy metals. It can also work to purify the water from these harmful minerals.

REFERENCES :

1. Abdolali A, Ngo H.H, Guo W, Zhou J.L, Zhang J, Liang S et al. Application of a breakthrough biosorbent for removing heavy metals from synthetic and real waste waters in a lab-scale continuous fixed-bed column. Bioresource technology;2017:229, 78-87.
2. Al-Taisan W. Suitability of using *Phragmitus australlis* and *Tamarixa phylla* as vegetation filters in industrial areas. America J.of Environ.Sci.;2009:5(6) : 740-747.
3. Aravind P, Prasad M.N.V, Malec P, Waloszek A, Strzalka K. Zinc protects *Ceratophyllum demersum* L. (Free floating hydrophyte) against reactive oxygen species induced by cadmium .J. of Trace Elem. Medi. Bio;2009; 23 : 50- 60.
4. Skorbilowicz E. Aquatic plants as bio indicators of contamination of upper Narew river and some of its tributaries with heavy metals . Environ. Protec. Engineer ;2009:35 (1) : 65-77.
5. Ferrat L, Martini P.C, Romeo M. Assessment of the use of bio indicators in aquatic plants for evaluation of environmental quality : application to sea grasses . Aquatic Toxicology ;2003;(65) : 187 204.
6. Kakar S, Wahid A, Tareen R.B, Kakar S.A , Tariq M, Kayani S.A. Impact of municipal waste water of Queta city on biomass , physiology and yield of canola (*Brassica napus* L.) .Pak. J. Bot. ;2010: 42 (1) : 317- 328.
7. Antonijevic M.M, Maric M. Determination of the content of heavy metals in Pyrite contaminated soil and plants . Sensoers;2008: 8 : 5857-65.
8. Makinney G. Absorption of light by chlorophyll solution. J. Biol. Chem;1941:140:315-322.
9. Arnon D.I. Copper enzyme in isolated chloroplasts polyphenol oxidase in (Beta vulgarisL.) Plant Physiol;1949: 24: 1-15.
10. Lambert P, Dehnel P.A. Seasonal variation in biochemical composition during the reproduction cycle of the intertidal gasteropoda*Thais lamellose* candian Journal of Zoology;1974 52: 305-318.
11. Chevre N, Gagne F, Blaise C. Development of a biomarkers based index for assessing the ecotoxic potential of aquatic sites . Biomarkers;2003; 8 : 287 -298.
12. Videa J.R, Loppz M.L, Narayan M. The biochemistry of environmental heavy metals uptake by plants : implication for the food chains. The Inter. Nation. J. of Boche & cell.,Bio;2009;41:1665-1677.
13. Delavar A. M, Safari Y. Spatial distribution of heavy metals in soils and plants in Zinc Town, northwest Iran . Int. J. Environ. Sci. Technol;2016;13:297306.
14. Mourato M.P, Moreira I.N, Leitão I, Pinto F. R, Salesn J.R, Martins L.L. Effect of Heavy Metals in Plants of the Genus Brassica . Int. J. Mol. Sci.;2016:16, 17975-98.
15. Al-Khafaji, Hoda N.F. (2018) The effect of heat plant emission on the concentration of some heavy elements and some biochemical characteristics of two types of wild plants (Suaedavermiculata) and alaci (Alhagimaurorum). Master Thesis. DhiQar University / College of Science
16. Meharg A.A. The role of the plasmalemma in metal tolerance in angiosperms. Physiologia Plantarum;1993:88(1), 191-198.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00096.5

Original Research Paper

Arsenic Induced Histopathological Changes in Brain, Liver and Kidneys of Wistar Albino Rats : A Dose Comparative Study

1. **Hashim A,** Lecturer/Toxicologist, Department of Forensic Medicine and Toxicology, Yenepoya deemed to be University, Mangalore, Dakshina Karnataka, India
2. **Sanila Rahim,** Assistant Professor, Department of Pathology, Yenepoya deemed to be University, Mangalore, Dakshina Karnataka, India
3. **Mohammed Gulzar Ahmed,** Dean, Yenepoya Pharmacy College and Research centre, Yenepoya deemed to be University, Mangalore, Dakshina Karnataka, India
4. **K. Leena Pramod,** Assistant Professor, Department of Forensic Medicine and Toxicology, Yenepoya deemed to be University, Mangalore, Dakshina Karnataka, India

ABSTRACT :

Introduction : Several line of studies have indicated high concentrations of arsenic in the liver, kidney, brain, lungs, hair and nails. Epidemiological studies have shown association between chronic arsenic exposure liver disease, kidney failure and brain damage. Moreover, the pathological changes are poorly understood. Understanding the organ specific histological effect of arsenic is necessarily important to know the detailed mechanism of arsenic mediated toxicity in mammals.

Material and Method : This study was designed to evaluate the histopathological changes by chronic arsenic exposure on some tissue architecture in rats.

Results : These findings from animal model clearly indicate the possible role of arsenic in various diseases in human populations continuously being exposed to arsenic through drinking water as well as food. A better understanding of the effect of arsenic at target organs with an emphasis on observation of tissue architecture at critical sites may be useful to develop an effective drug for its treatment, where thousands of people are suffering from arsenic poisoning.

Corresponding Author:
Dr. Hashim. A,
Lecturer/Toxicologist, Department of Forensic Medicine and Toxicology, Yenepoya deemed to be University, Mangalore, Dakshina Karnataka, India
Contact : +91 9742555052
Email : mhdhashim@gmail.com

Article History :
Received : 20 August 2019
Received in revised from : 29 August 2019
Accepted on : 29 August 2019
Available online : 30 April 2020

Key words: Arsenic, Histopathology, rat tissues

INTRODUCTION :

Arsenic is a naturally occurring steel grey colour solid material. It is widely distributed in the Earth's crust in both organic and inorganic forms. Inorganic arsenic, is the most abundant type, found in soils, sediments, ground water and in many kinds of rock, especially in minerals and ores that contain copper or lead. It is associated with more adverse health effects for humans. About 21 countries around the world are being affected by groundwater arsenic contamination. The risk of arsenic-induced diseases is particularly high in developing countries[1, 2]. Water sources in some parts of India have higher naturally occurring levels of inorganic arsenic than other areas[3]. Studies have indicated that the toxicity of arsenic depends on the exposure dose, frequency and duration, biological species, genetic, age, sex as well as individual susceptibilities.

Chronic exposure to arsenic produces renal injuries in human. Kidney tissues are more vulnerable to arsenic intoxication. It is evident from various studies that arsenic accumulation in rat liver is dose dependent and can cause histopathological changes. Recent studies have shown that even low concentrations of arsenic can damage neurological function, particularly in children[4,5].

Several studies have showed effect of arsenic in various tissues and organs. Moreover, the risk involvement of this metal is not well documented. In this study an attempt is made to know about the histopathological changes associated with different doses of arsenic in experimental rats. Understanding the organ specific histopathological effect of arsenic is necessarily important to identify the detailed mechanism of arsenic induced toxicity in mammals.

MATERIAL AND METHODS :

Animals and housing conditions : Present study was conducted in 2018 after obtaining ethical clearance from Institutional Animal Ethics Committee, Yenepoya deemed to be University, Mangalore, Karnataka. Aim of the study was to find out the histopathological effects of arsenic toxicity in animal model. Female *Wistar* albino rats weighing about 200-220 g, of age 60-90 days, were procured from Kasturba Medical College, Mangalore, Karnataka, India. The animals were housed in solid bottom polypropylene cages with 12 h-12 h light-dark cycle. Animals were placed on commercial standard pellet feed for rats and provided water *ad libitum.*

Wister albino rats was administered with Sodium arsenite by oral route for consecutive 28 days. Total of rats (n=20) were divided randomly into four groups of 5 rats each with Group 1: normal control, Group 2: arsenic treated (sodium arsenite @ 20 mg/kg/day, low dose), Group 3: arsenic treated (sodium arsenite @ 40 mg/kg/day, medium dose), Group 4: (sodium arsenite @ 80 mg/kg/day, high dose) respectively. At the end of 28th day, animals were euthanized using high dose of ketamine. The brain, kidney and liver were collected in 10% buffered formalin for histopathology. The histological examination was carried out by Haematoxylin & Eosin (H&E) staining.

Chemical and dosing : Sodium arsenite ($NaAsO_2$) purchased from Durga Laboratory, Mangalore, Karnataka, India was dissolved in distilled water (2g/Litre.) and kept as a stock solution. The daily dose levels of Sa used in the present study, was set as: **20** mg/kg/day, **40** mg/kg/day, **and 80** mg/kg/day**.** Control rats were maintained with available supply of distilled water and normal rats feed.

Histopathological study : At the end of 4 weeks, rats were euthanized and kidney, liver and brain were collected and kept in 10% buffered formalin solution for 24 hours., passed through ascending series of ethanol baths, cleared in xylene and embedded in paraffin. Tissues were sectioned at 5 µm and stained with Haematoxylin and Eosin (H&E). The sections were examined under light microscope.

RESULTS AND DISCUSSION :

Histopathological Observations

To understand the tissue changes in different doses of arsenic, three types of tissue (Brain, Liver and Kidney) were subjected to histopathological examination

Kidney :

Normal Kidney Architecture in shown in **Figure 1 a**

In 80 mg/kg body weight - Histopathology slide showed congestion, fat bodies, degenerative changes in epithelial cells of renal tubules, lumen filled with granular material and desquamated epithelium (more than 50%).Degenerated cells were showing cytoplasmic vacuolation and cytoplasmic blebbing. Necrosis of the convoluted, distal and proximal tubules were in abundance**(Figure 1 b).**

Fig. 1 (a) Normal Kidney

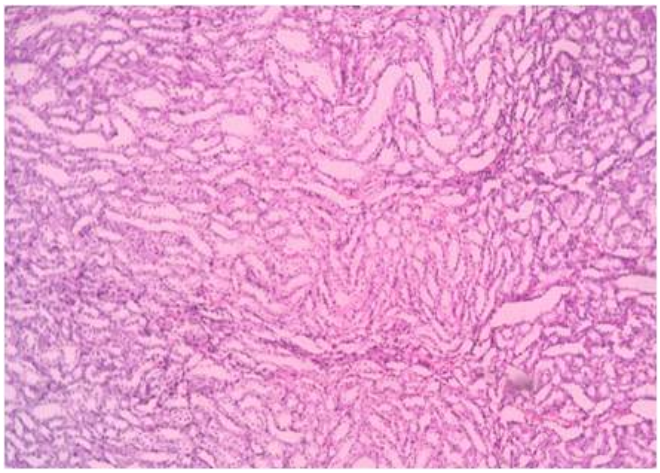
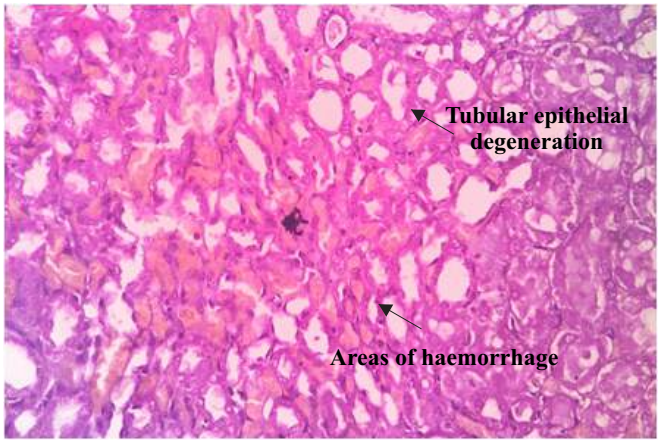


Fig. 1 (b) Arsenic treated 20 mg



In 40 mg/kg body weight - degenerative changes, lumen filled with granular material and desquamated epithelium (less than 50%). mononuclear cell infiltration in the tubules and reduced glomerular space was observed. **(Figure 1 c).**

In 20 mg/kg body weight - The kidney showed the areas of hemorrhages. Epithelial cells of Proximal and distal tubules were showing areas of degeneration**(Figure 1 d).**

In contrast, tissue architecture, glomerulas were normal in control kidney tissue**(Figure 1 a).**

There was a strong dose-response relationship between kidney damage and arsenic exposure.

Degenerative changes was observed in kidney tissue in arsenic treated rats **(Figure 1 b to figure 1 d)**. These findings may be justified by a recent observation made by other authors that

includes shrinkage of the glomerulus, increase in the Bowman's space, papillary necrosis, hyperplasia of the epithelium covering the papillae, irregularities in the renal tubule including apoptotic and necrotic cells, decreased intertubular space and enlargement of the height of the brush border cells [6,7].

Fig. 1 (c) Arsenic treated 40 mg

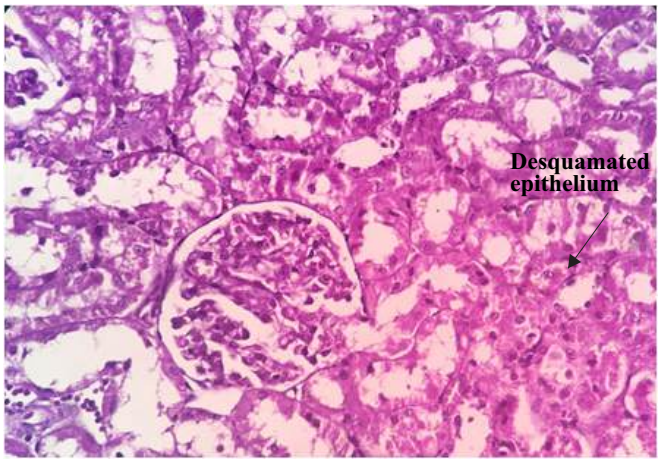
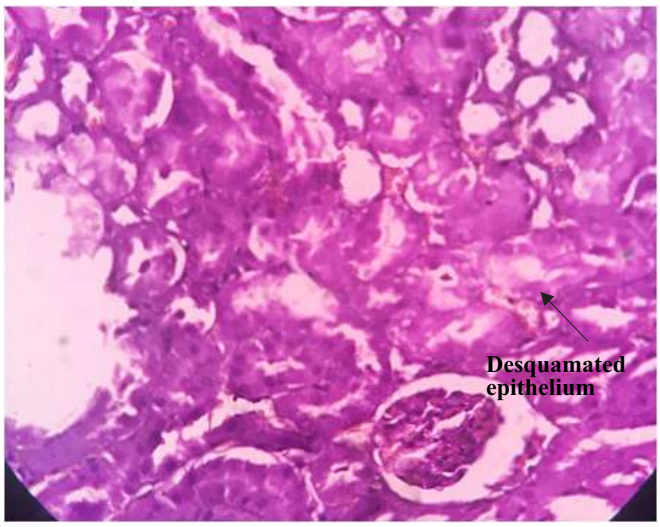


Fig. 1 (d) Arsenic treated 80 mg



Another study revealed mild to severe type of necrosis and degenerative changes in distal and proximal tubules of kidney. The renocytes of proximal and distal tubules were showing hydropic and fatty degeneration and Glomeruli cells were contracted. Due to degenerative changes cells were showing cytoplasmic vacoulation and nuclear blebbing [8].

Nephrotoxicity of sodium arsenate was also evaluated in dogs. Examination of biopsy specimens indicated that the low dose of the arsenic salt produced histologic changes consisting of mild degeneration and vacuolation of renal tubular epithelium, acute tubular necrosis, moderate glomerular sclerosis [9].

Kidney is an organ that is rich in phospholipids and presence of arsenic leads to the oxidative degradation of phospholipids. Chronic exposure to arsenic induces damages to kidney tissue, during its urinary elimination especially the epithelial cells of proximal convoluted tubule and the podocytes of the Bowman's capsule[10].

Combined oxygen electrode and electron microscopic studies were conducted on kidneys of rats exposed to arsenate in the drinking water at different concentrations to evaluate in vivo mitochondrial toxicity. Ultrastructural alterations, which consisted of swollen mitochondria and increased numbers of dense autophagic lysosome-like bodies, were confined to proximal tubule cells of these animals [11.12].

These findings suggest that chronic exposure to low or high levels of arsenic might produce tubular damage in the kidney through oxidative stress in experimental animals or humans.

Further observation included areas of hemorrhages **(Figure 1 d),**lumen filled with granular material and desquamated epithelium. **(Figure 1 b)**

Previous studies done by various researchers, support current findings of this study.

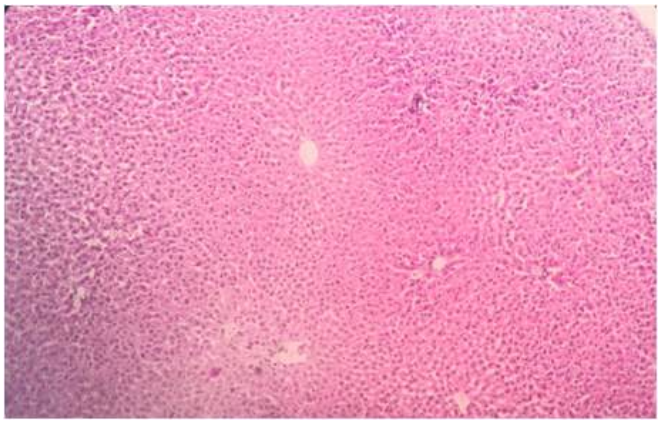
Generally, the histological changes seen in cortex and medulla of kidney in 80 mg/kg body weight and 40 mg/kg body weight were more serious than those observed in 20 mg/kg body weight.

Liver :

Heavy metals are known to produce necrosis in tissues especially in liver. Necrosis was observed in all the treated groups.

Normal liver architecture in shown in **Figure 2a**

Fig. 2 (a) Normal liver



In 80 mg/kg body weight, the sections of liver in this group showed cellular oedema, loss of eosinophilia, nuclear pyknosis, cytoplasmic vacuolation (more than 50%), congestion of central vein with degeneration and necrosis in hepatic parenchyma and fatty changes **(Figure 2b).**

In 40 mg/kg body weight showed congestion of central vessels, cytoplasmic vacuolation, periportal fibrosis, mono nuclear inflammatory infiltrate and fatty change in hepatocytes **(Figure 2c).**

In 20 mg/kg body weight showed congested vessel and mono nuclear inflammatory infiltrate **(Figure 2d).**

In control liver, tissue architecture hepatic lobules were intact **(Figure2a).**

Fig. 2 (b) Arsenic treated 20 mg

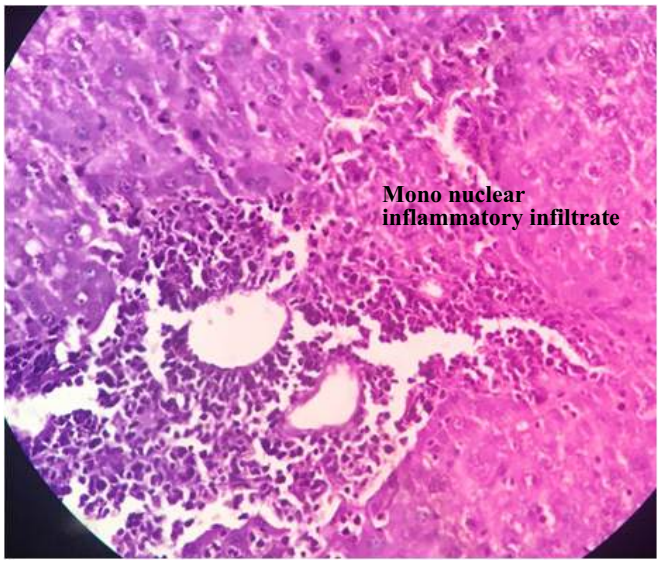
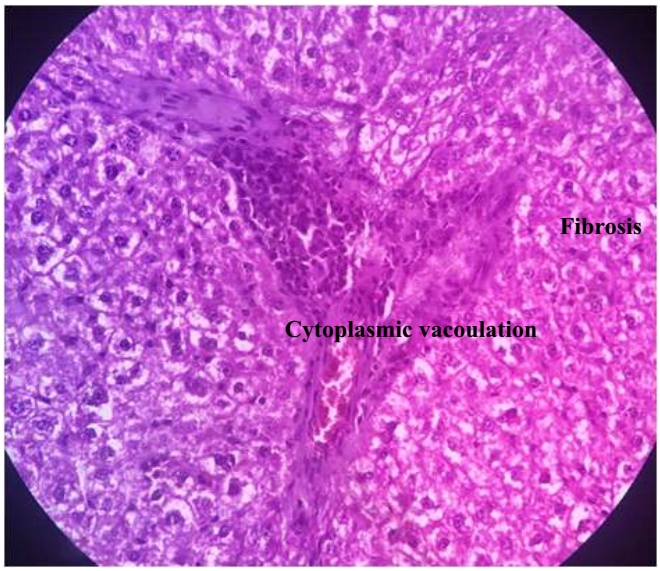
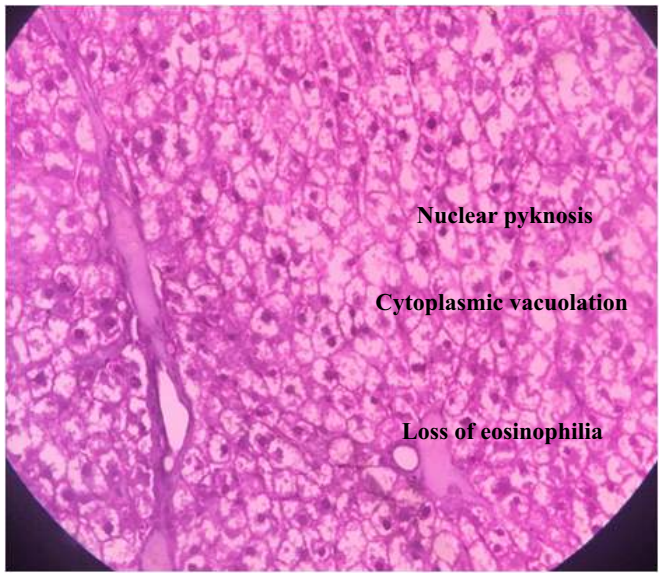


Fig. 2 (c) Arsenic treated 40 mg



Liver has long been identified as a target organ of many xenobiotics including arsenic because of its unique metabolic functions. The sections of liver in treated groups showed severe to moderate fatty degeneration and necrosis in hepatic parenchyma (Figure 2 b to Figure 2 d), this is as a result of disintegration of the normal cellular structure in the control group whereas control did not reveal any lesions of pathological significance (Figure 2 a).

Fig. 2 (d) Arsenic treated 80 mg



Previous studies revealed that there is a marked fatty infiltration characterized by vacuolar degeneration followed by hepatic necrosis. Tissue disorientation, peliosis, karyolysis, apoptosis were also evident in arsenic treated rats[6]. Liver inflammation, steatosis (fatty liver), cytoplasmic blebbing, fibrosis, sinusoidal spaces were expanded due to shrinkage were also observed in the studies[7-13].Chronic arseniasis also been attributed to hepatocellular carcinoma, angiosarcoma, cirrhosis, and hepatoportal sclerosis[14].

Pattern of toxicopathology in the exposure group may be related to the significantly higher oxidative stress, demonstrated through lipid peroxidation at higher doses[15]. Like other toxic elements sodium arsenite primarily increased the generation of free radical species and causes an imbalance between pro-oxidation and antioxidant homeostasis in liver resulting in hepatic degeneration. Raised serum level of liver enzymes is primarily due to disruption of the liver cells by arsenic. Another study observed various parameters of oxidative stress such as significant lipid peroxidation and cytochrome-P450 induction along with significant decrease in catalase, glutathione, and superoxide dismutase in liver tissue [16-17].

Santra et al. have shown that two-month exposure to arsenic caused significant elevation of hepatic GSH compared to control mice. The results suggested that the antioxidant defence system in the liver of mice is activated after exposure to arsenic for two months. However, prolonged exposure to

arsenic probably causes overuse failure of this system, which might result in initiation of biochemical injury to the liver[18].

Brain :

Normal brain architecture in shown in **Figure 3a**

In 80 mg/kg body weight Nuclear vacuolation, pyknosis, cellular oedema, neuritic loss and lysis of neurons were observed in the cerebral cortex of the rats. These changes were also observed in Purkinje cells of the cerebellar cortex **(Figure 3b).**

Fig. 3 (a) Normal brain

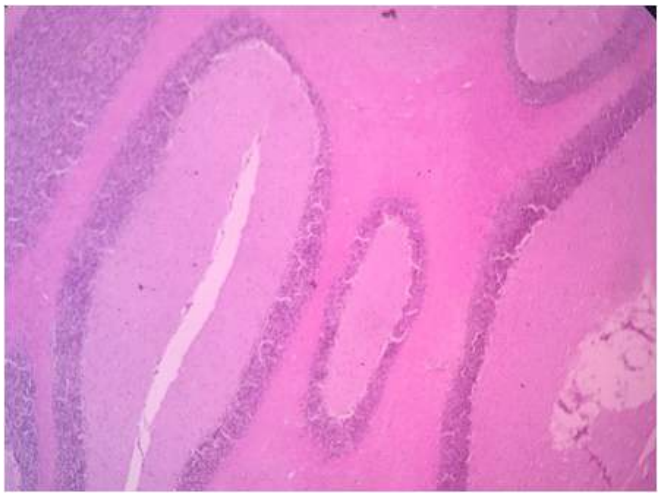
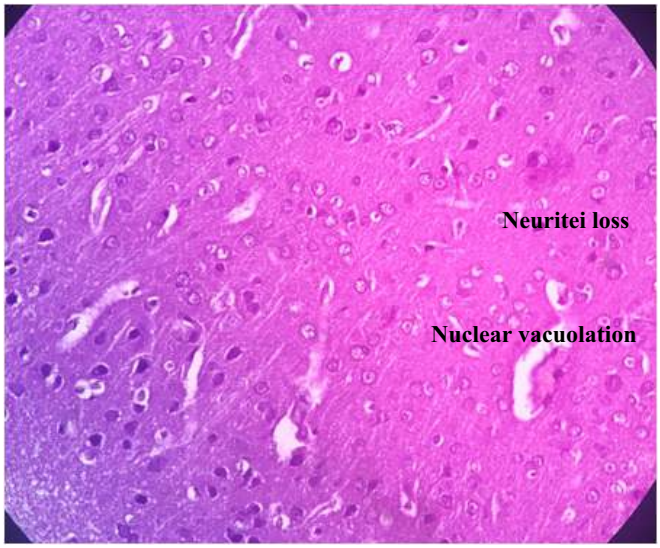


Fig. 3 (b) Arsenic treated 20 mg



In 40 mg/kg body weight neuritic loss, nuclear vacuolation, pyknosis, cellular oedema, and necrosis in mild to moderate **(Figure 3c)**.

In 20 mg/kg body weight neuritic loss, nuclear vacuolation, pyknosis, cellular oedema in mild to moderate **(Figure 3d)**.

No histopathological changes were observed in the cerebral and cerebellar cortex of the control groups **(Figure 3a)**

There are numerous reports on arsenic induced brain disorders, a few have evaluated the histological changes in brain by arsenic. In the current report, we have found oedema, neuritic loss, lysis of neurons, nuclear vacuolation, pyknosis in arsenic exposed rat brain tissue **(Figure 3 b to Figure3 d).**

Fig. 3 (c) Arsenic treated 40 mg

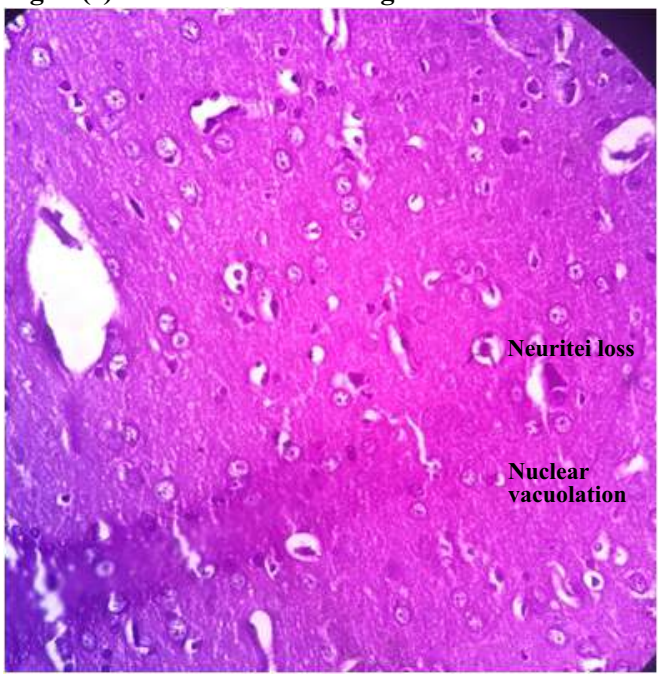
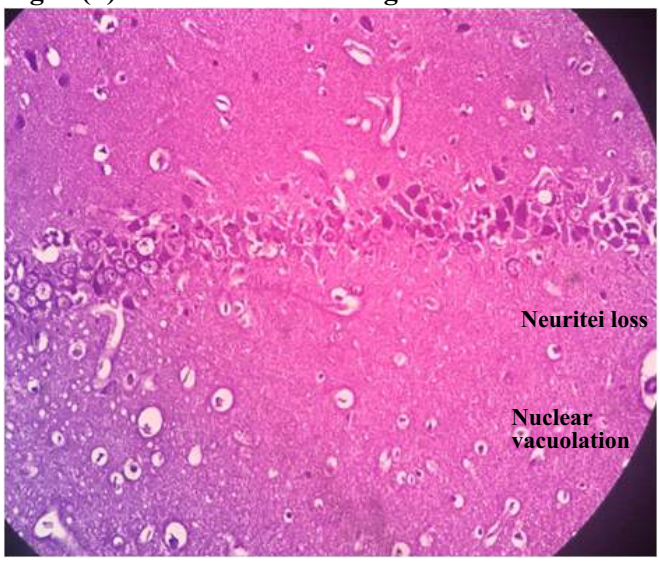


Fig. 3 (d) Arsenic treated 80 mg



Nuclear vacuolation, neuritic loss, clustering of nerve cells and lysis of neurons were observed in the cerebral cortex and purkinje cells of the cerebellar cortexby Piao et al. [19]Accumulation of serous fluid and neuronal degeneration and necrosis were observed in cerebrum and spinal cord. [20, 21]. Brain of rats treated with sodium arsenate revealed pyknosis of

neurons, neuronophagia, focal cerebral gliosis, cellular oedema, congestion of cerebral blood vessel and focal cerebral haemorrhage[22]. Ultrastructural pathological changes of cortex showed vacuolar degeneration of neurons, karyotin aggregating the side of karyotheca, nuclear oedema and hydropic degeneration [23,24].

Chronic arsenic exposure causes oxidative damage in rat brain, so the brain histopathological changes may be due to the oxidative stress mediated by sodium arsenite. Oxidative stress plays a crucial role in the arsenic (III)-induced neurotoxic effects on locomotor behaviour and the structures and function of Amphid finger cell (AFD), sensory neurons in exposed nematodes (Caenorhabditis elegans) [25]. Disturbed balance of oxidants and antioxidants and heat shock protein (HSPS) response was also observed in chicken brain tissues [26]. A study by Chattopadhyay et al showed that the rats exposed to arsenic had increased level of ROS (reactive oxygen species) and RNO (reactive nitrogen species), loss of glutathione content, increase in lipid peroxidation and decreased superoxide dismutase and may lead to apoptosis [27].

The toxicity effects of sodium arsenite display on histological changes shows the effect of renocytes, hepatocytes and neuronal cells under microscopic observation. In addition, these results showed direct relationship between concentration of sodium arsenite and histological changes on Wistor albino rat's tissue. In another words, the increases of arsenic doses directly increasing the severity of histological changes.

CONCLUSION :

The current investigation revealed varied degree of histopathological changes in different organs such as liver, kidney and brain at different doses of arsenic. These findings from animal model clearly indicate the possible role of arsenic in various diseases in human populations continuously being exposed to arsenic through drinking water as well as food. The results of present study are in agreement with previous observation. However, further research is necessarily important to know the detailed mechanism of sodium arsenite induced changes in tissue architecture, for which knowledge on the histopathology may be utilized. The findings of this study in animal model might become useful to develop effective drug against arsenic mediated toxic effects on human health.

Funding: Self funded

The manuscript is not presented in any CME/conferences.

Declarations : Conflict of interest: The authors declared that there is no conflict of interest.

Ethical approval: Obtained from (Yenepoya University Ethics Committee and Institutional Animal Ethics Commitee, Mangalore, Karnataka, India)

Acknowledgment : I am thankful to Dr. Shareef NM,Shaik Rasheed MPT, Fathimath Rasbeena,Teaching and nonteaching staffs of Department of Forensic Medicine and Toxicology, Department of Pharmacology, Department of Pathology, Yenepoya Medical College, Mangalore, India for their kind help and support during this study.

REFERENCES :

1. Rakhunde R, Jasudkar D, Deshpande L, Juneja HD, Labhasetwar P. Health Effects and Significance of Arsenic Speciation in Water. International Journal of Environmental Sciences and Research. 2012;1(4): 92-96.
2. US Environmental Protection Agency. Drinking Water Requirements for States and Public Water Systems. Chemical Contaminant Rules. Office of water. EPA 815-F-00-016. 2001
3. Ghosh NC, Singh RD. Groundwater Arsenic Contamination in India: Vulnerability and Scope for Remedy. National Institute of Hydrology, Roorkee, Uttarakhand, India.
4. Ratnaike RN. Acute and chronic arsenic toxicity. Postgrad Med J. 2003; 79:391396.
5. Mazumder GDN. Chronic arsenic toxicity and human health. Indian J Med Res. October; 2008; 128:436-447.
6. Roy S, Bhattacharya S. Arsenic-induced histopathology and synthesis of stress proteins in liver and kidney of Channa punctatus. Ecotoxicology and Environmental Safety. October 2006; 65(2): 218-229.
7. Murai T, Iwata H , Otoshi T , Endo G, Horiguchi S,Shoji Fukushima S. Renal lesions induced in F344/DuCrj rats by 4-weeks oral administration of dimethylarsinic acid. Toxicology Letters. January 1993;66 (1):53-61.
8. Ferzand R, GadahiJA, SalehaS, Ali Q.Histological and Haematological Disturbance Caused by Arsenic Toxicity in Mice Model. Pakistan Journal of BiologicalSciences. 2008;11 (11): 1405-1413.
9. Tsukamoto H , Parker HR , Gribble DH , Mariassy A , Peoples SA . Nephrotoxicity of sodium arsenate in dogs. American Journal of Veterinary Research. Dec 1983;44(12):2324-2330
10. Li Z, Piao F,Liu S, Yan Wang Y.Subchronic exposure to arsenic trioxide-induced oxidative DNA damage in kidney tissue of mice. Experimental and Toxicologic Pathology. September 2010; 62 (5) :543-547.
11. Brown MM, Rhyne BC, Goyer RA, Fowler BA. Intracellular effects of chronic arsenic administration on renal proximal tubule cells. Journal of Toxicology and

Environmental Health. 1976;1(3) :505-514.

12. Huang M, Choi SJ, Kim DW, Kim NY, Park CH, Yu SD. Risk Assessment of Low-Level Cadmium and Arsenic on the Kidney. Journal of Toxicology and Environmental Health, Part A. 2009;72 (21-22): 1493-1498
13. Wu J, Liu J, Waalkes MP, Cheng ML, Li L, Li CX, Yang Q. High Dietary Fat Exacerbates Arsenic-Induced Liver Fibrosis in Mice. Experimental Biology and Medicine.March 2008; 233 (3):377-84
14. Centeno JA, Mullick FG, Martinez L, Norbert P, Gibb H, Longfellow D. Pathology related to chronic arsenic exposure. Environmental health perspectives. October 2002
15. Nain S, Smits. Environ Toxicol. Wiley Periodicals, Inc. 2010;(2)
16. Mazumder DNG. Effect of chronic intake of arsenic contaminated water on liver. Toxicology and Applied Pharmacology. August 2005;206 (2): 169-175
17. Bashir S, Sharma Y, Irshad M, Dutta Gupta SD, Dogra TD. Arsenic-Induced Cell Death in Liver and Brain of Experimental Rats. Basic and clinical pharmacology and toxicology. January 2006; 98 (1): 38-43.
18. Santra A, Maiti A, Chowdhury A, Mazumder DN. Oxidative stress in liver of mice exposed to arsenic-contaminated water. Indian Journal of Gastroenterology. Jul 2000, 19(3):112-115.
19. Piao F, Ma N, Hiraku Y, Murata M, Oikawa S, Cheng F, et al. Oxidative DNA Damage in Relation to Neurotoxicity in the Brain of Mice Exposed to Arsenic at Environmentally Relevant Levels. J Occup Health 2005; 47: 445449
20. Mundey MK, Roy M, Roy S, Awasthi MK, Richa Sharma R. Antioxidant Potential of Ocimum sanctum in ArsenicInduced Nervous Tissue Damage. Braz J Vet Pathol, 2013, 6(3), 95 101.
21. Ghosh A, Ardhendu K. Mandal, Sarkar S, Das N. Hepatoprotective and neuroprotective activity of liposomal quercetin in combating chronic arsenic induced oxidative damage in liver and brain of rats. Drug Delivery. 18:6, 451-459
22. Amal EA, Mona HM. Protective effect of some antioxidants on the brain of adult male albino rats, Rattus rattus, exposed to heavy metals. Bioscience Research, 6(1): 12-19, 2009
23. Hua XS, Fan SG, Juan SW. Arsenic-induced Oxidative Damage and Histopathological Changes in Brain of Rat Offspring. Industrial Health and Occupational Disease. 2008;02
24. Noman ASM, Dilruba S, Mohanto NC, Rahman L, Khatun Z,Riad W, et al. Arsenic-induced Histological Alterations in Various Organs of Mice. J Cytol Histol. 2015 May; 6(3): 323.
25. Yu CW, Liao VH. Arsenite induces neurotoxic effects on AFD neurons via oxidative stress in Caenorhabditis elegans. Metallomics. 2014 Oct;6(10):1824-31.
26. Zhao P, Guo Y, Zhang W, Chai H, Xing H, Xing M. Neurotoxicity induced by arsenic in Gallus Gallus: Regulation of oxidative stress and heat shock protein response. Chemosphere. 2017 Jan;166:238-245.
27. Chattopadhyay S, BhaumikS, Purkayastha M, BasuS, Chaudhuri AN, Gupta SD. Apoptosis and necrosis in developing brain cells due to arsenic toxicity and protection with antioxidants. Toxicology Letters. 2002;136 (1) : 65-76

J Punjab Acad Forensic Med Toxicol 2020;20(1) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00097.7

Original Research Paper

Determining the effect of emotions on handwriting from suicide notes

1. **Vaishali,** Ph.D Research Scholar, School of Forensic Science, National Forensic Sciences University, Gandhinagar-382007, Gujarat.
2. **Surbhi Mathur,** Senior Assistant Professor, School of Forensic Science, National Forensic Sciences University, Gandhinagar-382007, Gujarat.

ABSTRACT :

Suicide notes nowadays are more commonly encountered by the document expert, with a challenge to establish its source and authenticity. It is always believed that suicide notes demonstrate high degree of natural variations in comparison to the natural writings of victims due to wide diversity of emotions. The main objective of this study is to measure the effect of emotions on the handwriting samples of victims of suicide cases in comparison to their natural handwritings. In this regard, the suicide notes and their standard samples were studied using different parameters and the class, individual and stylistic features were studied. Statistical evaluation carried out presented a significant result to be stated here. In this study significant differences in the results have been obtained for suicide note handwritings in contrast with their natural writings.

Corresponding Author :
Dr Surbhi Mathur,
Senior Assistant Professor,
School of Forensic Science, National Forensic Sciences University, Gandhinagar-382007, Gujarat.
Contact : +91 96879-24168
Email : surbhi.mathur@gfsu.edu.in

Article History:
Received: 3 April 2020
Received in revised form: 17 July 2020
Accepted on: 17 July 2020
Available online: 30 April 2021

KEYWORDS : Forensic, Suicide notes, Natural writings, Handwriting, Natural variations

INTRODUCTION :

Handwriting is defined as individuals personal style of penmanship based on the neuro-muscular coordination, it comes unconsciously. Forensic document examiners can examine the handwritings and variations in the handwriting. Emotion is a mental state that developed from the brain after receiving signals from nervous system associated with thoughts, behavioral changes, feelings, displeasure or degree of pleasure. Feelings can be characterized as a positive or negative experience that is related with a specific example of physiological movement. Emotions produce diverse physiological, social and subjective changes. By virtue of some external components, handwriting of the writer might be changed by one way or another. But the habit of writing remains unchangeable. Physical and mental conditions affect the handwriting of the writer. Factors like environmental conditions, age, health condition, influence of drugs and alcohol, guided hand also affects the writing properties. Mechanical factors like writing surfaces, writing instruments, position of the writer while writing affects the handwriting properties.

MATERIALS AND METHODS:

In this study, suicide notes and their standard samples are taken in order to study the effect of emotions and physical condition on the handwriting. The suicide notes and their natural handwriting samples were collected from the solved cases. To study the variations in handwriting characteristics, 75 handwriting samples i.e. 25 suicide notes samples and their 2 natural standards were collected. Out of 25, 23 suicide note samples are written in Gujarati language, 1 is written in Hindi language and 1 is written in English language. Out of 25, 16 suicide note samples are written by male and 9 suicide note samples are written by female. A Xerox copy of the suicide notes and their standard samples were taken on A4 sheet. Handwriting characteristics such as general or class characteristics, individual characteristics and stylistic features were used for the analysis of suicide notes and their standard samples.

Sample analysis : It can be both intra-comparison and inter-comparison.

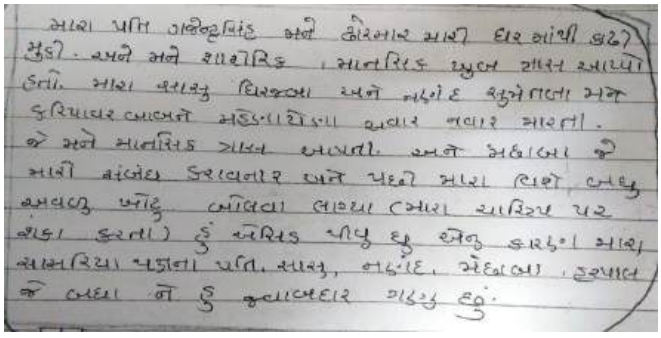


Figure 1 : Denotes the Suicide Note sample written in Gujarati language

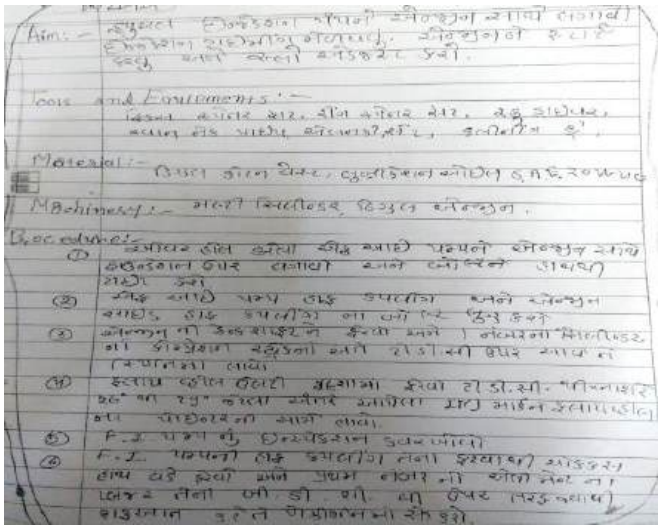


Figure 2 : Denotes the Natural writing sample written in Gujarati language

Results and discussions:

Table 1 : Denotes the Correlation Co-efficient analysis of various parameters of handwriting characteristics selected from suicide notes samples and natural samples.

Parameters	Suicide notes Samples	Natural Samples
Number of Words per line and Spacing between words	-0.49441	0.843501
Letter size and Spacing between words	0.992887	-0.46858
Number of Words per line and Letter size	-0.59439	0.079265

a) The correlation coefficient value for number of words per line and spacing in suicide notes was found to be **-0.49441** i.e**. -49.44%.** Negative weak correlation was observed where as in natural samples, it was found to be **0.843501** i.e. **84.35%.** Positive strong correlation was observed.

b) The correlation coefficient value for spacing and letter size in suicide notes was found to be **0.992887** i.e**. 99.29%.** Positive strong correlation was observed where as in natural samples, it was found to be -**0.46858** i.e. **-46.86%.** Positive strong correlation was observed.

c) The correlation coefficient value for number of words per line and letter size in suicide notes was found to be **-0.59439** i.e**. 59.44%.** Negative moderate correlation was observed where as in natural samples, it was found to be **0.079265 i.e**. **7.926%.** Positive weak correlation was observed.

The chi- values and P-values of parameter - Name and Identity of writer, Last wish of writer, Number of words per line and Spacing is found to be significant at alpha= 0.05, rejecting the null hypothesis and accepting the alternate hypothesis that the variations seen these parameters suicide notes and natural samples significantly depends upon the type of handwriting sample.

The chi- values and P-values of the other parameters except the above 4 is found to be not significant at alpha= 0.05, accepting the null hypothesis and rejecting the alternate hypothesis that the variations seen these parameters suicide notes and natural samples significantly not depends upon the type of handwriting sample. **(Table 2)**

Table 2 : Chi and P value of various parameters of handwriting characteristics selected from suicide notes and natural samples

No.	Parameters	Chi-Value	P Value
1	Name and Identity of writer	5.5556	0.018422
2	Last Wish of writer	24.5331	0.00001
3	Speed	0	1
4	Skill	0	1
5	Movement	0	1
6	Letter size	0	1
7	Spacing	18.5458	0.000094
8	Number of words per line	22.7426	0.000012
9	Margins	0.2222	0.637252
10	Alignment	0.8903	0.827763
11	Line Quality	0.3546	0.551515
12	Simplification of words	0	1
13	Mode of corrections	0	1
14	Cutting/ obliteration	2.5988	0.106948
15	Emphasizing on characters	2.1222	0.145174
16	Paragraph formations	0	1
17	Misspelling	3.3088	0.068909
18	Repeated Words	0.3546	0.551515
19	Retracings	0	1
20	Punctuation	0	1

CONCLUSION:

It is generally believed that handwriting is a behavioral characteristic which changes with time, physical, mental, emotional or by any other conditions. It is also believed that suicide notes demonstrate high degree of natural variations in comparison to the natural writings of victims due to wide diversity of emotions. But this study concluded that in spite of any change in physical or emotional condition of the writer, the style of penmanship of individual remains distinctive and can prove as a useful parameter for personal identification.

While there are some parameters like spacing, size, number of words per line, reason for suicide, last wish of writer and identity of writer, spelling mistakes, mode of corrections, alignment which shows notable variations in the handwriting of the writer under both normal conditions during the time of natural writings and emotional disturbances while writing suicide notes which can differentiate the handwriting of person

under different conditions.

But the majority of the handwriting characteristics do not show enough significant variations which can distinguish the writing of individual under several states of conditions. The parameters such as speed, movement, simplifications of words, repeated words, emphasizing on characters remains specific to a particular writer.

REFERENCES:

1. Sharma B. Forensic science in criminal investigation and trials. : 5th ed. New Delhi: Universal Law Publishing. Co.; 2003.
2. Hilton O. Scientific examination of questioned documents. Boca Raton, FL: CRC Press; 1993.
3. Huber R, Headrick A. Handwriting identification. Boca Raton: CRC Press; 1999.
4. Koppenhaver K. Forensic document examination. Totowa, N.J.: Humana Press; 2007.
5. Kelly J, Lindblom B. Scientific examination of questioned documents. Boca Raton, FL: CRC/Taylor & Francis; 2006.
6. Osborn A. Questioned documents. Albany, N.Y.: Boyd Print. Co.; 1929.
7. Saferstein R. Forensic science handbook. Upper Saddle River, NJ: Pearson/Prentice Hall; 2005.
8. Weissman M, Bland R, Canino G, Greenwald S, Hwu H, Joyce P et al. Prevalence of suicide ideation and suicide attempts in nine countries. Psychological Medicine. 1999;29(1):9-17.
9. Soman C, Safraj S, Kutty R, Vijayakumar K, Ajayan K. Suicide in South India: A community-based study in Kerala. Indian Journal of Psychiatry. 2009;51(4):261.
10. Hilton O. How Individual are Personal Writing Habits?. Journal of Forensic Sciences. 1983;28(3):11563J.
11. DeAngelis C. Effects of writing surfaces and author's position on handwriting. Journal of Questioned Document Examination. 1997;6:10 – 70.
12. Sanger S, Veach P. The Interpersonal Nature of Suicide: A Qualitative Investigation of Suicide Notes. Archives of Suicide Research. 2008;12(4):352-365.
13. Ballur M. Strategic evaluation of suicide notes. ICJJR. 2014.
14. Tarannum A. Suicide Notes on Unconventional Surface: A Trending Challenge. International Journal of Social Relevance & Concern (IJSRC). 2015.
15. Murty O. Suicide note: The last words. Journal of Forensic Medicine and Toxicology. 2015.
16. Gottschalk L, Gleser G. An analysis of the verbal content of suicide notes. British Journal of Medical Psychology. 1960;33(3):195-204.
17. Pak A, Bernhard D, Paroubek P, Grouin C. A Combined Approach to Emotion Detection in Suicide Notes. Biomedical Informatics Insights. 2012;5s1:BII.S8969.
18. Tuckman J, Kleiner R, Lavell M. Emotional Content Of Suicide Notes. American Journal of Psychiatry. 1959;116(1):59-63.
19. Koehler S. The Role of Suicide Notes in Death Investigation. Journal of Forensic Nursing. 2008;3(2):87-89.
20. Kishor M, Namratha P, Sathyanarayana Rao T, Raman R. Mysore study: A study of suicide notes. Indian Journal of Psychiatry. 2015;57(4):379.
21. Kuwabara H, Shioiri T, Nishimura A, Abe R, Nushida H, Ueno Y et al. Differences in characteristics between suicide victims who left notes or not. Journal of Affective Disorders. 2006;94(1-3):145-149.
22. Lester D. Differences Between Genuine And Simulated Suicide Notes. Psychological Reports. 2008;103(6):527.
23. Fernández-Cabana M, Ceballos-Espinoza F, Mateos R, Alves-Pérez M, García-Caballero A. Suicide notes: clinical and linguistic analysis from the perspective of the Interpersonal Theory of Suicide. The European Journal of Psychiatry. 2015;29(4):293-308.
24. Koppenhaver K. Forensic document examination. Totowa, N.J.: Humana Press; 2007.
25. Chynoweth R. The Significance of Suicide Notes. Australian & New Zealand Journal of Psychiatry. 1977;11(3):197-200.
26. Bandyopadhaya S. Method for authentication of handwritten suicide note. International Journal of Applied Research. 2016.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00098.9

Original Research Paper

Study of Fingerprints in Relation to Diabetes Mellitus

1. **Maitrayee Dutta Swargiary**, Assistant Professor, Department of Bio Sciences, Assam Don Bosco University, Tapesia Gardens, Sonapur
2. **Daibbyani Das**, B.Sc 4th Semester, Department of Zoology, Science College, Kokrajhar

ABSTRACT :

Introduction : Diabetes mellitus is a global disease and an endocrine disorder which results from defects in insulin secretion. The present study was carried to study the dermatoglyphic patterns of different age groups and to find the association of fingerprint patterns with Diabetes mellitus.

Materials and Methods : Fingerprints of 40 individuals of age group 40-70 years were sampled from Sapatgram Hospital, Sapatgram (Dhubri District) to study the pattern of fingerprints and their relation with Diabetes mellitus as they may be associated with the disease and serve as a predictor for its early detection. Analysis was carried out in the affected individuals.

Results : Percentage of ulnar loop is highest (18.57%) in females and also in males (50%) and percentage of accidental whorl is lowest (2.85% and 1.66%), whereas the normal had more percentage of radial loop in both males and females.

Conclusions: The study shows an association of dermatoglyphic pattern of fingerprints and prevalence of Diabetes mellitus.

Corresponding Author:
Dr. Maitrayee Dutta Swargiary,
Assistant Professor,
Department of Bio Sciences, Assam Don Bosco University,
Tapesia Gardens, Sonapur
Contact : +91 9957823714
Email : maitrayee.zoo@gmail.com

Article History :
Received : 21 June 2019
Received in revised from : 24 June 2019
Accepted on : 24 June 2019
Available online : 30 April 2021

Key words : Diabetes mellitus, fingerprint patterns, prevalence

INTRODUCTION:

Diabetes mellitus is a global disease and an endocrine disorder which results from defects in insulin secretion[1-6]. It may be of two types Type I and Type II Diabetes mellitus. Deficiency of insulin secretion leads to Type I and resistance to insulin action leads to type II diabetes [7-11]. As diabetes is predicted to double itself by 2030 affecting millions with maximum prevalence in India, investigators are on the lookout for predicting its detection at an early stage. Dermatoglyphics may hence play a significant role as its predictor and saving people from acquiring the disease [12]. As fingerprints formed during early gestation period are unique to each individual and since the importance of fingerprints in various fields viz., criminology, anthropology, medicine[5-6] is known and as the study of fingerprints reveal vital, genetical and medical information about an individual, there may be diseases like Diabetes mellitus which can also be solved by clinical dermatoglyphics[8-10]. Studies also reveal more prevalence of diabetes in elderly females than males[7]. If we have prior knowledge, necessary precautions can be taken much before its occurrence and so the present study was carried to study the dermatoglyphic patterns of different age groups and to find the association of fingerprint patterns with Diabetes mellitus.

MATERIALS & METHODS:

A total number of 40 elderly individuals in the age group of 40-70 years were selected from Sapatgram Medical Laboratory, Sapatgram Hospital (Dhubri District). A tabular chart was prepared before taking the fingerprint and clean finger imprints was taken for both hands on an A4 size paper by using a Kores stamp pad for the Ink Method of Cummins[3]. Sample fingerprints was then dried and studied with a magnifying lens with prior reference to identify the fingerprints. The fingerprint patterns were then classified according to the topological method of Galton[4] and Cummins[3] for fingerprint identification.

RESULTS:

Among the 40 individuals, 20 individuals suffered from Diabetes mellitus, out of which 6 were normal women and 14 were affected women, and 14 were normal males and 6 were affected males.

Fingerprints in normal individuals : Table1. established that in all normal individuals, the highest percentage of fingerprint pattern was observed for radial loops (38.5%), followed by plain whorl (20%), ulnar loop (18.5%), plain arch (11%), tented arch (6%), spiral whorl (4.5%), accidental whorl (4%),

Table 1. Comparative study of fingerprint patterns of normal and affected individuals

Fingerprint patterns	Left Hand				Right Hand				Both Hands			
	No. of Normal	Normal (%)	No of Affected	Affected (%)	No. of Normal	Normal (%)	No of Affected	Affected (%)	No. of Normal	Normal (%)	No of Affected	Affected (%)
Radial loop	42	21	15	7.5	35	17.5	25	12.5	77	38.5	40	20
Ulnar loop	17	8.5	41	20.5	20	10	15	7.5	37	18.5	56	28
Lateral pocket loop	0	0	0	0	3	1.5	0	0	3	1.5	0	0
Double loop	2	1	3	15	2	1	4	2	4	2	7	3.5
Plain whorl	15	7.5	6	3	25	12.5	19	9.5	40	20	25	12.5
Spiral whorl	1	0.5	2	1	8	4	3	1.5	9	4.5	5	2.5
Tented arch	8	4	15	7.5	14	7	25	12.5	22	11	40	20
Central pocket loop whorl	7	3.5	5	2.5	5	2.5	1	0.5	12	6	6	3
Accidental whorl	2	1	8	4	2	1	7	3.5	4	2	15	7.5
Accidental whorl	5	2.5	5	2.5	3	1.5	0	0	8	4	5	2.5

central pocket loop whorl (2%), double loop (2%) and lateral pocket loop (1.5%). The left hand shows a higher per centage (21%) radial loop count in normal and the radial loop count is 17.5% for right hand.

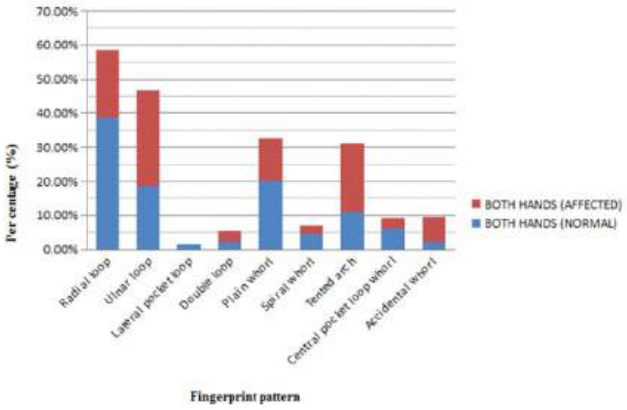
Fingerprints in affected individuals : In affected individuals with diabetes the highest per centage of fingerprint pattern was seen for ulnar loop (28%), followed by plain arch (20%), radial loop (20 %), plain whorl (12.5%), central pocket loop whorl (7.5%), double loop (3.5%), tented arch (3%), accidental whorl (2.5%) and spiral whorl (2.5 %) (**Table 1**).

The left hand results shows a lesser per centage (7.5 %) radial loop and tented arch count compared to ulnar loop (20.5%) in affected individuals with no occurrence of lateral pocket loop. The right hand shows highest radial and tented arch loop count (12.5%) in affected individuals compared to ulnar loop (7.5%), with absence of lateral pocket loop whorl and accidental whorl. The fingerprint patterns of affected female and male individuals are graphically represented in **Fig.1 .**

Fingerprints in normal female individuals : The fingerprints of normal female in **Table 2**. shows radial loop (35.83%), plain whorl (22.5%), ulnar loop (15.83%), plain arch (10.83%), tented arch (8.33%), accidental whorl (5%), spiral whorl (4.16%), central pocket whorl (3.33%), lateral pocket loop (1.66%) and double loop (1.66%)

Fingerprints in affected female individuals : The data

Fig 1. Comparison of Fingerprint patterns of female and male individuals



represented in **Table 2.** on the fingerprints of affected female shows radial loop (18.57 %), radial loop (12.85%) and plain arch (12.85%), plain whorl (9.28%), central pocket whorl (3.57%), accidental whorl (2.85%), double loop (1.42%), spiral whorl (1.42%), tented arch (1.42%). In affected females the lateral pocket loop is not observed.

Fingerprints in normal male individuals : As observed in **Table 2** in normal male the highest percentage of fingerprint is found in radial loop (42.5%), ulnar loop (22.5%), plain whorl (16.25%), plain arch (11.25%), spiral whorl (5%), double loop (2.5%), tented arch (2.5%), accidental whorl (2.5%), lateral

Table 2. Comparative study of fingerprint patterns of normal and affected female and male individuals

		Difference in percentage					
Sl. No	Fingerprint patterns	Normal individuals (%)	Affected individuals (%)	Normal Female (%)	Affected Female (%)	Normal Male (%)	Affected Male (%)
1	Radial loop	38.5	20	35.83	12.85	42.5	36.7
2	Ulnar loop	18.5	28	15.83	18.57	22.5	50
3	Lateral pocket loop	1.5	0	1.66	0	1.25	0
4	Double loop	2	3.5	1.66	1.42	2.5	8.33
5	Plain whorl	20	12.5	22.5	9.28	16.25	20
6	Spiral whorl	4.5	2.5	4.16	1.42	5	5
7	Spiral arch	11	0	10.83	12.85	11.25	36.66
8	Tented arch	6	3	8.33	1.42	2.5	6.66
9	Central pocket loop whorl	2	7.5	3.33	3.57	0	18.33
10	Accidental whorl	4	2.5	5	2.85	2.5	1.66

pocket loop (1.25%). Central pocket whorl is not observed in normal male **(Table 2).**

Fingerprints in affected male individuals : In affected male (**Table 2**), ulnar loop is found to be the highest (50%), followed by radial loop (36.7%), plain arch (36.66%), plain whorl (20%), central pocket whorl (18.33%), double loop (8.33%), tented arch (6.66%), spiral whorl (5%), accidental whorl (1.66%). Lateral pocket loop is not observed in affected male.

DISCUSSION:

In the study the loop fingerprint pattern varied among the individuals affected with Diabetes mellitus. The radial loop pattern (38.5%) fingerprint was found to be the highest and more prevalent in normal unaffected individuals whereas, ulnar loop (28%) is more prevalent in affected individuals. This result contradicts the results of workers where whorls are more prevalent in affected individuals [5].

Furthermore, comparative study between normal female and affected female also shows more number of radial loop (35.83%) and ulnar loop (18.57%) which contradicts the study of workers [6] where whorls were found to significantly increase in affected females.

This study also contradicts the study of workers [6] wherein female diabetic patients had higher frequency of arches. This result however may be at par with the studies that females are more prone to diabetes, which require further study [7].

Spiral arch and tented arch were found to be increased in males with significant reduction in arches in right hand in males compared to females and establishes conformity with workers [6]. The results of this study also show similarity of radial loop fingerprint pattern in both normal and affected males. However, in comparative studies with normal males the per centage of radial loop was found to be 42.5% and in affected male the fingerprint pattern in ulnar loop was found to be 50%. Thus ulnar loop may be an indicator to assess the susceptibility of an individual to Diabetes mellitus. The study thus shows a similarity with the studies of workers [1] wherein ulnar loops was indicated for its prevalence in affected individuals.

Comparative studies also showed that in normal male central pocket whorl is not observed and in diabetic male the lateral pocket loop is found to be lowest in per centage (1.25%) in normal compared to accidental whorls (1.66%) in affected males.

CONCLUSIONS:

It is hereby concluded from this study that

1. Ten different fingerprint patterns were observed in normal and frequency distribution of fingerprint patterns among normal students differs from affected individuals.
2. Frequency of Ulnar loop pattern is more prevalent

followed by radial loop pattern with the spiral loop pattern being the least in individuals with Diabetes mellitus, with no occurrence of accidental whorls compared to normal. This may serve as a predictor between fingerprint patterns and Diabetes mellitus.

3. The frequency of ulnar loop is more in left hand compared to right hand followed by the radial loop pattern. More radial loops is a negative indicator for Diabetis mellitus in normal and less radial loops compared to ulnar pattern can also be a predictor for diabetes mellitus as it is followed by the ulnar loop in affected individuals.
4. Lateral pocket loops are however, not found in affected individuals.
5. Out of the 40 individuals, 6 males and 14 females was found to be affected which may indicate that females may be more prone to Diabetes mellitus when they reach an age group of 40-70 years which however, require further study.
6. Thus dermatoglyphics gives a hope to predict Diabetes mellitus much before its initiation and gives us ample time to implement preventive measures. So further comparative studies is required to be carried out in the field of medicine in relation to genetical studies with large samples.

Funding: None

Conflicts of Interests: No conflicts of interest.

REFERENCES:

1. Burute P, Kazi SN, Vatsalaswamy, Arole V. Role of Dermatoglyphic Fingertip Patterns in the prediction of Maturity Onset Diabetes Mellitus (Type II). *IOSR* Journal of Dental and Medical Sciences 2013;8:1-5.
2. Chinmaya BR**,** Smitha BV**,** Tandon S**,** Khurana C. Dermatoglyphics: An indicator of dental caries in humans. Journal of Indian Association of Public Health Dentistry 2016;14(3):272-275
3. Cummins. Revised methods of interpretation and formulation of palmar dermatoglyphics. American Journal of Physical Anthropology 1929;12: 415-502
4. Galton F. Finger Prints. London: Macmillan and Co. 1892. pp.3-5
5. Lakshmi PJ, Thenmozhi R. A Short Review on Dermatoglyphics. J. Pharm. Sci. & Res. 2014;6(4):200-202
6. Mehta A and Mehta A. Study of fingerprint patterns in type II Diabetes mellitus, International Journal of Anatomy and Research 2015; 3(2):1046-1048
7. Mercedes SM, Augusto B, María VC, Alicia GM, Juan IGM, Maria VZ et al., Diabetes in older people: Prevalence, incidence and its association with medium- and long-term mortality from all causes, Atención Primaria 2014;46(7):376-384
8. Narang D, Das A, Kumar P, Sahani M, Tripathi V, Sur J et al., Dermatoglyphics (finger prints) as predilection marker for impacted teeth: A randomized blind trial, International Journal of Bioassays 2016;5(9):4851-4857
9. Rashad MN. Dermatoglyphic traits in patients with cardiovascular disorders. American Journal of Physical Anthropology 1975;42(2): 281-283.
10. Sehmi S. Dermatoglyphic patterns in Type II Diabetes mellitus. Anatomy Journal of Africa 2018;1:1162 - 1168
11. Sona M, Prasad LJ. Study of fingerprint pattern in patients with diabetes mellitus in a tertiary care centre, IOSR Journal of Dental and Medical Sciences(IOSR-JDMS) 2015;14(11):39-41
12. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes-estimates for the year 2000 and projections for 2030. Diabetes Care. 2004;27(3):104753

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00099.0

Original Research Paper

Comparison of Demirjian, Nolla and Cameriere's technique of age estimation using third molar teeth – A pilot study

1. **Deborah Sybil,** Professor, Department of Oral and Maxillofacial Surgery*
2. **Arpita Rai,** Associate Professor, Department of Oral Medicine and Radiology, Rajendra Institute of Medical Sciences, Ranchi
3. **Mandeep Kaur,** Professor, Department of Oral Medicine and Radiology*
4. **Megha Mohanan**, Dental Surgeon*
5. **Himani Khatter,** Biostatistician, Department of Neurology, Christian Medical College, Ludhiana

*Faculty of Dentistry, Jamia Millia Islamia, New Delhi-110025

ABSTRACT :

Introduction : There are numerous age estimation techniques available on the basis of developmental stages of third molar teeth. The present study aimed to determine the most accurate method of age estimation among Demirjian, Cameriere and Nolla based on the development of third molar tooth in the North Indian population.

Materials and Methods : The study included 100 patients between 12 and 25 years of age requiring orthopantomograms (OPG) for diagnostic or therapeutic purposes. Chronological age was obtained by subtracting the date of birth from the date of radiograph. The developmental stage of third molars was assessed using three methods – Demirjian, Nolla and Cameriere. Two investigators assessed all the blinded radiographs individually for all the three techniques at a gap of one week each.

Results : The coefficient of determination R^2 for entire sample in Demirjian method was 0.7575 and for Nolla and Cameriere method was 0.7326 and 0.7425 respectively. ROC analysis was done to determine if one of these three methods was more accurate to estimate legal age of maturity of 18 years. The Cameriere method showed greater accuracy with the cut off point for estimating the maturity age with 90.1% sensitivity and 94.7% specificity was a tooth maturity index of ≤0.34 having accuracy of 91%.

Discussion : All the three methods were good fit to estimate the chronological age of the patients in our study population. Cameriere method showed higher sensititvity and accuracy in estimating legal age of maturity as compared to the other two methods. .

Corresponding Author:
Dr. Deborah Sybil,
Professor,
Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Jamia Millia Islamia, New Delhi-110025
Contact : +91-9910766166
Email : dsybilg@gmail.com

Article History :
Received : 3 July 2019
Received in revised from : 6 July 2019
Accepted on : 6 July 2019
Available online : 30 April 2021

Key words: Age estimation, third molar, Demirjian, Nolla, Cameriere

INTRODUCTION:

Age estimation is one of the vital criteria in establishing the identity of a person. In forensic odontology, there is a need to estimate the chronological age due to increasing number of cases lacking age documentation and growing number of unidentified cadavers. Age estimation significantly narrows the search possibilities for law enforcement. In mass disaster and cluster victim situations, age segregation aids in the process of identification. It also helps in determining eligibility for social benefits, the age of license and the age of legal majority.[1] Reliability and adequate precision of dental age estimation is very important for legal reasons to judge a person of unknown age as juvenile or adult.[2]

Durability of dental structure makes it the material of choice in age estimation as compared to skeletal method, which is influenced by exogenous factors.[3] Age estimation using dental development determined from radiographs has been considered more definitive and useful than other maturity indicators such as hand wrist radiographs and cervical vertebrae maturity indicators, as it is least affected by variation in nutrition and endocrine status.[4] Tooth formation is suitable for age estimation because it is a continuous, progressive process that can be followed radiographically from the crypt stage to the closure of the root apex.[5]

Age estimation after 14 years of age has greatly shifted the focus on development of third molar as after the early teens most teeth have calcified and erupted except for the third molars. This makes the third molar development the most important choice for age assessment from the late teens to the early twenties.[6]

There are numerous age estimation techniques available on the basis of developmental stages of third molar teeth such as Demirjian et al, 1973; Nolla, 1960; Camerier, 2006; Gleiser and Hunt, 1955; Gustafson and Koch, 1974; Harris and Nortje, 1984; and Kullman et al, 1992.[7-13] Tooth development varies with different populations. Population specific studies have been conducted by various authors such as Mesotten et al, 2002; Olze et al, 2005; Mathew et al, 2017 and Thevissen et al, 2009.[14-17] Olze et al have validated the Demirjian method to provide the most accurate correlation between estimated and true chronological age compared to four other developmental staging systems.[9] Since then the Demirjian method has been popularly used for age estimation. But, in a recent study by Berkvens et al in 2017 the method by Nolla was found to be more suitable for the Canadian population as compared to Demirjian and Moorrees.[18] Demijian and Nolla are the most frequently used methods but there are conflicting results in literature (Olze et al, 2005 and Berkevns et al, 2017);[9,18] thus it was appropriate to compare these methods in a contemporary Indian sample. We additionally compared a third method (Cameriere, 2006) as it is based exclusively on third molar development. The present study aimed to determine the most accurate method of age estimation among Demirjian, Cameriere and Nolla based on the development of third molar tooth in the North Indian population. The specific objectives of this study were 1. To determine the range of variation of the three age estimation techniques from the chronological age and 2. To determine if one of these three methods was more accurate to estimate legal age of maturity of 18 years.

MATERIALS AND METHODS:

After due clearance from Internal Research Review Committee, Ethics Committee of Jamia Millia Islamia, New Delhi (21/3/168/JMI/IEC/2018) and Informed consent of participants, the present study was conducted in the Department of Oral and Maxillofacial Surgery and Department of Oral Medicine and Radiology, Faculty of Dentistry, Jamia Millia Islamia. 100 patients (both males and females) between 12 and 25 years of age requiring OPG for diagnostic or therapeutic purposes were enrolled in this study. All OPGs were made using Kodak 8000C digital panoramic and cephalometric system (Carestream Health Inc., France) 60-90 kV, 10 mA and total filtration of 2.5mm aluminium.

Inclusion criteria:

1. Indian nationals (both males and females) between 12- 25 years of age.
2. Patients whose chronological age could be accurately determined by documentary evidence of date of birth (only government approved documentary evidence was accepted)
3. Presence of left mandibular third molar whether erupted or unerupted on OPG taken for diagnostic or treatment purpose.

Exclusion criteria:

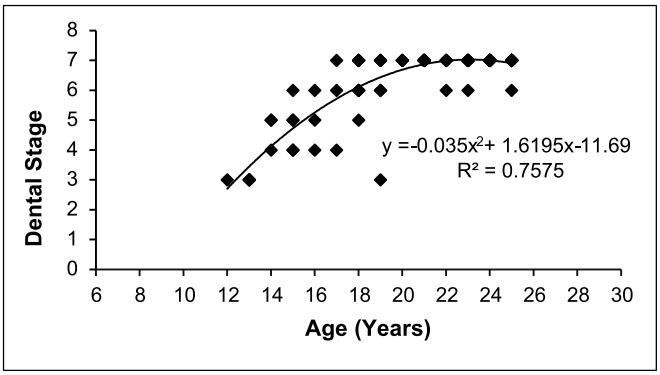
1. Patients who have pathologies associated with left mandibular third molar tooth
2. Patients with reported growth abnormalities like amelogenesis imperfecta, regional odontodysplasia, nutritional deficiency, Down's syndrome etc.

After careful selection of subjects, each subject was allotted a separate ID. Chronological age was obtained by subtracting the date of birth from the date of radiograph. The developmental stage of third molars was assessed using three methods – Demirjian, Nolla and Cameriere.[7-9] Two investigators assessed all the blinded radiographs individually for all the three techniques. (Blinding was done by the third investigator) The mandibular left third molar was assessed first by Demirjian method followed by Nolla's method and then by Cameriere's method at a gap of one week each to prevent intra-observer bias. In cases of statistically significant inter observer variability both the investigators reached a consensus for the estimated age. Repeat assessment was done for 10% of the OPG by the same investigator to evaluate intra-observer bias

RESULTS:

The estimated ages were compared with chronological age for entire sample for each method using polynomial regression analysis. The coefficient of determination R^2 for entire sample in Demirjian method was 0.7575 **(Figure 1)**.

Figure 1: DGT overall mean score calculated from third molar for both the sexes



This showed that the Demirjian method explains total of 76% variation of the dependent variable (Chronological Age of patients). The coefficient of determination for Nolla and Camerier method for entire sample was 0.7326 **(Figure 2)** and 0.7425 respectively **(Figure 3)**, suggesting that all the three methods were good fit to estimate the chronological age of the

patients.

Figure 2: Nolla's overall mean score calculated from third molar for both the sexes

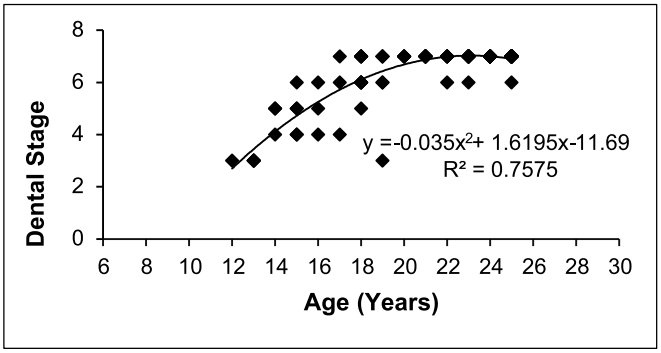


Figure 3: Camerier's overall mean score calculated from third molar for both the sexes

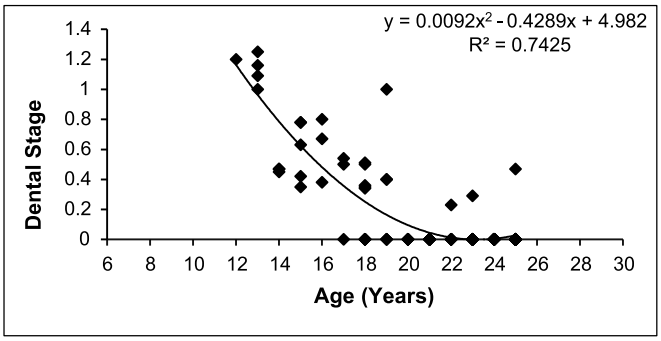


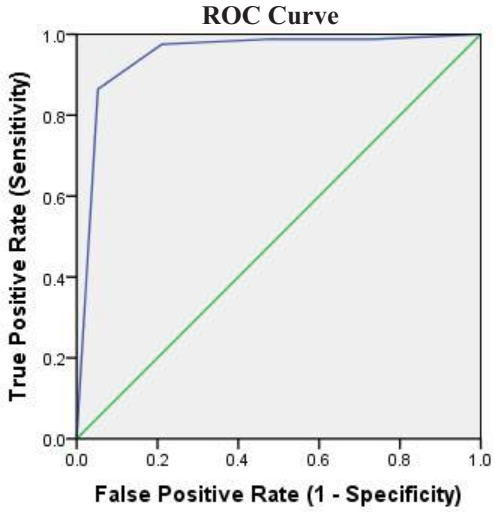
Table 1 shows the Polynomial regression equation and value of R^2 for all the three methods for both the sexes. Both males and females showed a higher coefficient of determination using the Demirjian method suggesting that the Demirjian method was a good fit to estimate chronological age in North Indian population.

Table 1: Polynomial regression equations and R^2 values for the overall mean scores of third molar for each method according to sex.

	DGT	Nolla	Camerier
Overall	$y=-0.035x^2+1.6195x-11.69$ $R^2 = 0.7575$	$y=-0.0339x^2+1.5894x-8.6171$ $R^2 = 0.7326$	$y = 0.0092x^2-0.4289x+4.982$ $R^2 = 0.7425$
Male	$y=-0.0436x^2+1.9655x-15.004$ $R^2 = 0.8325$	$y = -0.0425x^2+1.9372x-11.95$ $R^2 = 0.7838$	$y = 0.011x^2-0.503x+5.7286$ $R^2 = 0.8113$
Female	$y=-0.028x^2+1.3395x - 9.1053$ $R^2 = 0.7103$	$y = -0.0268x^2+1.3083x - 6.0211$ $R^2 = 0.6934$	$y = 0.0081x^2 - 0.3828x + 4.5313$ $R^2 = 0.6911$

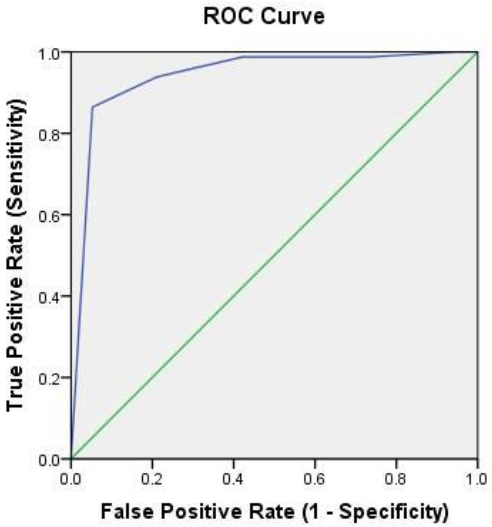
ROC analysis was done to determine if one of these three methods was more accurate to estimate legal age of maturity of 18 years. Our results showed that all the three methods accurately estimated the maturity age of ≥ 18 years with excellent area under curve. In Demirjian method the cut off point for estimating the maturity age with 86.4% sensitivity and 94.7% specificity was stage H having accuracy of 88% **(Figure 4)**. In Nolla method the cut off point for estimating the maturity age with 86.4% sensitivity and 94.7% specificity was stage 10 having accuracy of 88% **(Figure 5)**. In Cameriere method the cut off point for estimating the maturity age with 90.1% sensitivity and 94.7% specificity was a tooth maturity index of ≤0.34 having accuracy of 91% **(Figure 6)**. Camerie're's method showed higher sensititvity and accuracy in estimating legal age of maturity as compared to the other two methods **(Table 2)**.

Figure 4: ROC according to Demirjian's stages for third molar for estimating maturity age.



Area Under Curve 0.948

Figure 5: ROC according to Nolla's stages for third molar for estimating maturity age.



Area Under Curve 0.942

Figure 6: ROC according to Camerier's stages for third molar for estimating maturity age.

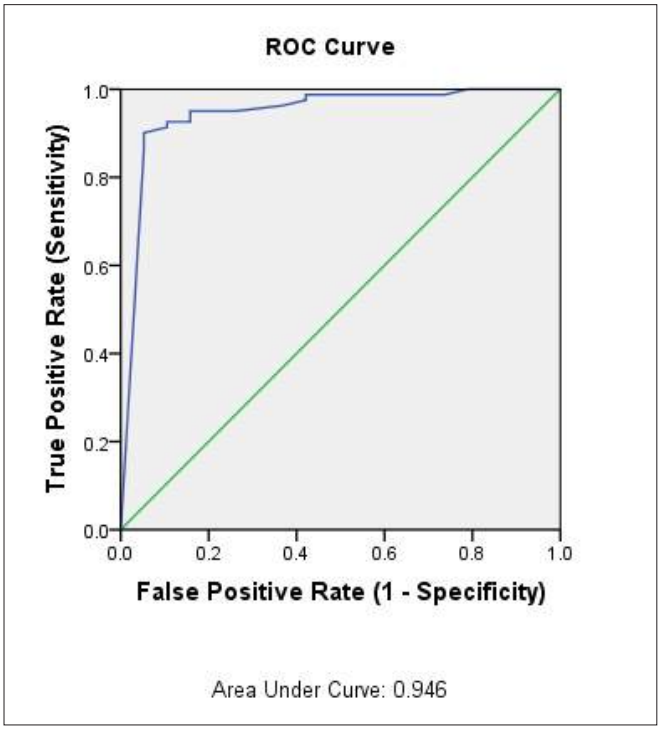


Table2: ROC analysis for different methods to estimate maturity age (≥18 years)

Methods	Area Under Curve	p-value	Sensitivity	Specificity	Accuracy
Demirijian	0.948	<0.001	86.4%	94.7%	88%
Nolla	0.942	<0.001	86.4%	94.7%	88%
Cameriere	0.946	<0.001	90.1%	94.7%	91%

DISCUSSION:

Demirjian's7-teeth method provides a schematic diagram of stages of tooth development for permanent left mandibular teeth.[7] Chaillet along with Demirjian in 2004 included evaluation of third molar to the original Demirjian method to make the method applicable to a wider age group.[19] This method has been extended for age estimation using third molar alone in several populations eg Mincer et al 1993, Kasper et al 2009,[2,20] including Indian population (Verma et al, 2011 and Mathew et al, 2017).[21,16] One such study (Mincer et al, 1993) highlighted the fact that 90% of males and 92% of females with third molars in Demirjian's stage H (end of mineralization) were more than 18 years old.[2] Another study (Mathew et al, 2017) showed that males reached the stages at indicated ages earlier than females.[16] The study by Verma et al in 2011 concluded that the earlier stages in teeth development (D, E and F) indicates that the person is younger than 18 years, falling under juvenile legislation: stages G and H indicates that the person has reached 18 or more and considered as an adult in Indian law.[21] The present study also showed that Demirjian method was 86.4% sensitive and 94.7% specific and 88% accurate to estimate age of maturity which corresponded with stage H.

Nolla's method uses a 10-stage model of dental development ranging from stage 1 (crypt formation) to stage 10 (complete formation of apical root ends) for permanent teeth.[8] This method has been applied previously for age estimation using third molars.[6,18] Panchbhai et al in 2011 studied 479 OPGs and concluded that no significant differences were observed in mean ages at which the developmental stages were reached in all four third molars. In case of presence of four completely developed third molars in a subject, the probability of an individual to be older than 18 years of age was 94.35% for females and 95.23% for males.[6] In the present study, Nolla's method showed a high correlation between chronological age and estimated age with R^2 value of 0.7326 (0.7838 for males and 0.6934 for females).

In the Camerier's method of age estimation, the seven left permanent mandibular teeth are valued.[9] This study has been applied for age estimation using third molars previously by Galic et al.[22] Using 906 OPG from Caucasian population, the authors concluded that the choice of the third molar maturity index, I_{3M}<0.08 showed 70% sensitivity and 98% specificity. The proportion of individuals with a correct classification was 83% in this study. In our study, Camerier's method showed a high R^2 value of 0.7425 along with a high accuracy of 91% in estimating the maturity age of ≥18. The maturity age of ≥18 corresponded to Camerier's tooth maturity index of ≤0.34.

Berkvens et al in 2017 compared three age estimation techniques using third molar teeth in 361 OPGs in a modern Canadian population.[18] They tested the accuracy of Demirjian, Nolla and Moorees, Fanning and Hunt methods in age group of 7.9 to 29.9 years. They found that all the methods were suitable in the estimation of chronological age but Nolla's method proved to be most applicable based on polynomial regression analysis. The Nolla method was found to have the highest coefficient of determination at all levels, indicating that it is the most applicable method of age estimation in the sample population. The mandibular third molars were shown to be more accurate than their maxillary counterparts. Additionally, it was observed that males reached the complete formation of third molars earlier than females. Contrastingly in our pilot study we found that though all the three analyzed methods were suitable in estimation of chronological age, Demirjian's method proved to be most applicable in our population (with R^2 0.7575 over 0.7326 for Nolla and 0.7425 for Camerier). Separate analysis for both males and females again proved

Demirjian more applicable than Nolla and Camerier. Also, all the three methods showed high sensitivity and specificity to estimate the legal age of maturity but Camerier's method showed higher accuracy.

The main limitation of this study was the exclusion of patients with absent third molar or third molar associated with pathologies. The present study can be expanded to include a larger sample size with wide inclusion criteria to observe variations due to ethnicity. The study can also be expanded to include evaluation of all four third molars.

REFERENCES:

1. Lewis JM, Brumit P. Dental age estimation and determination of the probability an individual has reached the legal age of majority. Paper presented at Annual Meeting of the American Academy of Forensic Sciences, Odontology section, February 21-25, 2011, Chicago, IL.
2. Mincer HM, Harris EF, Berryman HE. The ABFO study of third molar development and its use as an estimator of chronological age. J Forensic Sciences 1993;38(2):379-90.
3. Eid RMR, Simi R, Friggi MNP, Fisberg M. Assessment of dental maturity of Brazilian children aged 6 to 14 years using Demirjian's method. International Journal of Paediatric Dentistry 2002;12: 423-28.
4. Priyadarshini C, Puranik M P, Uma S R. Dental Age Estimation Methods: A Review. Int J Adv Health Sci 2015;1(12): 19-25.
5. Nykanen R,Espeland L,Kvaal SI, Krogstad O. Validity of Demirjian method for dental age estimation when applied to Norwegian children. Acta odontol Scand 1998;56:238-44.
6. Panchbhai AS. Radiographic Evaluation of Developmental Stages of Third Molar in Relation to Chronological Age as Applicability in Forensic Age Estimation. Dentistry 2012; S1:1-7
7. Demirjian A, Goldstein H, Tanner JM. A new system of dental age assessment. Human Biology 1973;45:211-227
8. Nolla CM. The development of permanent teeth. Journal Dentistry for Children 1960;27: 254–266.
9. Cameriere R, Ferrante L, Cingolani M. Age estimation in children by measurement of open apices in teeth. Int. J. Legal Med. 2006;120: 49–52.
10. Gleiser I, Hunt EH. The permanent mandibular first molar: Its calcification, eruption and decay. Am J Phys Anthropol 1955;13: 253–283.
11. Gustafson G, Koch G. Age estimation up to 16 years of age based on dental development. Odontol Revy. 1974;25(3):297-306
12. Harris MJ, Nortje CJ. The mesial root of the third mandibular molar. A possible indicator of age J Forensic Odontostomatol. 1984;2(2):39-43
13. Kullman L, Johanson G, Akesson L. Root development of the lower third molar and its relation to chronological age. Swed Dent J. 1992;16(4):161-7.
14. Mesotten K, Gunst K, Carbonez A, Willems G. Dental age estimation and third molars: a preliminary study. Forensic Sci Int. 2002;129(2):110-5.
15. Olze A, Bilang D, Schmidt S, Wernecke KD, Geserick G, Schmeling A. Validation of common classification systems for assessing the mineralization of third molars. Int J Legal Med. 2005;119(1):22-6.
16. Mathew AL, Cherian SA and Mathew R. Chronological Age Estimation Based on Mandibular Third Molar Development from Digital Panoramic Radiograph in a South Kerala Population. J Ora Med 2017; 1(1):12
17. Thevissen PW, Pittayapat P, Fieuws S, Willems G. Estimating age of majority on third molars developmental stages in young adults from Thailand using a modified scoring technique. J Forensic Sci. 2009;54(2):428-32.
18. Berkvens ME., Fairgrieve SI., Keenan S. A comparison of techniques in age estimation using third molar. Canadian Society of Forensic Science Journal 2017; 50(2): 74-83
19. Chaillet N, Demirjian A. Dental maturity in South France: A comparison between Demirjian's method and polynomial functions. J Forensic Sci. 2004; 49:1059–66.
20. Kasper KA, Austin D, Kvanli AH, Rios TR, Senn DR. Reliability of third molar development for age estimation in a Texas Hispanic population: a comparison study. J Forensic Sci. 2009;54(3):651–657.
21. Verma P, Sachdeo J, Verma KG, Gupta SD, Guruprasad R. Age estimation of adolescents and young adults based on development of mandibular third molar: A panoramic study. Journal of Indian Academy of Oral Medicine and Radiology 2011; 23(1):9-13
22. Galic I, LaucT, BrkicH, VodanovicM, Galic E, Biazevi MGH, Brakus I, Badrov J, Cameriere R. Cameriere's third molar maturity index in assessing age of majority. Forensic Science International 2015; 252: 191.e1–191.e5

J Punjab Acad Forensic Med Toxicol 2020;20(1) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00100.4

Original Research Paper

A Retrospective Study of Fatal Road Traffic Accident Cases in a Hilly Region of Uttarakhand

1. **Niraj Kumar,** Assistant Professor, Department of Forensic Medicine, Govt Doon Medical College, Dehradun 248001
2. **Lalit Kumar,** Professor & Head, Department of Forensic Medicine, Shri Guru Ram Rai Institute of Medical & Health sciences, Dehradun 248001

ABSTRACT :

Introduction: RTA deaths in hilly terrain of Uttarakhand region needs special attention.

Materials and Methods: A retrospective autopsy based study consisting of 70 medicolegal autopsies on RTA cases was conducted at mortuary of Base Hospital, Srinagar town in Pauri Garhwal district, Uttarakhand, during the period January 1st 2012 to December 31st 2014. All deaths resulted from RTA of hilly roads were included while deaths of Kedarnath tragedy excluded.

Results: Most of mishaps occurred between months of May and October. Males outnumbered the females in total number of deaths due to RTA, 66 (94.28%) male cases compared to 4 (5.71%) female cases. Highest numbers of the cases were associated with public transport vehicles like bus and taxi.

Conclusions: Safety measures during Char Dham yatra and Rainy season is of utmost importance. Factors like Age group between 16-35 years, vehicles of public transport and cars, travelling during twilight hours, bears greatest risk of fatal accidents. Maintenance of traffic discipline and standard designing and construction of roads plus safety measures by authorities are of paramount importance in preventing RTA deaths.

Corresponding Author :
Dr. Lalit Kumar,
Head & Professor,
Department of Forensic Medicine, Shri Guru Ram Rai Institute of Medical & Health sciences, Dehradun 248001
Contact : +91 93585-07650
Email : drlalit303@gmail.com

Article History:
Received: 22 April 2020
Received in revised form: 24 May 2020
Accepted on: 24 May 2020
Available online: 30 April 2021

KEYWORDS : Autopsy, Hilly region, Post-mortem, Road traffic accident, Uttarakhand traffic

INTRODUCTION: According to Global status report on road safety 2018, WHO the number of road traffic deaths cases continues to go up, getting 1.35 million in 2016. Road traffic injury become leading cause of death among children and young adults aged 5–29 years and 8th leading cause of death surpassing HIV/AIDS, tuberculosis, and diarrhoeal diseases. The burden of RTA injuries and deaths is disproportionately borne by vulnerable road users and people of low and middle income nations, where the growing number of deaths is due to transport that is progressively motorized[1]. According to Government of India Ministry of Road Transport & Highways in its report on Road accidents in India -2018, India, however ranks 1 in the number of road accident deaths across the 199 countries reported in the World Road Statistics, 2018 followed by China and US. India carry burden of almost 11% of the accident related deaths in the World. A total of 4,67,044 road accidents have been reported by different states and Union Territories (UTs) in the calendar year 2018, claiming 1,51,417 lives and causing injuries to 4,69,418 persons[2]. In this report Uttarakhand is on rank 22 among 33 states & UTs in terms of Total Number of Fatal Road Accidents, whereas in terms of Accident Severity (Road accident deaths per 100 accidents) it stands at rank 3, which point towards gravity of situation in the state and that safety concerns must be dealt with evidence based interventions including policy level improvements. Selected area of our study Srinagar, Pauri Garhwal, Uttarakhand has a busy Highway road connecting most popular Pilgrimage places, which is prone to frequent land slide and damage. Also, there are many important educational institutes and famous temples, industrial and commercial areas in a mixed traffic and Hilly terrain, and other factors which leads to increased number of accidents. Driving in hills and mountains is extremely different from plains because of complex topography, driver's view is restricted due to frequent turns, and alertness deteriorates with driving duration due to fatigue caused by excessive manoeuvring of vehicle. The Road Traffic Injury Prevention Training Manual is published by the Transport Research and Injury Prevention Programme (TRIPP) of the Indian Institute of Technology and WHO, provides detailed instructions and guidelines to multi disciplinary audience including medical doctors, nurses, transport and road engineers, vehicle safety professionals, law enforcers, policy-makers, urban planners, and social scientists [3]. Directorate General Border Roads Organisation gives

instructions on road safety and MT discipline in its general maintenance instruction no. 212 [4] especially for hilly terrain. This study is an attempt to understand the trends of fatal traffic accident cases by retrospective analysis of information gathered from autopsies in mortuary of a tertiary care centre of a hilly region, that will help understand the necessary steps for formulation and implementation of guidelines to prevent fatalities and improve safety measures in complex terrain of hilly areas.

OBJECTIVE : To estimate the burden of road traffic accident cases, distribution of RTA victims by Year, Time, Season of occurrence & other Parameters and to determine the age & gender wise distribution of RTA victims.

MATERIALS AND METHODS :

This is a retrospective autopsy-based study consisting of 70 medico-legal autopsies on RTA cases performed at mortuary of Base Hospital, Srinagar town in Pauri Garhwal district, Uttarakhand, during the period of three calendar years from January 1st, 2012 to December 31st, 2014. Ethical clearance was obtained from the Institutional Ethical Committee of VCSGGMS & RI Srinagar, Pauri Garhwal, prior to the conduction of the study. Those autopsied cases included for study in which death resulted from RTA of hilly region; for example a moving vehicle collision either with another vehicle or pedestrian or stationary object like tree, roadside rock and mountain carvings; and fall from height, fall into river, turn over and boulder rock fall on a moving vehicle. It also included the cases where exact mechanism was not known but RTA was confirmed. All those death cases were excluded where a vehicle occupant died due to any reason when vehicle was not moving (e.g. a person died during loading a vehicle, slipping or fall from height or boulder fall on a passenger outside the vehicle etc). Bodies examined and DNA sampling done during Kedarnath Tragedy in the year 2013 is outside the purview of this study. The detailed analysis of these cases was based on the inquest reports, investigation officer's accounts, medical records, and evaluation of autopsy reports after obtaining prior proper permissions. Data was collected in a Proforma designed for this purpose on the socio-demographic profile of the victims, Age, Gender, Religion, Region, time, months of accident, vehicle and details of circumstances leading to accidents. The obtained data was entered into Microsoft excel, double checked for errors, and analysed using Microsoft Excel 2007. Interpretation of the collected data was done by using appropriate statistical methods like percentages & proportions.

RESULTS :

Out of total 294 autopsies conducted during study period; RTA related deaths accounted for 70 cases (23.8 %) **(Table 1)**.

Table 1 : Year wise distribution of cases.

S.No.	Year	Total No.
1.	2012	110
2.	2013	83
3.	2014	101

Month wise distribution of data showed most of mishaps occurred between months of May and October (87.14%, n=61) which is the season of Tirth Yatra and tourism **(Table 2)**.

Meanwhile, very low human casualty recorded in July month might be because of disturbances and stoppage of transport services and Yatra due to heavy rain and landslides in the month.

Majority of victims fall in the age group of 16 to 35 years which is most active and productive period of life accounts for 62.86% (n=44) of all cases. Age group of 6 to 15 years accounted for 3 cases only while age between 36 to 70 years involved rest of 23 cases (32.86%). Mean age was 33.5. Males outnumbered the females in total number of deaths due to RTA, 66 (94.28%) male cases compared to 4 (5.71%) female cases. **(Table 3)**

Table 3 : Age wise distribution of cases

Age Range	No. of Cases
00-05	-
06-10	1
11-15	2
16-20	8
21-25	13
26-30	11
31-35	12
36-40	3
41-45	6
46-50	3
51-55	3
56-60	4
61-65	3
66-70	1

Male Female Ratio M:F = 66:4

Table 2 : Month Wise Distribution

Year/Month	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total RTA	Total PM
2012	1	-	2	2	3	1	-	3	5	4	1	1	23	110
2013	-	1	-	1	10	2	-	1	-	-	1	-	16	83
2014	1	-	1	1	5	1	-	2	17	3	-	-	31	101
Total	2	1	3	4	18	4	0	6	22	7	2	1	70	297

Distribution of victims according to type of vehicle they were using/riding at the time of mishap. Highest numbers of the cases were associated with public transport vehicles like bus and taxi UV/SUV (47.14 %, n=33); motorbike and pedestrians accounted for 11 cases (15.71%) each, but low incidence seen with private car users (8.57%, n=8). 6 cases were difficult to determine after accident that which vehicle they belong to. **(Table 4)**

Table 4 : Type of vehicle occupant

Vehicle type	No. of Cases
Bus & Truck	22
Bicycle	1
Jeep/SUVs	11
Pedestrian	11
Car	8
Uncertain	6
Motorcycle	11

We can see unlike accidents of plains, most common mechanism of accident is vehicle fall from height (54.28%, n=38), followed by vehicle to vehicle collision (15.71%, n=11) and pedestrians (11.42%, n=8). **(Table 5)**

Table 5 : Mechanism of accident

Type of accident	No. of Cases
Vehicle Fall From height	38
Vehicle to vehicle collision	11
Vehicle Collision with mountain Rock	2
Vehicle Slipped while turning	1
JCB/Utility van fall on victim	3
Pedestrian to vehicle	8
Boulder/rock fall on passenger	1
Exact mechanism Unknown	6

Highest percentage of fatalities occurred between 6-9 pm evening rush hour (47.14%, n=33) Increased number of cases seen in morning in the table might be due to including the data of an incidence, when a bus was plunged into a shallow & narrow hilly stream in morning. In this study 81.43% cases (n=57) happened in twilight hours. Very few cases (10%, n=7) occurred during daylight (noon & afternoon). **(Table 6)**

Table 6 : Time of occurrence of accidents

Sr. No.	Period of time	No. of Cases
1	Morning	24
2	Noon	2
3	Afternoon	5
4	Evening	33
5	Night	6

Most of the victims dies on spot or near accident site (51.43%, n=36), followed by transport to nearby hospital (25.71%, n=18) and hospital death (20%, n=14). Two cases marked unknown, since carrying persons unable to diagnose whether live or dead during transport.**(Table 7)**

Table 7. Site of death
(Unknown= carrying persons unable to diagnose whether live or dead during transport)

Sr. No.	Site	No. of Cases
1	On spot	36
2	During transport	18
3	Hospital death	14
4	Unknown	2

Head injuries were associated with almost half of the cases (47.14%, n=33), while in most of the cases Polytrauma & Hypovolemic Shock was present (74.28%, n=52) **(Table 8)**.

Table 8 : Cause of death

Cause of death	No. of Cases
Head Injuries only	13
Polytrauma & Hypovolumic Shock + Head Inuries	22
Polytrauma & Hypovolumic Shock only	30
Drowning	1
Traumatic asphyxia	1
Septic shock	1
Aspiration pneumonia	1
Uncertain	1
Total	70

From the collected data it was known that a considerable number of deceased were also from outside of state (15.71%, n=11) (UP, Jharkhand, HP, Bihar & Nepal) than from state (82.85%, n=58 of which 34 were from the rural and 24 from the urban areas) **(Table 9).**

Table 9 : Regions belong to

Uttarakhand	Urban/Rural		Outsider	
	Urban	Rural		
Pauri Garhwal	5	**13**	UP	4
Tehri Garhwal	13	9	Jharkhand	2
Rudraprayag	-	7	HP	2
Chamoli	3	5	Bihar	3
Haridwar	1	-	Nepal	1
Dehradun	2	-		
Total	24	34		11

It is also revealed that 64 (91.42%) cases were Hindu, 3 cases Muslim and 1 Sikh, while religion of two cases was uncertain **(Table 10)**. Also, while investigating about use of seat belt we could not get reliable information, but it was learnt from police that neither of cases were found wearing seat belt.

Table 10 : Religion

Sr. No.	Religion	No. of Cases
1	Hindu	64
2	Muslims	3
3	Sikh	1

DISCUSSION :

Mountainous roads have complex road geometry and hence vehicle crashes likely to have different characteristics than crashes on plains. Srinagar of Uttarakhand is largest town in the Garhwal Hills, is situated on left bank of Alaknanda river on National Highway-58 and is 110 Km from Rishikesh. In present study, year 2013 shows decreased number of RTA death cases because of decrease in traffic that year, as the Uttarakhand has experienced worst natural disaster in June 2013, causing damage to road, bridges, and disruption of state infrastructure[5]. As evident in month-wise distribution of data most death seen between May to October, it shows two peaks in May and September. Since the Annual Char Dham Yatra starts in May and lasts up to end of October, increase in road traffic is seen but as monsoon reaches in June with heavy rainfall and occasional cloudbursts leading to landslides and damage to highway road, the traffic remains disturbed and reaches minimum in July. Hence the death incidence too corresponds with frequency of traffic. These findings are in accordance with trends of accident related death in Uttarakhand state[6].

Age group of 16 to 35 years accounted for 62.86% of all cases, which is consistent with other similar studies[7-9] as active lifestyle and involvement of outdoor activities make them more vulnerable to accident related death. The male to female ratio was 16.5:1 against the national average of 4.2:1 in 2014 [10]. In our study most common type of vehicle involved in RTA death cases were Bus and Truck 31.4% followed by car, UVs, SUVs 27.1%, and two-wheelers 17.1%, whereas national data for Road traffic accidents calculated average for years 2012-2014[11][6][10] shows 27%, 17.3% and 26.6% respectively for the same. Unlike data from different states[10] and national figures[9] in our study we see a large number of cases are due to fall from height (54.28%). Use of crash-barriers on open valley sides of road and convex mirrors on turnings help reduce the consequences of a collision or minimize damage, but they are not installed in sufficient quantity to prevent fatal accidents.

Most fatalities happened at morning, evening, and twilight periods (81.4%), the cause of which can be attributed to factors like peculiar hilly terrain combined with low visibility at that period, tiredness, and rush hours of these areas. This finding is different from RTA data of plains as observed by Siddaramanna T C et al[9] and Shruthi P, Venkatesh V T et al[12] and national RTA cases records[10].

Maximum death occurred on the spot (51.43%) followed by transfer to hospital and then hospital death which is comparable to similar observation recorded by Harnam S, Dhattarwal S et al[13] regarding time of survival after fatal RTA. Study of injuries which were associated with causation of death revealed that Head injuries contributed to almost half of the cases (47.14%) and Polytrauma & Hypovolemic Shock was present in 74.28% of cases. These findings were consistent with study by Dileep K R, Raju G M et al[14] Ranjana S et al[15] and Farooqui, J M et al[16]. Although 82.85% of cases were nearby residents of Uttarakhand but a lot of deceased were from outside the state (15.71%). This data is slightly more than state's demography ratio of migrants to inhabitants according to 2011 census that 12% of the state's population are migrants from neighbouring states- UP, Bihar and Delhi etc[17] who come here in search of opportunities. More victims were from rural areas (48.6%) than the city dwellers (34.3%). Most of the victims were Hindu (91.42%). We also investigated about use of seatbelt, but exact information was not available. Although Police personals said that neither of victims were found wearing seat belt, the local drivers believe that wearing seat belt in hilly areas is risky when accidents occur.

CONCLUSION :

Road traffic accidents in hilly region of Uttarakhand causing loss of valuable work force and resources, needs urgent and special attention. Additional preventive and safety measures are required by local and state administration in rainy and pilgrimage season which faces peak of RTA deaths. Law enforcing agencies should frequently inspect especially young age groups, bus, and taxi drivers to ensure for adequate training, driving skill and traffic disciplines. Measures like installing more crash barrier on valley side and convex mirror on turns may reduce death, as the maximum number of cases were due to fall from height. Driving during twilight state of morning and evening and unavailability of some nearby health facility in hilly road found to be crucial dangerous contributors to RTA deaths.

Funding: None.

Ethical approval: Obtained from the Institutional Ethical Committee of VCSGGMS & RI Srinagar, Pauri Garhwal, Uttarakhand.

Conflicts of interest: We have no conflicts of interest to report.

Acknowledgement: The authors are very thankful Dr. Naman

Kandpal and Dr. Aishwarya Bajpai for acquisition of relevant data from Police stations for carrying out this research project.

REFERENCES :

1. World Health Organization. Global status report on road safety 2018. Geneva: World Health Organization; 2018. Report No.: ISBN 978-92-4-156568-4.
2. Transport Research Wing of the Ministry of Road Transport and Highways, Government of India. ROAD ACCIDENTS IN INDIA–2018. New Delhi: Government of India, Ministry of Road Transport and Highways; 2019.
3. Mohan D, Tiwari G, Khayesi M, Nafukho FM. Road Traffic Injury Prevention Training Manual Angela Haden CA, editor. Geneva 27: World Health Organization; 2006.
4. Directorate General Border Roads Organization. ROAD SAFETY AND MT DISCIPLINE, GENERAL MAINTENANCE INSTRUCTION NO. 212 (REVISED)..
5. National Institute of Disaster Management (Ministry of Home Affairs, Government of India). Uttarakhand Disaster 2013. New Delhi: Ministry of Home Affairs, Govt. of India, National Institute of Disaster Management; 2015. Report No.: ISBN: 978-93-82571-14-8.
6. Transport Research Wing, New Delhi. ROAD ACCIDENTS IN INDIA 2013. New Delhi: Government of India, Ministry of Road Transport & Highways; 2014.
7. Kandpal SD, Vyas S, . D, Semwal J. Epidemiological profile of Road Traffic Accidents reporting at a Tertiary Care Hospital in Garhwal Region of Uttarakhand. Indian J Comm Health. 2015 June; 27(02): p. 235-240.
8. Kumar A, Joshi C, Singh M, Singh V. Road traffic accidents in hilly regions of northern India: What has to be done? World J Emerg Med. 2014; 5(2): p. 112–115.
9. Siddaramanna TC, DIlip KR. Retrospective Study of Pattern of External Injuries in Road Traffic Accidents. International Journal of Biomedical And Advance Research. 2014 Sep 30; 5(9): p. 451-453.
10. Transport Research Wing MoRTH&S. ROAD ACCIDENTS IN INDIA 2014. New Delhi:, Ministry of Road Transport, Highways & Shipping, Government of India; 2015.
11. Transport Research Wing, New Delhi. Road Accidents in India 2012. New Delhi:, Ministry of Road Transport & Highways, Government of India; 2013.
12. Shruthi P, Venkatesh VT, VIshwakanth B, Ramesh C, Sujatha PL,Dominic IR. Analysis of Fatal Road Traffic Accidents in a Metropolitan City of South India. J Indian Acad Forensic Med. 2013 October-December; 35(4): 317-320
13. Singh H, Dattarwal SK, Sharma G, Mittal S, Aggarwal A, Chawala R. Survival period in fatal road traffic accidents. Medico-Legal Update. 2009;(9): p. 34-7.
14. Dileep KR, Raju GM, Vijaynath V, Shahina. Deaths due to Fatal Road Traffic Accidents. J Indian Acad Forensic Med. 2013 July-September; 35(3)
15. Singh R, Hemant KS, Gupta SC, Kumar Y. Pattern, Severity and Circumtances of Injuries Sustained in Road Traffic Accidents: A Tertiary Care Hospital-Based Study. Indian J Community Med. 2014 Jan; 39(1): p. 30-34.
16. Farooqui JM, Chavan KD, Bangal RS, Syed MMA, Thacker PJ, Alam S. Pattern of injury in fatal road traffic accidents in a rural area of western Maharashtra, India. The Australasian medical journal. 2013; 6(9): p. 476-82.
17. Office of the Registrar General & Census Commissioner, India. Office of the Registrar General & Census Commissioner, Ministry of Home Affairs, GOI. [Online].; 2011 [cited 2020 May 23. Available from: https://www.censusindia.gov.in/2011census/migration.html.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00101.6

Original Research Paper

Effect of dental caries on human individualization based on Multiplex STR Typing including Amelogenin marker study

1. **Leena Kumari,** PhD Scholar, Department of Forensic Science, SGT University, Gurgaon, Haryana, India
2. **Tirath Das Dogra,** Professor Emeritus, Department of Forensic Medicine & Science, SGT University, Gurgaon, Haryana, India
3. **Rakesh Dube,** Professor, Department of Mathematics, SGT University, Gurgaon, Haryana, India
4. **Vijay Kumar,** Reader, Department of Audiology & Speech-Language Pathology, Amity University Gurgaon, Haryana, India
5. **Braja Kishore Mohapatra,** Principal Scientific Officer and Head, Department of Biology & DNA Profiling, Central Forensic Science Lab, Central Bureau of Investigation, New Delhi, India
6. **Kamal Chauhan,** Senior Scientific Officer, Department of Biology & DNA Profiling, Central Forensic Science Lab, Central Bureau of Investigation, New Delhi, India

ABSTRACT :

Introduction: Although role of teeth as a substrate for forensic investigation is established since long time, the relationship between the status of extracted tooth and DNA yield has not been clearly established. Thus, the primary objective of this study was to estimate the quality and quantity of DNA in mild to moderate carries teeth samples and compare it with freshly extracted control teeth using Real Time-Polymerase Chain Reaction (RT-PCR) and subsequent multiplex STR typing.

Method: A total of 40 teeth, mild to moderately caries tooth (Twenty) and freshly extracted normal teeth (Twenty) were randomly collected. Isolation and extraction of DNA was done by organic extraction method. Precipitation of samples was done using 100% chilled ethyl alcohol followed by concentration and washing of DNA via column based technique using DNA binding buffer and DNA wash buffer. Agarose gel electrophoresis was done to roughly estimate the DNA content while exact quantity of DNA was estimated by RT-PCR technique. Short Tandem Repeat (STR) profiling was done for generation of DNA profile including sex determination by identification of amelogenin gene.

Result: Independent sample t test analysis revealed that the mean quantity of DNA (in µg/l) was significantly higher in freshly extracted (M=29.91, SD=0.65) than mild to moderate carious (M=9.71, SD=0.45), $t(38)=114.19$, $p<0.000$. Similarly, quality of DNA was analyzed using smear quality and it was obtained that the quality of DNA of freshly extracted teeth (M=4.55, SD=0.51) was significantly higher that the mild to moderate carious (M=2.55, SD=0.6), $t(38)=11.3$, $p<0.000$.

Conclusion: Despite, the significant quantitative and qualitative loss of DNA in carries tooth, DNA profiles with adequate resolution of the autosomal markers and amelogenin marker were observed in present study valuable for human identification and the gender identification leading to individualization was facilitated.

Abbreviations: Phenol Cholroform Isoamylalcohol(PCI), Short Tandem Repeat(STR), Real Time Polymerase chain reaction (RT-PCR)

Corresponding Author :
Dr. Leena Kumari,
PhD Scholar,
Department of Forensic Science, SGT University, Gurgaon, Haryana, India
Contact : +91 99583-58380
Email : leena.bhardwaj2000@gmail.com

Article History:
Received: 21 July 2020
Received in revised form: 24 July 2020
Accepted on: 24 July 2020
Available online: 30 April 2021

KEYWORDS : Amelogenin, DNA, Hydroxyapetite, Gender Identification, Electrophoresis,Forensic Investigation

INTRODUCTION :

Teeth are the hardest known structure in humans and based on the hardness of teeth it resists to get deteriorated under extreme environmental situations such as traumas, incineration, or prolonged exposure to adverse conditions[1].The indestructible property even under extreme testing conditions is commonly used in forensic investigations for human identification[2]. Based on the morphological characteristics the tooth can serve as an identification tool. Teeth can serve as source of human tissue in the form of pulp and human cell in form of embedded cells in the calciferous material of the teeth for DNA extraction. The recent advancement in molecular biology based on DNA amplification and sequencing of nucleotide have revolutionized the Forensic Odontology by allowing identifications in missing persons, mass disasters, terroristic acts or crimes scenes[3-4]. Tooth pulp is assumed to be the

potential source for DNA extraction and validated for forensic identification purpose[5].

Several methods are used to extract DNA from tooth which facilitates forensic identificationl. It includes aspartic acid racemization for age estimation, racial origin estimation by analysis of occlusal surface of tooth or by presence of accessory cusp or supernumerary cusp. Cusp of carrebelli in posterior tooth or shovel shaped incisors is one of the examples[6].

Gunn, A. mentioned that STR typing is proved to be cornerstone of DNA profiling. Short Tandem Repeats (STRs) is sequence repeats of non-coding region of the human genome consisting of less than 400 base pairs in which repeating length consist of 2-6 base pairsl. The STR profiling owes to identification of this repeated sequence of base pair. STR is found in autosomal cells as well as in the sex chromosome and it varies across individuals. The variability of STR is caused by the effect of mutation, independent chromosomal variation and recombination[7]. The diversity of STR on Y-chromosome is solely due to the mutation but not due to recombination; hence STR found on Y-chromosome has lesser diversity[8].

Generally healthy tooth is employed for human forensic identification, while tooth with mild to moderate caries are not considered for DNA extraction and analysis due to possible chances of contamination and degradation of DNA which may give misleading results[9-10]. But in absence of healthy tooth for forensic analysis, carious tooth can be considered as a potential source of DNA5. Moreover, various retrieval methods have been demonstrated to recover the pulp from tooth[11]. Several studies have reported that cavities have worldwide distribution affecting all ethnic groups[12.] The bacterial biota associated with oral cavity has deleterious effect on tooth structures[13]. The gram-positive cocci, Streptococcus mutants has cariogenic pathology, although it has been demonstrated the existence of a complex microbiota with different genera and species associated with this pathology[14]. However, the influence of this cariogenic microbiota on DNA extraction from human teeth has not been yet evaluated. It was previously validated by Alia-Garcia et al., for the possibility of using cavities-affected dental pieces for human identification purposes[15]. The primary objective of the study was to assess the quality and quantity of DNA obtained from mild to moderately carious teeth and compare it with the freshly extracted teeth for human individualization in forensic. The process of identification was completed by STR profiling including amelogenin gene.

MATERIALS AND METHODS :

Participant/sample: A total of 40 teeth were randomly selected from various dental clinics of Delhi/NCR region as sample for this study. Consent from the person who was scheduled for dental extraction was obtained. The extracted teeth collected from the patients had history of some periodontal pathology/wasting disease/moderately carious tooth. The samples were collected based on the criteria of mild to moderate carious tooth, tooth undergoing orthodontic extraction, extraction performed by the registered dental practitioner, participants of the age range of 20 to 60 years, and permanent premolar and molar. Since premolar and molar teeth are voluminous thus it was assumed to be a rich source of DNA reservoir compared to the incisors and canines. Grossly carious tooth, anterior tooth like central incisor, lateral incisor and canines were not considered for the study. Permanent tooth under root canal treatment were also excluded from the study. Each tooth of the collected sample was considered as exhibit in this study. The quality of DNA for freshly extracted tooth was compared with DNA obtained from the mild to moderately carious tooth. Sample preparation was done by washing with the solution of ethyl alcohol prior to grinding and tissue lyzer was used for grinding the tooth. All the laboratory work was performed in the Central Forensic Science Laboratory, CBI, New Delhi, an NABL accredited laboratory strictly as per the DNA standards.

Materials: The chemicals used for Phenol-Chloroform-Isoamyl Alcohol based organic extraction method were-

i. Proteinase K (20 mg/ml), EDTA (0.5 M; pH 8.0)
ii. Sodium Dodecyl Sulfate (SDS)
iii. Sodium Chloride (NaCl)
iv. Tris Saturated Phenol: Chloroform: Isoamyl alcohol i.e. PCI (25:24:1 v/v),
v. Absolute Ethyl alcohol,
vi. 70% Ethyl Alcohol,
vii. DNA Clean & Concentrator Kit (M/S Zymo Research) to clean & concentrate the DNA.

The chemicals used for Quantitation of DNA done by both Agarose Gel electrophoresis method as well as RT-PCR method were:

i. Bromophenol blue loading dye,
ii. Interchelating Ethidium bromide solution
iii. Tris-Acetic acid-EDTA (TAE) running buffer.
iv. Quantifiler Human DNA quantification kit

Teeth samples were pulverized using of tissue lyzer machine after cleaning the tooth thoroughly for DNA recovery.

Procedure: The outcome of the study was achieved by using following seven step procedure-

S**tep 1:** Each Tooth sample was pulverized in Tissue Lyzer machine after washing it with ethyl alcohol as well as Milli Q

water thoroughly and collected in 1.5 ml Eppendorf tube. After each step of crushing of tooth, jar was washed with warm water to avoid contamination.

Step 2: 300 µl Stain Extraction Buffer + DTT (0.006gm /1ml of SEB) was added to each Eppendorf tube containing the tooth sample. Each sample was vortexed for 15 seconds to facilitate homogenization. 20 µl Proteinase-K was added to each sample and they were incubated for 48hours at 56°C in Hot Water Bath shaker. The samples were vortexed followed by centrifugation for 5min at 5000rpm. The supernatant was scooped out into fresh Eppendorf tubes.

Step 3: 300µl PCI was added to each tube and centrifugation was done at 15000 rpm for 15 minutes. Top layer was scooped out into fresh Eppendorf tubes.

Step 4: Then precipitation was done with 100% chilled ethyl alcohol. The tubes were kept for 20 minutes at the temperature of -20°C. It is followed by centrifugation at 10,000 rpm at 10 min. The supernatant was removed from each tube. Washing of the pellet was done with 70% Ethyl alcohol.

Step 5: DNA purification and concentration was achieved by DNA binding buffer and DNA wash buffer (supplied with DNA Clean & Concentrator Kit).

Step 6: Basic Quality and quantity of DNA was obtained by gel electrophoresis by Agarose gel based electrophoresis technique and accurate Quantitation of DNA was assessed by Real-time PCR technique. The gel electrophoresis technique is a semi-quantitative/qualitative assay that allows for the estimation of the concentration and quality of DNA present in a specimen. The method consists of the electrophoresis of DNA in an agarose gel matrix by incorporating a fluorescent intercalating dye such as Ethidium bromide (EtBr). The agarose gel based quantitation has two step procedures. It comprises of preparation of gel followed by Electrophoresis.

The same samples were analyzed by Quantitative PCR (Real Time PCR). It is one of the most accurate, precise and efficient method currently available for human DNA quantitation. The rate of progression of amplification process is detected and measured by the accumulation of fluorescent dyes. The initial quantity of DNA in the sample was detected by monitoring the exponential growth phase of the reaction. It is also measured by the cycle number at which the fluorescent intensity of the sample overcomes the background noise or threshold. This cycle number is directly proportional to the quantity of DNA in the reaction. Analysis of the quantity of DNA in the sample is performed using software that compares the unknowns with the best fit regression line constructed from the standards. The principle behind the method is that as the PCR amplification process progresses, there is an increase in fluorescence from SYBR Green dye. As the SYBR Green dye binds to double-stranded amplicon, it undergoes a conformational change and emits fluorescence at a greater intensity. The TaqMan probe principle relies on the 5′–3′ nuclease activity of Taq polymerase to cleave a dual-labeled probe during hybridization to the complementary target sequence and fluorophores-based detection. As in real-time PCR methods, the resulting fluorescence signal permits quantitative measurements of the accumulation of the product during the exponential stages of the PCR.

Step 7 After quantitation of DNA, STR profiling was done for determining the sex of an individual. Commercially available kits, STR kits supply allelic ladders containing common STR alleles that have been previously characterized for the number of repeat units via DNA sequencing.

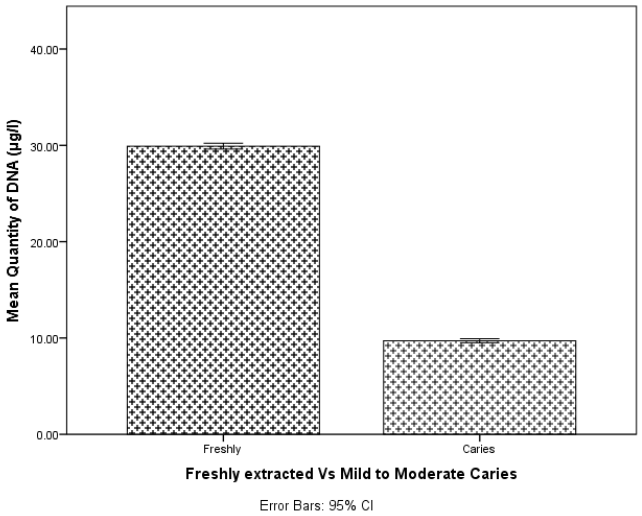
RESULTS :

Quantification of DNA was examined by comparing for the mild to moderately carious tooth with freshly extracted tooth. The mean quantity of DNA **(in µg/l)** was compared across mild to moderately carious tooth with freshly extracted tooth.

It was assumed that quantitatively the DNA obtained from mild to moderate carious tooth will be lesser compared to freshly extracted tooth. Level of significance was tested using independent sample t test at $p<0.05$ using two-tailed assumptions.

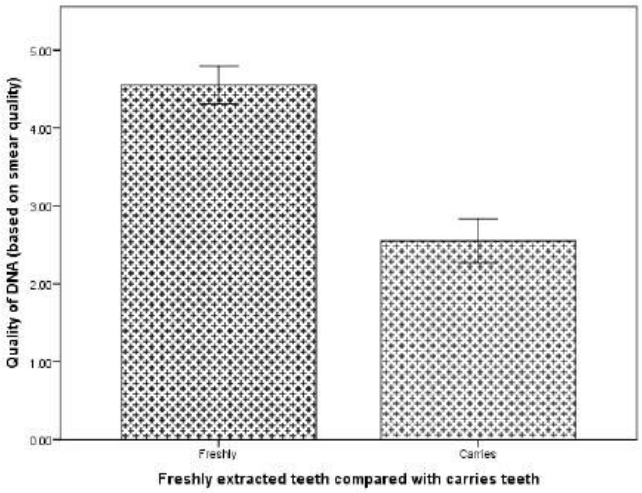
A significant difference was observed between freshly extracted ($M=29.91$, $SD=0.65$) and mild to moderate carious ($M=9.71$, $SD=0.45$), $t(38)=114.19$, $p<0.000$. The outcome of the result suggested that mean quantity of DNA **(in µg/l)** obtained from mild to moderate caries was significantly lesser than the freshly extracted tooth.**(Figure 1)**

Figure 1: Mean quantity of DNA of mild to moderately carious tooth obtained from RT-PCR technique compared across freshly extracted teeth.



Quality of DNA was also examined for the mild to moderately carious tooth and it was compared with the freshly extracted tooth obtained from agarose gel electrophoresis. The smear quality was compared across mild to moderately carious tooth with freshly extracted tooth. The quality of DNA based on the smear quality was categories in to five subcategories, extremely good, good, average, below average and poor qualities. It was assumed that qualitatively the DNA obtained from mild to moderate carious tooth will be lesser compared to freshly extracted tooth. Level of significance was tested using independent sample t test at $p<0.05$ using two-tailed assumptions. A significant difference was observed between freshly extracted ($M=4.55$, $SD=0.51$) and mild to moderate carious ($M=2.55$, $SD=0.6$), $t(38)=11.3$, $p<0.000$. The outcome of the result suggested that median quality of DNA obtained from mild to moderate caries was significantly lesser than the freshly extracted tooth. **(Figure 2)**

Figure 2: Quality of DNA based on the smear quality obtained from agarose gel electrophoresis of mild to moderately carious tooth compared across freshly extracted teeth



DNA Profile generated using Promege powerplex fusion DNA amplification kit which includes 23 Autosomal STR markers and Amelogenin marker from a freshly extracted normal tooth and carious tooth are as per **Figure 3 and 4**.

DISCUSSION :

From the above experiment it was observed that high molecular weight amplifiable DNA was extracted from both freshly extracted normal tooth or well of from carious tooth. The quantity of DNA extracted from the carious tooth was exceptionally lower in comparison to the normal tooth. But the quantity extracted from the carious tooth via organic tooth DNA extraction method followed by the sensitive purification

Figure 3: Freshly extracted normal tooth.

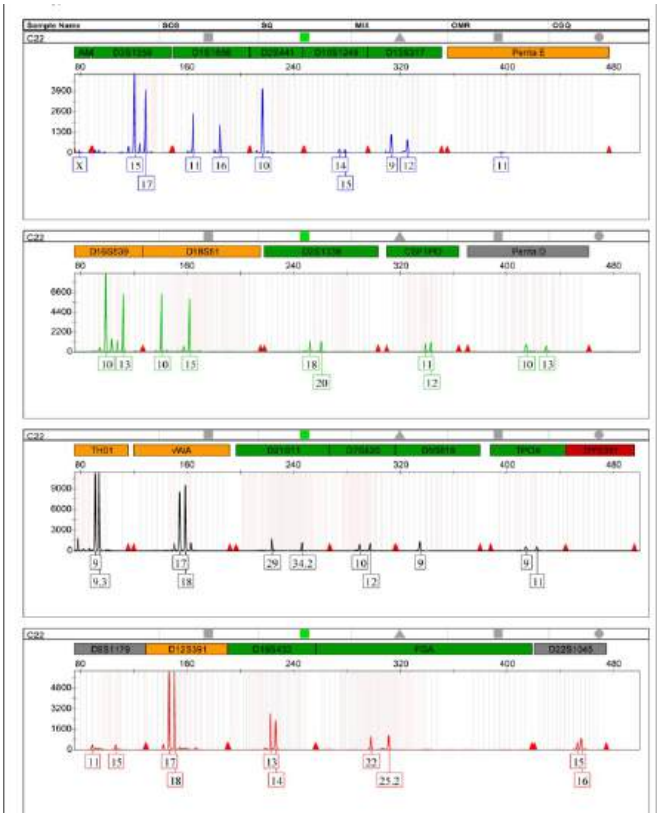
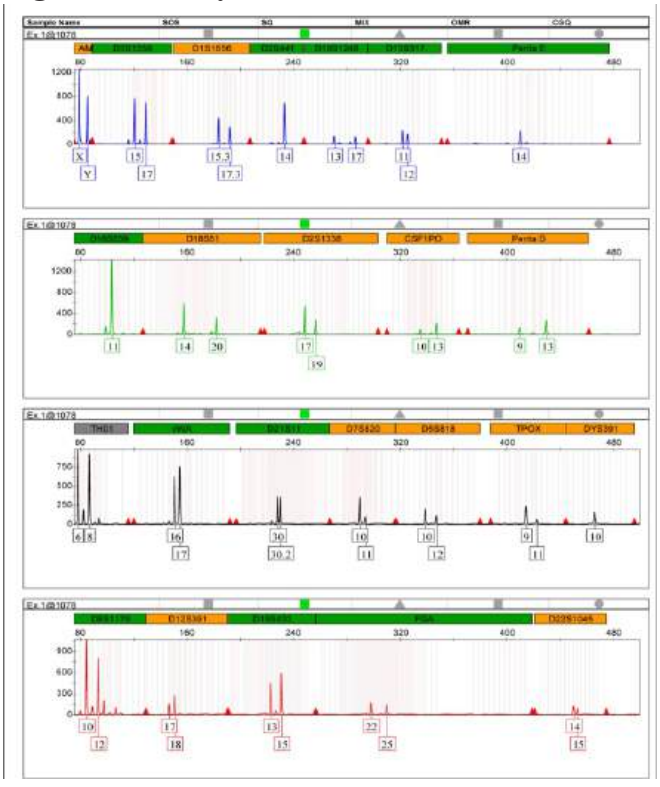


Figure 4: Freshly extracted carious tooth



method was adequate for generating a complete DNA profile, sufficient enough for forensic identification purpose. When we

compared the DNA profile generated from a normal tooth to a profile generated from a carious tooth the visible differences can be concluded in the following basic points. First, the peaks are sharp and uniformly distributed at all the loci throughout the plot. But the profile generated from a carious tooth shows the peak of less height on a graded, short towards the right side of the plot that is towards the loci of larger base pairs. This is mainly because of the less quantity of DNA extracted in the carious tooth samples. Secondly, the profile generated in the case of normal tooth was comparatively clear and clean, it was also devoid of any stutters and extra peaks. But in the profile generated from the carious tooth the profile shows certain small stutters and peak in the loci region of small base pairs. This is because of the extra amount of microbial DNA present in the extracted DNA which sometimes competes for binding of the primers in the reaction mix during amplification process. Thirdly, slightly broader peaks were observed in case of the profile generated from the carious tooth. The best possible reason could be the presence of natural inhibitors like radicals of pan-masala, gutka or microbial infections in the extracted DNA samples of carious tooth.

Besides above differences it can be clearly opinioned that the carious tooth samples are capable of yielding sufficient amplifiable DNA that can generate a complete DNA profile for subsequent use in human identification and comparison. However, careful procedure of optimized DNA extraction and its purification are to be employed for its success in generation of readable genetic profile. In current socioeconomic, cultural and diversified human society getting a carious tooth sample for human individualization is not a limitation.

Caries in tooth are considered to be multifactorial disease initiated and progression takes place by various risk factors. The risk factors for caries can be categorized as biological, environmental or socio-behavioral[16]. However caries also has its prevalence with socioeconomic factors such as income, education level and family size[14]. Hence one can correlate the socioeconomic status of victim or suspect with the tooth evidences, further individualization can be established by DNA profiling with the same carious tooth. The several species of microbes found to be pathogenic in caries are Streptococcus spp., Streptococcus mutans, Lactobacillus spp, Enterococcus spp., Enterococcus faecalis; and the fungus Candida albicans. The most abundant species is Streptococcus spp, followed by Lactobacillus spp. and Enterococcus spp12. The pathogens were organized into two correlated groups that are; the fungus C. albicans and the bacteria Enterococcus spp. cluster together, whereas Streptococcus spp., S. mutans and Lactobacillus spp. form separate cluster.

The important limitation of our study was the use of freshly extracted normal teeth instead of teeth exposed to environmental insult. Considering of all the factors DNA integrity decrease considerably due to effect of putrefaction. In this study the pulp material was taken into consideration for DNA extraction, although other parts of the tooth, mainly cementum may be accountable as the other source of DNA[15]. Several methodologies have been validated for tooth sampling and DNA extraction because the method of processing a key determinant of the quality of the yield of DNA. As stated, all subjects included in this study belong to the same geographical area and differences between gender and age were matched with their dental pathology. The control group had underlying orthodontic causes for dental extractions, and as they were younger they presented. The concentration and the purity of the DNA samples. can further be increased

CONCLUSION :

It was observed that the mean quantity of DNA was lower in carious tooth when compared with the freshly extracted normal tooth. Occurrence of carious tooth is common across various socioeconomic strata thus it is useful for individualization. In forensic investigations, the procedures are of high value as in a number of cases, the investigators received the exhibit materials not having enough visible biological materials as observed in the freshly extracted normal tooth. Similarly, a DNA profiling data with enough resolution can be generated from the samples like in severely decomposed bodies in mass disasters. However, a good result always depends on the magnitude of contaminations and careful handling by the investigators. Hence good result is expected from the carious tooth which proves to have significant role in human identification as even in carious tooth the amount of stutter, allelic drop and split peaks are minimal. Present study advocates the role of carious tooth human identification.

Conflict of Interest: There are no conflict of interest associated with this research.

Funding: The authors have not received any financial assistance from any source to conduct this research.

Acknowledgment: The authors acknowledge all the participants of this study.

Contributions: Conceptualization of idea: LK, TD, RD; Hypothesis generation: LK, TD; Manuscript writing: LK, VK, KC, BM; Sample collection and analysis: LK, KC, BM; Statistical Analysis and references: LK, VK, Editing: LK, TD, RD, VK, KC, BM.

REFERENCES :

1. Gunn A. Essential forensic biology: John Wiley & Sons; 2019.

2. Higgins D, Austin JJ. Teeth as a source of DNA for forensic identification of human remains: a review. Sci Justice. 2013;53(4):433-41.
3. Manjunath B, Chandrashekar B, Mahesh M, Rani RV. DNA profiling and forensic dentistry–A review of the recent concepts and trends. J Forensic Leg Med. 2011;18(5):191-7.
4. Datta P, Datta SS. Role of deoxyribonucleic acid technology in forensic dentistry. J Forensic Dent Sci. 2012;4(1):42.
5. Hervella M, Iñiguez MG, Izagirre N, Anta A, de-la-Rúa C. Nondestructive methods for recovery of biological material from human teeth for DNA extraction. J Forensic Sci. 2015;60(1):136-41.
6. Nelson SJ. Wheeler's Dental Anatomy, Physiology and Occlusion-E-Book: Elsevier Health Sciences; 2014.
7. Jeffreys A, Wilson V, Thein S. Hypervariable'minisatellite'regions in human DNA. 1985. Biotechnology (Reading, Mass). 1992;24:467.
8. Butler JM. Short tandem repeat typing technologies used in human identity testing. Biotechniques. 2007;43(4):Sii-Sv.
9. Edelstein BL, editor The dental caries pandemic and disparities problem. BMC Oral Health; 2006: Springer.
10. Kidd EA, Fejerskov O. Essentials of dental caries: Oxford University Press; 2016.
11. Pötsch L, Meyer U, Rothschild S, Schneider P, Rittner C. Application of DNA techniques for identification using human dental pulp as a source of DNA. Int J Legal Med. 1992;105(3):139-43.
12. Bourgeois D, David A, Inquimbert C, Tramini P, Molinari N, Carrouel F. Quantification of carious pathogens in the interdental microbiota of young caries-free adults. PLoS One. 2017;12(10):e0185804.
13. Sosa C, Baeta M, Núñez C, Casalod Y, Luna A, Martínez-Jarreta B. Nuclear DNA typing from ancient teeth. The American journal of forensic medicine and pathology. 2012;33(3):211-4.
14. Elamin A, Garemo M, Gardner A. Dental caries and their association with socioeconomic characteristics, oral hygiene practices and eating habits among preschool children in Abu Dhabi, United Arab Emirates—the NOPLAS project. BMC Oral Health. 2018;18(1):104.
15. Alia-García E, Parra-Pecharromán D, Sánchez-Díaz A, Mendez S, Royuela A, Gil-Alberdi L, et al. Forensic identification in teeth with caries. Forensic Sci Int. 2015;257:236-41.
16. Tran-Hung L, Tran-Thi N, Aboudharam G, Raoult D, Drancourt M. A new method to extract dental pulp DNA: application to universal detection of bacteria. PLoS One. 2007;2(10):e1062.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00102.8

Original Research Paper

The attitude of Iranian Psychiatrists toward diminished criminal liability

1. **Azadeh Memarian,** Associate Professor of Forensic Medicine, Iran University Of Medical Science, Tehran, Iran
2. **Seyed Mehdi Saberi,** Associate Professor of Psychiatry ,Legal Medicine Research Center, Legal Medicine Organization, Tehran, Iran
3. **Leyla Abdolkarimi,** Assistant Professor of Forensic Medicine, Shahid Rajaei Cardiovascular Medical and Research Center, Tehran, Iran
4. **Ali Pourmojarab,** MD, Iran University of Medical Sciences, Tehran, Iran
5. **Amir Najafi Ghamat,** Ph.D candidate in private law, Islamic Azad University of Tabriz, Tabriz, Iran

ABSTRACT :

Introduction : This study investigated the attitude of Iranian psychiatrists towards criminal responsibility .

Materials and Methods : One hundred and fifty four Iranian psychiatrists that were randomly selected from general university hospitals, psychiatric hospitals and offices participated in this research by simple random sampling. The study questionnaire consisted of two main parts including demographic information and a list of 38 psychiatric disorders defined on DSM V and provided by the American Psychiatry Association.

Results: The most frequent psychiatric disorders that were thought by the psychiatrist to cause a diminished criminal responsibility were schizophrenia (total 98.7%, male 48.7% and female 50.0%, $p > 0.05$), brief psychotic disorder (total 87.7%, male 42.2% and female 45.5% $p > 0.05$) and schizophrenia form disorder (total 87%, male 42.9% and female 44.2%, $p > 0.05$). On the other hand, the least frequent disorders were histrionic personality disorder (total 2.6%, male 1.3% and female 1.3%, $p > 0.05$), oppositional defiant disorder (total 3.2%, male 0.6% and female 2.6%, $p > 0.05$) and borderline personality disorder (total 3.8%, male 3.2% and female 0.6%, $p > 0.05$).

Conclusion : Iranian psychiatrists do not receive proper training in the field of forensic psychiatry during their residency program which necessitates a reform in the current curriculum to cover the ever-challenging subjects of forensic psychiatry, a point in which law and psychiatry meet.

Corresponding Author:
Dr. Seyed Mehdi Saberi,
Associate Professor of Psychiatry,
Legal Medicine Research Center, Legal Medicine Organization, Tehran, Iran
Contact : +98 02166551201
Email : saberi_md@yahoo.com

Article History :
Received : 23 March 2020
Received in revised from : 23 April 2020
Accepted on : 23 April 2020
Available online : 30 April 2021

Key words: psychiatrics, criminal, liability

INTRODUCTION:

The issue of mental illness and its laws has been of interest to psychiatrists and lawyers in all countries. In some countries, there are comprehensive laws in this regard and it is also clear dealing of various social institutions with mental ill patients [1]. Although it apparently seems that approach to the legal aspects is the result of the West in the last century[2], reviewing the studies show a long records of these aspects in the history of Islamic and the orient criminal laws[3]. The history of laws related to criminal responsibility of mental patients in Western countries goes back to about two hundred years ago, while Islamic laws on these responsibilities refer to fourteen centuries ago[4]. Rules concerning the rights of psychiatric patients have exclusively changed during the time because of a lot scientific and social developments. Advances in the psychiatric literatures and new divisions of mental disorders within recent decades emphasize the necessity for creating coordination between existing legislation and compliance in the field of psychiatry[5]. In this regard, the formulation and codification of laws related to the removal subjects of criminal liability in psychiatric patients has been of particular interest.

Criminal liability is commonly consist of 2 components: the guilty action which is identified as the "actus reus", and the forbidden state of mind or guilty mind that is identified as the "mens rea"[6]. The mental component usually needs the proof of an intention on the part of the person who commits the criminal act. Article 149 of the penal code of the Islamic Republic of Iran specifies that any psychiatric illness that interferes with the person's ability to decide at the time of commission of a crime, excuses the offender from criminal liability[7-8]. To

decide which psychiatric disorder fulfills this criterion has always been a challenge to both psychiatrists and jurists. The main aim of this study is to investigate the attitude of Iranian psychiatrists towards criminal responsibility of the mentally ill patients and finally help to shed light on some aspects of the challenge noted above.

MATERIALS AND METHODS :

Present cross sectional survey was conducted in the city of Tehran on one hundred and fifty four randomly selected Iranian psychiatrists from general university hospitals, psychiatric hospitals and offices. The list of psychiatrists was prepared from the website of Iranian Psychiatrists Association (http://www.psychiatrist.ir/psy/). Data was collected using a researcher-made questionnaire. The questionnaire consisted of two main parts. The first part focused on demographic information such as age and sex of the participant, the university in which the participant passed the psychiatry residency program, years of experience in the field of psychiatry and history of presence in the forensic and medico-legal commissions. The second part consisted of a list of 38 psychiatric disorders defined on DSM V and provided by the American Psychiatry Association. The content validity of the questionnaire was tested via survey of eight psychiatrists in the University obtaining a mean content validity index of 0.82.The participants were asked to mark the disorders which they thought would result in a diminished criminal responsibility if proven to be present at the time of commission of an offence. The participants were asked to discuss the ambiguities if any.

For quantitative variables the results were demonstrated as mean ± SD and for categorical variables were shown by absolute frequencies and percentages. Normality of data was analyzed using the Kolmogorov-Smirnoff test. Categorical variables were compared using chi-square test or Fisher's exact test when more than 20% of cells with expected count of less than 5 were observed. Quantitative variables were also compared with t test or Mann- Whitney U test. For the statistical analysis, the statistical software SPSS version 16.0 (SPSS Inc., Chicago, IL) was used. P values of 0.05 or less were considered statistically significant.

RESULTS :

In total, 154 psychiatrics (mean age 48.27 ± 8.36 years, ranged 33 to 69 years, 49.4% male) were finally assessed. In this regard, 24.0% were working in Tehran University, 13.0% in Shahid Beheshti University, 30.5% in Iran University, and 32.5% in other universities. The average job experience was 11.39 ± 6.98 years (ranged 1 to 31 years). Among all, 24.0% were the members of faculty or research centers. Also, 33.1% had the history of the presence in legal psychiatry commission. Moreover, 33.1% passed one-month course of forensic medicine within medical residency period. The most frequent psychiatric disorders that were thought by the psychiatrist to cause a diminished criminal responsibility were schizophrenia (total 98.7%, male 48.7% and female 50.0%, $p > 0.05$), brief psychotic disorder (total 87.7%, male 42.2% and female 45.5% $p > 0.05$) and schizophrenia form disorder (total 87%, male 42.9% and female 44.2%, $p > 0.05$). On the other hand, the least frequent disorders were histrionic personality disorder (total 2.6%, male 1.3% and female 1.3%, $p > 0.05$), oppositional defiant disorder (total 3.2%, male 0.6% and female 2.6%, $p > 0.05$) and borderline personality disorder (total 3.8%, male 3.2% and female 0.6%, $p > 0.05$) **(table 1).** The gender of psychiatrics did not affect their attitude toward criminal responsibility of the mentally ill patients except for autism as s main cause of diminishing criminal responsibility that was selected more in men than in women (14.3% versus 6.5%, $p = 0.014$). The level of attitude of psychiatrics was not influenced by their academic position. Those with previous history of the presence in legal psychiatry commission introduced Bipolar I Disorder as diminishing indication of criminal liability more than those without this commission history (56.9% versus 39.8%, $p = 0.045$). Also, Dissociative Amnesia has been more indicated to diminish criminal liability among psychiatrics who passed one-month course of forensic medicine compared to other psychiatrics (21.6% versus 6.8%, $p = 0.007$). Also, those psychiatrics who introduced Dissociative Amnesia and cannabis-related mental disorders for diminishing criminal liability were significantly older than other physicians **(Table 2)**. Cannabis-related mental disorders were also the most frequent psychiatric disorder thought by the psychiatrist with more job experiences to cause a diminished criminal liability.

DISCUSSION :

By emphasizing on the necessity for assessing the attitude of psychiatrics towards criminal liability, our study could revealed that the most common mental disorders introduced as reason for diminishing criminal responsibility include schizophrenia followed by brief psychotic disorder and schizofreniform disorders. We also showed that among various mental disorders, autism was introduced as the most important disorder to diminish criminal liability more by male compared with female psychiatrics. Also, the selection of Bipolar I Disorder as a cause of diminishing criminal responsibility was related to history of the presence in commission, the selection of Dissociative Amnesia was related to passing forensic medicine courses, the selection of cannabis-induced disorders was related to lower physicians' age as well as to those with less occupational experiences. More importantly, a notable number

Table 1: Diminished criminal responsibility in male and female psychiatrics

Disorder	Male		Female	
Intellectual Developmental Disorder	Pos.	Neg	Pos.	Neg
Autism Spectrum Disorders	35.1%	14.3%	39.6%	11.0%
Attention-Deficit/Hyperactivity Disorder	14.3%	35.1%	6.5%	44.2%
Tourette's Disorder	2.6%	46.8%	2.6%	48.1%
Schizophrenia	3.9%	45.5%	2.6%	48.1%
Schizophreniform Disorder	48.7%	0.6%	50.0%	0.6%
Brief Psychotic Disorder	42.9%	6.5%	44.2%	6.5%
Delusional Disorder	42.2%	7.1%	45.5%	5.2%
Schizoaffective Disorder	16.9%	32.5%	22.1%	28.6%
Substance Induced Psychotic Disorder	42.2%	7.1%	37.7%	13.0%
Bipolar I Disorder	14.3%	35.1%	14.9%	35.7%
Bipolar II Disorder	22.1%	27.3%	23.4%	27.3%
Major Depressive Disorder	5.8%	43.5%	8.4%	42.2%
Dysthymia	5.8%	43.5%	6.5%	44.2%
Generalized Anxiety Disorder	3.2%	46.1%	1.9%	48.7%
Obsessive-Compulsive Disorder	1.9%	47.4%	3.9%	46.8%
Posttraumatic Stress Disorder	2.6%	46.8%	7.1%	43.5%
Dissociative Amnesia	4.5%	44.8%	5.8%	44.8%
Dissociative Identity Disorder	3.9%	45.5%	7.8%	42.9%
Conversion Disorder	9.1%	45.5%	7.1%	43.5%
Non-REM Sleep Arousal Disorder	0.6%	40.3%	3.9%	46.8%
Oppositional Defiant Disorder	1.9%	48.7%	7.1%	43.5%
Intermittent Explosive Disorder	10.4%	47.4%	2.6%	48.1%
Conduct Disorder	5.2%	39.0%	1.9%	48.7%
Alcohol Use Disorder	5.2%	44.2%	13.0%	37.7%
Cannabis Use Disorder	17.5%	44.2%	7.1%	43.5%
Hallucinogen-Related Disorders	3.9%	31.8%	6.5%	44.2%
Stimulant Use Disorder	44.8%	45.5%	22.1%	28.6%
Neurocognitive Alzheimer's Disease	42.9%	4.5%	4.5%	46.1%
Neurocognitive Disorder With Lewy Bodies	39.6%	6.5%	41.6%	9.1%
Neurocognitive Disorder Due to brain Trauma	33.1%	9.7%	40.3%	10.4%
Neurocognitive Disorder Due to HIV Infection	4.5%	16.2%	38.3%	12.3%
Paranoid Personality Disorder	11.0%	44.8%	34.4%	16.2%
Schizoid Personality Disorder	13.6%	38.3%	7.8%	42.9%
Schizot y pal (Personality) Disorder	3.2%	35.7%	7.1%	43.5%
Antisocial Personality Disorder	3.2%	46.1%	16.2%	34.4%
Borderline Personality Disorder	1.3%	46.1%	2.6%	48.1%
Histrionic Personality Disorder		48.1%	0.6%	50.0%
			1.3%	49.4%

of psychiatrics believed personality disorders as the main disorder for diminishing criminal liability that is not comparable to forensic psychiatry texts. Also, borderline disorders were considered as the causes of criminal liability in some physicians. It is no accepted that most patients with borderline disorders considerable tend to addiction, self-injury, severe attacks furiously to others and impulsive behavior leading proof of intentional criminal act, except in very rare cases that the patient act in transient psychosis status [9]. In some literatures, the main requirements for diminished responsibility have pointed to be 1) there should be a mental functioning abnormality, 2) this abnormality of the mind must

have been caused by a declared medical condition, and 3) the mind abnormality should considerably ruin the defendant's mental responsibility[10].The contradiction of treatment of psychiatric patient against his or her punishment has been ongoing for a long time[11-14]. In some countries such as Iran, the concept of partial responsibility or diminished capacity is currently used as a defense. Nowadays, need for modifying the law to understand the concept of diminished criminal liability is well felt and now supported by medical societies and even medical professionals in our country, however the awareness of these professionals towards factors for diminished criminal liability seems to be low need to holding different courses of forensic psychiatry with the approach to criminal liability.

Various investigators could show high rates of mental disorders in criminal populations, however they could not reliably demonstrated that the mental disorder is a preexisting factor that is directly responsible for the criminal behaviors[15]. In fact, it seems that inadequate treatment of mental disturbances in these patients being arrested for their violent and nonviolent crimes. In fact, victims of crimes by mentally ill persons are often familiar with patient, in contrast non-psychiatrically ill criminals may violate strangers or not[16]. According to our findings, most psychiatrics believed that schizophrenia is a cause for diminished capacity regardless of the patients' treatment schedule. It has been suggested that people who develop schizophrenia are at increased to involve in violence towards others. It has been well demonstrated that the symptoms of psychosis and drug misuse in schizophrenic patients are associated with violent behavior for offenders with schizophrenia that may be prevented by proper treatment and thus may inhibit their criminal behavior. These evidences can be also documented in individuals with psychotic and schizofreni form disorders.

Another important finding was that none of the psychiatrics did not ask the symptoms and signs of mentally ill patients and only emphasized the final diagnosis of disease indicated that the physicians are more disease-oriented not symptoms-oriented. In fact, in legal cases, in addition to the mere diagnosis, the patient's symptoms are also important[17]. In addition, although none of the psychiatrists did ask about the criminal offense, the assessment and decision on diminishing or non-diminishing criminal liability should be based on both diagnosis and other factors such as the type of crime. In fact, psychiatrist's academic view is stronger than their legal view. In most European countries, the existing legislation in relation to criminal disclaimer in mental patients, in addition to stating the type of mental disorder, the effects of these disorders on voluntary and perceptual abilities are also considered. In fact, the judge must first recognize is guilty suffering from any mental disorders during committing a crime and second does this disorder affect the ability of offenders[18]. In total, it seems that our psychiatrists do not pass adequate training courses in the field of legal psychiatry during their assistance period that should be considered in all universities.

In conclusion, our psychiatrics believe that the schizophrenia is the main criterion for diminishing criminal liability; however they ignore other disease aspects such as symptoms and patients' mental situation during committing a crime. None of the participants asked about the signs and symptoms of the disorder although they were asked to discuss any ambiguities. This reflects the diagnosis-oriented system of thinking rather than symptom-oriented which usually is the preferred approach to the medicolegal cases. Also, none of the participants asked about the type of the 'offence" that the person is being accused of, which shows the academic attitude of psychiatrists rather than forensic. Overall, it seems that Iranian psychiatrists do not receive proper training in the field of forensic psychiatry during their residency program which necessitates a reform in the current curriculum to cover the ever-challenging subjects of forensic psychiatry, a point in which law and psychiatry meet.

REFERENCES :

[1] Fistein EC1, Holland AJ, Clare IC, Gunn MJ. A comparison of mental health legislation from diverse Commonwealth jurisdictions. Int J Law Psychiatry. 2009 May-Jun;32(3):147-55. doi: 10.1016/j.ijlp.2009.02.006. Epub 2009 Mar 19.

[2] Geferakos G1, Lykouras L1, Douzenis A1. Forensic psychiatry and Islamic law. Psychiatriki. 2014 Oct-Dec;25(4):303-8.

[3] Chaleby KS1. Issues in forensic psychiatry in Islamic jurisprudence. Bull Am Acad Psychiatry Law. 1996;24(1):117-24.

[4] Stuart H1. Violence and mental illness: an overview. World Psychiatry. 2003 Jun;2(2):121-4.

[5] Kamath RM. Psychiatry and law: past, present and future. Mens Sana Monogr. 2015 Jan-Dec;13(1):105-13.

[6] Kiehl KA1, Hoffman MB2. THE CRIMINAL PSYCHOPATH: HISTORY, NEUROSCIENCE, TREATMENT, AND ECONOMICS. Jurimetrics. 2011 Summer;51:355-397.

[7] Nakatani Y, Kojimoto M, Matsubara S, Takayanagi I. New legislation for offenders with mental disorders in Japan. Int J Law Psychiatry. 2010 Jan-Feb;33(1):7-12.

[8] Olié JP, Lôo H. Forensic psychiatry. Bull Acad Natl Med. 2008 Feb;192(2):381-9

[9] Sansone RA, Sansone LA. Borderline personality and

criminality. Psychiatry (Edgmont). 2009 Oct;6(10):16-20.

[10] Mobbs D1, Lau HC, Jones OD, Frith CD. Law, responsibility, and the brain. PLoS Biol. 2007 Apr;5(4):e103.

[11] Wall BW: Criminal responsibility, diminished capacity, and the gay panic defense. J Am Acad Psychiatry Law 28:4549, 2000

[12] Linhorst DM: The impact of system design on the characteristics of Missouri's insanity acquittees. J Am Acad Psychiatry Law 25: 50929, 1997

[13] Morse SJ: Undiminished confusion in diminished capacity. J Crim Law Criminol 75:155, 1984

[14] Zabow A: Israel: law and the psychopath. Isr J Psychiatry 35: 1501, 1998

[15] Rueve ME1, Welton RS. Violence and mental illness. Psychiatry (Edgmont). 2008 May;5(5):34-48.

[16] Dyer C. Consent to treatment and criminal responsibility in the mentally ill. Br Med J (Clin Res Ed). 1987 Nov 28;295(6610):1402-3.

[17] Spaans M, Barendregt M, Haan B, Nijman H, de Beurs E. Diagnosis of antisocial personality disorder and criminal responsibility. Int J Law Psychiatry. 2011 Sep-Oct;34(5):374-8.

[18] Teplin LA1, McClelland GM, Abram KM, Weiner DA. Crime victimization in adults with severe mental illness: comparison with the National Crime VictimizationSurvey. Arch Gen Psychiatry. 2005 Aug;62(8):911-21.

Positive : The age of psychologist who estimate such disorder may cause a diminished criminal responsibility
Negative : The age of psychologist who did not estimate such disorder may cause a diminished criminal responsibility

Table 2: The mean age of psychiatrics who selected diminished criminal responsibility

Disorder	Mean age	
	Positive	Negative
Intellectual Developmental Disorder	48	48
Autism Spectrum Disorders	50	48
Attention-Deficit/Hyperactivity Disorder	47	48
Tourette's Disorder	49	48
Schizophrenia	48	45
Schizophreniform Disorder	48	50
Brief Psychotic Disorder	48	49
Delusional Disorder	48	48
Schizoaffective Disorder	48	48
Substance Induced Psychotic Disorder	49	48
Bipolar I Disorder	49	48
Bipolar II Disorder	48	48
Major Depressive Disorder	48	48
Dysthymia	46	48
Generalized Anxiety Disorder	47	48
Obsessive-Compulsive Disorder	46	48
Posttraumatic Stress Disorder	47	48
Dissociative Amnesia	44	49
Dissociative Identity Disorder	48	48
Conversion Disorder	49	48
Non-REM Sleep Arousal Disorder	48	48
Oppositional Defiant Disorder	45	48
Intermittent Explosive Disorder	46	48
Conduct Disorder	50	48
Alcohol Use Disorder	46	49
Cannabis Use Disorder	44	49
Hallucinogen-Related Disorders	49	48
Stimulant Use Disorder	47	48
Neurocognitive Alzheimer's Disease	48	48
Neurocognitive Disorder With Lewy Bodies	48	49
Neurocognitive Disorder Due to brain Trauma	48	49
Neurocognitive Disorder Due to HIV Infection	48	49
Paranoid Personality Disorder	45	48
Schizoid Personality Disorder	48	48
Schizot y pal (Personality) Disorder	48	48
Antisocial Personality Disorder	49	48
Borderline Personality Disorder	51	48
Histrionic Personality Disorder	52	48

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00103.X

Original Research Paper

Reliability of Chilotic Index over Mid Pubic Width in Sex Determination in Kalaburgi Region of South India

1. **Shreekrishna H K,** Associate Professor, Department of Forensic Medicine & Toxicology, DM Wayanad Institute of Medical Sciences, Wayanad
2. **Yatiraj Singi,** Associate Professor, Department of Forensic Medicine & Toxicology, AIIMS Bilaspur, Himachal Pradesh
3. **Prakash Babladi,** Professor & Head, Department of Forensic Medicine & Toxicology, MRMC, Kalaburgi.

ABSTRACT

Introduction : Identification of the sex from the skeletal remains is the prime work of forensic experts.

Materials and Methods : The present study was carried out to determine the sex of hip bone from mid pubic width and chilotic index. One hundred adult hip bones of known sex (50 male and 50 female) available in the department of Forensic Medicine and Department of Anatomy, M R Medical College and KBN Institute of medical sciences, Kalburagi were used.

Results : Between the two variables statistically analyzed, the most reliable parameter was chilotic index (74% of male and 82% of female hip bones) that is, overall 78% of hip bones can be sorted out by this parameter alone. This parameter was found to be statistically significant.

Corresponding Author:
Dr. Yatiraj Singi,
Associate Professor,
Department of Forensic Medicine & Toxicology, AIIMS Bilaspur, Himachal Pradesh
Contact : +91 9972828903
Email : drsingiyatiraj@gmail.com

Article History :
Received : 31 August 2019
Received in revised from : 4 September 2019
Accepted on : 26 September 2019
Available online : 30 April 2021

Key words: Mid Pubic Width, Chilotic index, Demarking point

INTRODUCTION :

Identification of sex of the deceased from skeletal remains is in practice since long ago, as it becomes important expert evidence in the court of law. In medico legal cases forensic experts are often asked for their expert opinion regarding species, age, sex, race and stature and probable cause of death from skeletal remains.

In Medico legal cases bones form important evidence in establishing identity of deceased. The determination of deceased sex is first step in skeletal analysis since estimation of age at death, race, and stature depends on sex of deceased. Bernard Knight[1] (2016) in his treatise quotes "the accuracy of determination of the sex of skeletal remains varies with the age of the subject, the degree of fragmentation of the bones and biological variability." Observations and measurements suggesting age, sex and race of an individual skeleton or its remains are not only useful in anthropology and archeology but also essential for establishing personal identity in forensic medicine[2].

The distinctive morphology of the human hip bone and its clear sexual dimorphism makes it of interest from anatomical, anthropological and forensic points of views[3].

The determination of sex is statistically the important criterion, as it immediately excludes approximately half of the population whereas age, stature, and race each provide points within a wide range of variables" The sexual dimorphism in the shape and size of the pelvis is very high because of females giving birth to large-brained infants, under the constraints of the human trait of bipedal organization to the pelvis and lower limbs[4-6.] Large number of studies has been done in different parts of world by many workers to determine the sex from skeleton. Most of the older studies were centered on morphological traits in descriptive manner. Later on sexual differences in skeleton were studied metrically and morphometrically and nowadays they are studied by applying the statistical comparative univariate and multivariate discriminant functional analysis to the data obtained.

MATERIAL AND METHODS :

One hundred adult human hip bones of known sex available in the Department of Forensic Medicine & Toxicology and Department of Anatomy, M.R. Medical College & K.B.N. Institute of Medical Sciences, Kalaburgi were used for the present study. Out of 100 hip bones, 50 were of males and 50 were of females. All the hip bones were dry, free of damage or deformity and were completely ossified.

Sliding Vernier caliper, Compass, Chalk and Marker pencil were used for measurements of various parameters of hip bone. Sufficient care was taken to avoid manual error and all measurements were taken personally.

Mid-pubic width : This is the shortest distance from the middle of pubic symphysis to obturator foramen measured with sliding caliper.

$$\textbf{Chilotic index} = \frac{\text{Sacral part of chilotic line}}{\text{Pelvic part of chilotic line}} \times 100$$

Pelvic part of chilotic line: It extends from pubo-iliac point to the auricular point.

Sacral part of chilotic line: It extends from auricular point to the iliac crest.

As the first part of study all the values were tabulated and analysed statistically by routine statistical methods. The values of range, mean, standard deviation, calculated range (mean±3SD), Demarking points and Identification points were obtained. For each parameters with male range of a b and female range of c d, values 'a' and 'd' were the identification points (I.P) for females and males respectively. Any hip bone parameter reading less than 'a' was regarded as female hip bone and greater than 'd' was regarded as male hip bone and in case where female range is more than male then 'b' and 'c' were identification points (I.P) for female and male respectively. Similarly Demarking Points (D.P) was calculated from calculated range i.e., Mean ± 3 S.D (a = minimum value in male range, b = maximum value in male range, c = minimum value in female range and d = maximum value in female range). Subsequently 't' test was applied all the four parameters.

RESULTS :

One hundred hip bones (50 males and 50 females) were studied in the present study. In all the hip bones midpubic width, sacral and pelvic part chilotic line measurements were measured. As the first part of study each parameter were analyzed statistically and mean, standard deviation, range, calculated range (mean±3 SD), demarking points (DP) and identification point (IP) were obtained. Percentage of the hip bones identified by demarking point, percentage of hip bones identified by identification point was calculated. Then 't' test was applied.

The mean value of pelvic part of chilotic line of the male hip bone is 61.88 mm ranging between 51-73 mm. The mean value of pelvic part of chilotic line of female hip bone is 73.6 mm with the values ranging between 58-86 mm. The S.D. for male and female are 7.01 & 6.20 respectively. The range of mean ± 3 S.D. in males and females is 40.80-82.92 mm & 54.99-92.21 mm respectively. Identification point for male is less than 58 mm & for female it is more than 73 mm. The demarking point for males is <54.9 mm and for females it is >83 mm, and the percentage of hip bones identified by demarking point alone is 22% of male and 8% of female. 't' test is highly significant with P<0.001. **(Table 1)**

Table 1 : Statistical analysis of the pelvic part of chilotic line

S. No.	Particular	Male (mm)	Female (mm)
1.	Number of bones	50	50
2.	Range	51-73	58-86
3.	Mean	61.88	73.6
4.	Standard deviation (SD)	7.01	6.20
5.	Statistical Significance	Sig	Sig
6.	Identification Point	<58	>73
7.	Percentage of identified bones	40%	40%
8.	Calculated range (mean±3SD)	40.84-82.92	54.99-92.21
9.	Demarking point	<54.4	>83
10.	Percentage beyond Demarking Point	22%	8%
11.	Standard Error	0.99	0.88

't'test=8.86; p<0.001 *statistically highly significant

The mean value of sacral part of chilotic line of the male hip bone is 68.76 mm ranging between 58-78 mm. The mean value of sacral part of chilotic line of female hip bone is 60.1 mm with the values ranging between 48-70 mm. The S.D. for male and female are 5.44 & 6.34 respectively. The range of mean ± 3 S.D. in males and females is 52.45-85.07 mm & 41.09-79.11 mm respectively. Identification point for male is more than 70 mm & for female it is less than 58 mm. The demarking point for males is >79.1 mm and for females it is <52.45 mm, and the percentage of hip bones identified by demarking point alone is 0% of male and 10% of female. 't' test is highly significant with P<0.001. **(Table 2)**

Table 2 : Statistical analysis of the sacral part of chilotic line

S. No.	Particular	Male (mm)	Female (mm)
1.	Number of bones	50	50
2.	Range	58-78	48-70
3.	Mean	68.76	60.1
4.	Standard deviation (SD)	5.44	6.34
5.	Statistical Significance	Sig	Sig
6.	Identification Point	>70	>58
7.	Percentage of identified bones	44%	38%
8.	Calculated range (mean±3SD)	52.45-85.07	41.09-79.11
9.	Demarking point	>79.1	<52.45
10.	Percentage beyond Demarking Point	0%	10%
11.	Standard Error	0.77	0.90

't'test=7.33; p<0.001 *statistically highly significant

The mean value of chilotic index of male hip bone is 111.89 ranging between 98.41-122.64. The mean value of chilotic index of female hip bone is 81.88 with the values ranging between 65.88-95.89. The S.D. for male and female are 6.96 & 8.03 respectively. The range of mean ± 3 S.D. in males and females is 90.8-132.58 & 57.79-105.96 respectively. Identification point for male is more than 95.89 & for female it is less than 98.41. The demarking point for males is <105.96 and for females it is >90.8, and the percentage of hip bones identified by demarking point alone is 74% of male and 82% of female. 't' test is highly significant with P<0.001 **(Table 3)**

Table 3: Statistical analysis of the chilotic index

S. No.	Particular	Male (mm)	Female (mm)
1.	Number of bones	50	50
2.	Range	98.41-112.64	65.88-95.89
3.	Mean	111.69	81.88
4.	Standard deviation (SD)	6.96	8.03
5.	Statistical Significance	Sig	Sig
6.	Identification Point	>95.89	<98.41
7.	Percentage of identified bones	100%	100%
8.	Calculated range (mean±3SD)	98.8-132.58	57-79-105.96
9.	Demarking point	>105.96	<90.8
10.	Percentage beyond Demarking Point	74%	82%
11.	Standard Error	0.98	1.14

't'test=19.84; p<0.001 *statistically highly significant

The mean value of mid pubic width of male hip bone is 26.44 mm ranging between 17-36 mm. The mean value of mid pubic width of female hip bone is 29.30 mm with the values ranging between 23-38 mm. The S.D. for male and female are 4.63 & 4.71 respectively. The range of mean ± 3 S.D. in males and females is 14.54-40.39 mm & 15.17-43.43 mm respectively. Identification point for male is less than 23 mm & for female it is more than 36 mm. The demarking point for males is <15.2 mm and for females it is >40.32 mm and the percentage of hip bones identified by demarking point alone is 0% for both male and female. 't' test is highly significant with P<0.001. **(Table 4)**

Table 3: Statistical analysis of the mid pubic width

S. No.	Particular	Male (mm)	Female (mm)
1.	Number of bones	50	50
2.	Range	17-36	23-38
3.	Mean	26.44	29.30
4.	Standard deviation (SD)	4.63	4.71
5.	Statistical Significance	Sig	Sig
6.	Identification Point	<23	>36
7.	Percentage of identified bones	18%	10%
8.	Calculated range (mean±3SD)	12.54-40.34	15.17-43.43
9.	Demarking point	<15.2	>40.34
10.	Percentage beyond Demarking Point	0%	0%
11.	Standard Error	0.65	0.67

't'test=3.06; p<0.001 *statistically highly significant

DISCUSSION :

In the discussion of sexual dimorphism of human hip bone Davivongs (1963)[7] has stated. "As a general rule, the male bones are more massive and heavier than female bones. The crests, tuberosities and lines of muscle and ligament attachments are more strongly marked in males. This rule also governs the size of joint and articular surfaces as well".

In the discussion of present study the values of each parameter of the hip bone are discussed below by taking into consideration the mean, standard deviation, its demarking points for male and female and statistical significance. The merits and demerits of each parameter are discussed by comparing with the previous similar studies.

Pelvic part of chilotic line: The mean value of pelvic part of chilotic line of the male hip bone is 61.88 mm ranging between 51-73 mm. The mean value of pelvic part of chilotic line of female hip bone is 73.6 mm with the values ranging between 58-86 mm. The S.D. for male and female are 7.01 & 6.20 respectively. The range of mean ± 3 S.D. in males and females is 40.80-82.92 mm & 54.99-92.21 mm respectively. Identification point for male is less than 58 mm & for female it is more than 73 mm. The demarking point for males is <54.9 mm and for females it is >83 mm, and the percentage of hip bones identified by demarking point alone is 22% of male and 8% of female. 't' test is highly significant with P<0.001.

Table-5 shows the comparison of pelvic part of chilotic line of the present study with findings of previous workers, previous study shows that the mean value of pelvic part of chilotic line in female hip bone was considerably larger than that of male. Our findings are comparable with the findings of previous workers.

Sacral part of chilotic line: The mean value of sacral part of chilotic line of the male hip bone is 68.76 mm ranging between 58-78 mm. The mean value of sacral part of chilotic line of female hip bone is 60.1 mm with the values ranging between 48-70 mm. The S.D. for male and female are 5.44 & 6.34 respectively. The range of mean ± 3 S.D. in males and females is 52.45-85.07 mm & 41.09-79.11 mm respectively. Identification point for male is more than 70 mm & for female it is less than 58 mm. The demarking point for males is >79.1 mm and for females it is <52.45 mm, and the percentage of hip bones identified by demarking point alone is 0% of male and 10% of female. 't' test is highly significant with P<0.001.

Table 6 shows the comparison of findings of the present study about sacral part of chilotic line with previous study. This parameters was found to be useful in the sex determination.

Chilotic Index : The mean value of chilotic index of male hip bone is 111.89 mm ranging between 98.41-122.64 mm. The mean value of chilotic index of female hip bone is 81.88 mm

with the values ranging between 65.88-95.89 mm. The S.D. for male and female are 6.96 & 8.03 respectively. The range of mean ± 3 S.D. in males and females is 90.8-132.58 & 57.79-105.96 mm respectively. Identification point for male is more than 95.89 mm & for female it is less than 98.41 The demarking point for males is <105.96 mm and for females it is >90.8 mm, and the percentage of hip bones identified by demarking point alone is 74% of male and 82% of female. 't' test is highly significant with P<0.001.

Table 7 shows the comparison of findings of the present study about chilotic index with previous studies.

Davivongs (1963)[7], Singh and Potturi (1979)[8] and Bagade (1981)[9] agreed that the chilotic index has higher values in cases of male than female. The results of present study also prove that the index was greater in male. The mean value for male hip bone was comparable with findings of Singh & Potturi[8] and lower than the values of Davivongs[7] and Bagade[9]. On the other hand mean value for female was lower than the values found by other workers. This parameter was found as an important demarker for the determination of sex.

Mid public width: The mean value of mid pubic width of male hip bone is 26.44 mm ranging between 17-36 mm. The mean value of mid pubic width of female hip bone is 29.30 mm with the values ranging between 23-38 mm. The S.D. for male and female are 4.63 & 4.71 mm respectively. The range of mean ± 3 S.D. in males and females is 14.54-40.39 mm & 15.17-43.43 mm respectively. Identification point for male is less than 23 mm & for female it is more than 36 mm. The demarking point for males is <15.2 mm and for females it is >40.32 mm and the percentage of hip bones identified by demarking point alone is 0% of male and 0% of female. 't' test is highly significant with P<0.001. **(Table 8)**

Table 5 : Showing comparison of the pelvic part of chilotic line

S. No.	Author	No. of Cases		Mean (mm)		Demark Point (mm)	
		Male	Female	Male	Female	Male	Female
1.	Davivongs (1963)[7]	97	97	49.91	58.53	<49.00	>58
2.	Singh & Potturi (1977)[8]	160	80	62.83	76.12	--	--
3.	Bagade (1981)[9]	70	30	50.51	67.2	<48.00	>59
4.	Present study (2009)	50	50	61.88	73.6	<54.9	>83

Table 6: Showing comparison of the sacral part of chilotic line

S. No.	Author	No. of Cases		Mean (mm)		Demark Point (mm)	
		Male	Female	Male	Female	Male	Female
1.	Davivongs (1963)[7]	97	97	64.01	56.75	>68.00	<50.00
2.	Singh & Potturi (1977)[8]	160	80	56.11	55.75	--	--
3.	Bagade (1981)[9]	70	30	64.06	47.93	>56.00	<54.00
4.	Present study (2009)	50	50	68.76	60.1	>79.1	<52.45

Table 7: Showing comparison of the chilotic index

S. No.	Author	No. of Cases		Mean (mm)		Demark Point (mm)	
		Male	Female	Male	Female	Male	Female
1.	Davivongs (1963)[7]	97	97	129.26	98.16	>138.8	<94.30
2.	Singh & Potturi (1977)[8]	160	80	103.68	83.01	--	--
3.	Bagade (1981)[9]	70	30	130.66	84.5	>96.55	<95.00
4.	Present study (2009)	50	50	111.69	81.88	>105.96	<90.8

Table 8: Showing comparison of the Mid Pubic width

S. No.	Author	No. of Cases		Mean (mm)		Demark Point (mm)	
		Male	Female	Male	Female	Male	Female
1.	Rajangam, Jankiram &	60	45	28.40	29.4	<15.00	>38.30
	Thomas (1991)[10]						
2.	Gadare (1993)[11]	141	41	28.59	29.41	<16.33	>38.28
3.	Present study (2009)	50	50	26.44	29.30	<15.2	>40.34

CONCLUSION :

Between the two variables statistically analyzed, the most reliable parameter is chilotic index, 74% of male and 82% of female hip bones that is, overall 78% of hip bones can be sorted out by this parameter alone. This parameter is found to be statistically significant.

Conflict of interest: Nil

Source of funding: Self

Ethical Clearance: Taken from Institutional Ethical Committee

REFERENCES :

1) Sauko P, Knight B., Knight's Forensic Pathology, London, Arnold Publications. 2016;4th Edition, p. 106.
2) Williams Peter L, Bannister Lawrence H; Gray's Anatomy - The Anatomical Basis of Medicine, Churchill Livingstone, 1995; 38th Edition p. 433 and 673
3) Dixit SG, Kakar S, Agarwal S, Choudhry R. Sexing of human hip bones of Indian origin by discriminant function analysis. J Forensic Leg Med 2007;14(7): 429-35
4) Thomson A.; The sexual differences of the foetal pelvis. J Anat Physiol 1899 Apr, 33: 359-80
5) Shiho K. Uber die Huftpfanne. ZMA, 1914, 1915; 17: 325-6.
6) Derry DE. Note on the innominate bone as a factor in the determination of sex with special reference to the sulcus preauricularis. J Anat Physiol 1909 Apr, 43: 26676
7) Davivongs V. The pelvic girdle of the Australian Aborigines: Sex differences and Sex determination. Am J Phys Anthropol, 1963 Dec; 21(4): 443-55.
8) Singh S and Potturi BR, Greater sciatic notch in sex determination. J Anat, 1978 Mar; 125(3): 619-24.
9) Bagade KG. Determination of sex from axial skeleton. MS Anatomy Dissertation, Marathwada University, Aurangabad, 1981.
10) Rajnagam S, Janakiram S. and Thomas IM, Sexing of hip bones of Karnataka origin. JASI.1991; 40(2): 105-8.
11) Gadare NH. Sexual dimorphism in human hipbone MS Anatomy Dissertation Pune University, Pune 1993.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00104.1

Original Research Paper

Impact of COVID lockdown on autopsy cases: A comparative study

1. **Rakesh Kumar Chopra,** Medical Officer (Forensic Medicine), Civil Hospital, Jalandhar.
2. **Didar Singh Walia,** Associate Professor, Department of Forensic Medicine, Government Medical College, Amritsar
3. **Akash Deep Aggarwal,** Professor and Head, Department of Forensic Medicine, Government Medical College, Patiala

ABSTRACT :

The present comparative study was conducted at Civil Hospital Jalandhar for all postmortem examination cases in a period from 23/3/2020 to 3/5/2020 in curfew/ lockdown due to COVID-19 with 23/3/2019 to 3/5/2019. A total of 59 and 96 postmortems was conducted in the respective period. The study shows the percentage change in the cause of death during the period of curfew/lockdown when people stayed at home. In this study, it has been found that there is a 38.54% decrease in death cases whose postmortem was conducted in the lockdown /curfew period. There was about a 4% increase in death cases in males. Death-cases decreased in all age groups except between 31 to 50 years. Accidental death cases, including road traffic and railway, fell by about 22%, and poisoning/drug overdoses death cases decreased by about 7%; however, hanging cases increased by about 11%.

Corresponding Author :
Akash Deep Aggarwal
Professor and Head,
Department of Forensic Medicine,
Government Medical College, Patiala
Contact : +91 98156 52621
Email : toakashdeep@gmail.com

Article History:
Received: 7 August 2020
Received in revised form: 16 August 2020
Accepted on: 16 August 2020
Available online: 30 April 2021

KEYWORDS : COVID-19, Autopsy, Pandemics, Cause of death, Coronavirus.

INTRODUCTION :

The COVID-19 pandemic, also known as the coronavirus pandemic, is an ongoing pandemic of coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

On 22nd March 2020, the Government of India decided to completely lockdown 82 districts in 22 states and Union Territories of the country where confirmed cases have been reported till 31st March 2020, which was extended up to 3rd May 2020.

There are a very high number of road-side accident cases in Punjab. A total of 4725 people died in different road accidents on an average of 13 people lost their lives daily in various road accidents in Punjab in the year 2018. Road accidents claimed the highest number of lives in India while drowning and poisoning were some of the other major causes of unnatural deaths, a report has revealed. According to the data released by the Central Bureau of Health Investigation in a report titled "National Health Profile 2015", a total of 166,506 people died in road accidents in 2013.[1-5]

No doubt, accidents are the primary cause of deaths, but deaths due to suicide is also very high. As per WHO rating, India ranks 43rd in descending order of rates of suicide with a rate of 10.6/100,000 reported in 2009. Other common modes of suicide were reported In India, during 2009 consumption of a poison (33.6%), hanging (31.5%), self-immolation (9.2%), and drowning (6.1%).

MATERIAL AND METHODS:

The aim of our study was to identify and compare the characteristics of cases referred for autopsy during the lockdown period for the COVID-19 outbreak versus the cases referred during the same period in the previous year. The present study was conducted at Civil Hospital, Jalandhar. The material for the present study was all dead bodies brought for postmortem examination in the mortuary during the period from 23/3/2020 to 3/5/2020 in curfew/lockdown due to COVID-19 with 23/3/2019 to 3/5/2019. The data has been tabulated for the total number of cases, gender distribution, age groups, and cause of death.

RESULTS AND DISCUSSION :

This comparative study was conducted on all dead bodies brought for postmortem examination at civil hospital Jalandhar during the period from 23/3/2020 to 3/5/2020 in curfew/lockdown due to COVID-19 with 23/3/2019 to 3/5/2019.

In this study, it has been found that there is a 38.54% decrease in death cases whose postmortem was conducted in the lockdown /curfew period. There is about a 4% increase in death cases in males whose postmortem was held in the lockdown/curfew period as compared to the same period

mentioned in the previous year. **(Table 1)** During the lockdown/curfew period percentage of death-cases decreased in all age groups except between 31 to 50 years. **(Table 2)**

During lockdown/curfew period accidental death cases, including road traffic and railway are decreased by about 22%, and poisoning/drug overdoses death cases are decreased by about 7%; however, hanging cases are increased by about 11%. **(Table 3)**

A similar study from Greece has also reported a decrease in the number of autopsies by 15.2%; however, there was an increase of female autopsies by 9.1%, and increase in autopsy cases in 60-90 year ages, and deaths due to accidents showed a decrease of 8.6%, as also suicides showing a reduction of 1%, in contrast to the current study. [6-9]

The reason for decreased accidental death cases can be attributed to the fact that the people did not come out of their houses due to curfew/lockdown. Suicide cases increase during curfew/lockdown as people lost their jobs, perceived financial loss, domestic violence, and frustration. On regular days the number of accidental deaths is very high as compare to other types of unnatural deaths. The major causes of the high number of unintentional deaths include modernization, urbanization, and tremendous growth in the road transport sector. Population explosion is also a significant factor in an increased number of accidents. Causes of unnatural deaths include hanging, poisoning, drug overdoses, and assault. As per police papers prepared by investigating officer hanging and poisoning, death

Table 1: Total no. of Postmortem Cases in the period

Gender	No. of cases from 23/3/2019 to 3/5/2019		No. of cases from 23/3/2020 to 3/05/2020		% Change
	N	%	N	%	
Male	77	80.21	50	84.75	+4.54
Female	19	19.79	9	15.25	-4.54
Total	96	100	59	100	-38.54

Table 2: Age-wise distribution of Postmortem Cases in the period

Age of Postmortem Cases in years	**No. of cases from 23/3/2019 to 3/5/2019**		**No. of cases from 23/3/2020 to 3/05/2020**		**% Change**
	N	%	N	%	
0-10	1	1.04	0	0.00	-1.04
11-20	9	9.38	4	6.78	-2.60
21-30	27	28.13	13	22.03	-6.09
31-40	14	14.58	13	22.03	+7.45
41-50	17	17.71	15	25.42	+7.72
51 and above	28	29.17	14	23.73	-5.44
Total	**96**	**100**	**59**	**100**	

Table 3: Cause of death in Postmortem Cases in the period

Cause of death in Postmortem Cases	**No. of cases from 23/3/2019 to 3/5/2019**		**No. of cases from 23/3/2020 to 3/05/2020**		**% Change**
	N	%	N	%	
Natural	16	16.67	21	35.59	+18.93
Road Traffic accidents	28	29.17	9	15.25	-13.91
Hanging	19	19.79	18	30.51	+10.72
Railway Accident	10	10.42	1	1.69	-8.72
Poisoning/Drug overdoses	20	20.83	8	13.56	-7.27
Assault	3	3.13	2	3.39	+0.26
Total	**96**	**100**	**59**	**100**	

cases are mostly suicidal.

Worldwide it has been said that stress, the disruption of social and protective networks, and decreased access to services can all exacerbate the risk of violence for women. As distancing measures are put in place, and people are encouraged to stay at home, the risk of intimate partner violence is likely to increase. All stakeholders involved in the COVID-19 response need to raise awareness of the potential effects that physical distancing, stay at home, and other measures are likely to have on women who are subjected to violence and their children.

The rapid adoption of emergency measures, in all relevant sectors of life (health system, education, public safety, economy), prevented hospitals from being overwhelmed and allowed prompt medical care of cases, not limited only to the COVID-19 outbreak. Medicolegal investigation of confirmed COVID-19 cases usually falls out of the scope of forensic work, as the cause of death is already known. Thus, all medicolegal cases should be submitted to meticulous history taking before the autopsy onset to identify COVID-19 suspicious cases. –

CONCLUSION :

Keeping in view the observations, mortality can be reduced with the following suggestions:

• The roads should be properly made and maintained. Flyovers and underpasses should be built at required sites. The driving licenses should be issued only after strict testing of driving skills, medical examination. He/she should have full knowledge of traffic rules. The promotion of maximum use of public transport should be there.

• Lifestyle should be stress-free. Any change in behavior, attitude, and personality of a person/family member should immediately consult a psychiatrist. This can reduce suicidal tendencies.

• Drug overdose or withdrawal is also a significant cause of death these days, so there should be strict action and long-term policy against drug peddlers.

• Hospitals should be well equipped, advanced trauma care centers, and intensive care units at major government hospitals for the management of all serious emergencies.

REFERENCES :

1. World Health Organisation. Naming the coronavirus disease (COVID-19) and the virus that causes it [Internet]. [cited 2020 Aug 6];Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-(COVID-2019)-and-the-virus-that-causes-it
2. 82 districts under lockdown over Covid-19: What is shut and where [Internet]. Hindustan Times2020 [cited 2020 Aug 6];Available from: https://www.hindustantimes.com/india-news/82-districts-under-lockdown-over-covid-19-what-s-open-and-what-is-shut/story-c1AEMZXuuXN6FvmrAdRvsJ.html
3. Chauhan SS, Asija NK, Ahmad A. Report on Punjab Road Accidents and Traffic 2018. SAS Nagar (Mohali): Road Traffic and Safety Laboratory, Director General of Police, Punjab; 2019.
4. IANS. Road accidents biggest cause of unnatural deaths in India [Internet]. Bus. Stand. India2015 [cited 2020 Aug 6];Available from: https://www.business-standard.com/article/news-ians/road-accidents-biggest-cause-of-unnatural-deaths-in-india-115092700573_1.html
5. WHO | Suicide rates (per 100 000 population) [Internet]. WHO [cited 2018 Nov 24];Available from: http://www.who.int/gho/mental_health/suicide_rates/en/
6. Accidental Deaths & Suicides in India - 2015 [Internet]. New Delhi: National Crime Records Bureau, Ministry of Home Affairs, Government of India; 2016 [cited 2018 30th December]. Available from: http://ncrb.gov.in/StatPublications/ADSI/ADSI2015/ADSI2015.asp
7. Sakelliadis EI, Katsos KD, Zouzia EI, Spiliopoulou CA, Tsiodras S. Impact of Covid-19 lockdown on characteristics of autopsy cases in Greece. Comparison between 2019 and 2020. Forensic Sci. Int. 2020;313:110365.
8. World Health Organisation. COVID-19 and violence against women: What the health sector/system can do. Sexual and Reproductive Health and Research, WHO Global; 2020.
9. Roesch E, Amin A, Gupta J, García-Moreno C. Violence against women during COVID-19 pandemic restrictions. BMJ 2020;369:m1712.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00105.3

Original Research Paper

Study on the pattern of fingerprints in relation to blood group and gender in a rural population of Ammapettai, Kancheepuram district

1. **Dipayan Deb Barman,** Associate professor*
2. **R. Karnaboopathy,** Assistant Professor*

*Department of Forensic Medicine, Shri Sathya Sai Medical College & Research Institute, Ammapettai

ABSTRACT:

Introduction: Identification of human is one of the most frequently encountered problems in our social walk of life. Human identification becomes necessary from the point of view of personal, social and legal reasons.

Materials and Methods: Fingerprint and blood group types of males and females of ethnic Tamil origin were obtained and analyzed in this study.

Results: Most common type of fingerprint in males was found to be the loop type (52.0%) followed by whorl (30%) and arch (18%). In females the most common type of fingerprint was loop (59%) followed by whorl and arch .In males and females the most number of participants were found to be Rh factor positive with 95% in males and 92% in females . The chi square test results showed a relationship between fingerprint and blood group type with p value of .034 and .042 and a Pearson's chi square test value of 13.590 and 11.985 respectively in males and females.

Corresponding Author :
Dr. Dipayan Deb Barman,
Associate professor,
Department of Forensic Medicine, Shri Sathya Sai Medical College & Research Institute, Ammapettai
Contact : +91 87540-96962
Email: dipayandebbarman@gmail.com

Article History:
Received: 11 February 2020
Received in revised form: 5 May 2020
Accepted on: 5 May 2020
Available online: 30 April 2021

KEYWORDS : Blood group, fingerprint, correlation

INTRODUCTION:

Identification is the establishment of identity of an individual based on certain unique physical and biological character or traits which are unique to that individual. There are several datas of human identification and among these data , blood group and fingerprint are considered very important for personal identification. There are various methods of personal identification and some commonly used methods are fingerprinting, Poroscopy, Cheiloscopy, DNA fingerprinting, serological methods such as blood grouping , determination of age ,sex, etc.[1]

Fingerprinting have been in use for a long time since the beginning of human civilization. The term fingerprints which is also known as dermatoglyphics was coined first by Cummins and which meant the configuration of dermal ridges on the skin of the fingers, palms and soles of feet.[2] The formation of fingerprint is formed on any opaque surface is very useful at crime scnes and the reason behind its formation is due the impression left by the of friction ridges which are present on the fingers of an individual.[3] The development of fingerprints begin in the intrauterine life and the epidermal ridge pattern on the skin of human fingers takes a definitive form between 3rd to 4th month of intrauterine life.[4] The deposition of fingerprint on any article or object may occur unintentionally or intentionally and is due to the secretion from the eccrine glands which are present in the skin of the fingers or also when fingers are smeared with blood, ink or other materials.[5] Fingerprints are constant and unchanged and they are not same even in the monozygotic twins and it is the personal identification data of an individual.[6,7] The use of blood as a tool of personal identification is also important and has important applications in forensic science. Among the various blood grouping systems the ABO system of blood grouping which as discovered by scientist Karl Landsteiner is the most widely used system. [8]

This study has been done to study the relation of different types of fingerprints compared to the different types of blood groups as per the ABO grouping system

This study has been done to study the relation of different types of fingerprints compared to the different types of blood groups as per the ABO grouping system

MATERIALS AND METHODS:

This cross sectional study was done in the Ammapettai and Nellikuppam are of Tamil Nadu after obtaining permission from the institute ethical committee of Shri Sathya Sai Medical

College and Research Institute. The study subjects were healthy adult males and females between 18-30 years. The total sample size was 200 comprising of 100 males and 100 females.

The inclusion criteria included all healthy adults between age group 18-30 years who willingly participated in this study. However, individuals who did not wish toparticipate in this study, those who have an y injury of finger, any deformity of hand , suffer from diseases such as diabetes, any carcinoma, those receiving chemotherapeutic drugs, are excluded from this study.

The study begins with the obtaining of informed consent from all willing participants. Samples were collected from males and females equally. The subjects were asked to wash their hands and wait till their hands become dry and in that period they are not allowed to touch any surface. Using blue ink pad and white A$ size paper their fingerprint of all ten fingers were taken without smudging. Thereafter, their blood is obtained under all aseptic conditions by doing a simple fingerpick with new sterilized dispovan needle and the blood is placed on two different areas of a clean glass slide. The blood is then treated with anti –serum A and anti-serum B and blood group is determined by the slide method of blood grouping.

The blood group of the individual is noted and recorded, and then the fingerprint of the subject which is already obtained is examined and the fingerprint type is determined and documented, All collected data is tabulated in Microsoft excel and the data is then processed fo analysis using SPSS 23 software. Descriptive statistics was used to calculate the frequency and percentage Pearson chi –square test was used to compare the male and female blood group type with their fingerprint pattern.

RESULTS:

In this study the most common type of blood group among the males was blood group A (47%), followed by blood group B (22%), group AB (20%), and group O (11%) and the most common blood group in females was blood group A(31%), followed by blood group B (25%), group AB (22%), and group O (12%) respectively, as shown in **table1**.

Table 1 : Showing distribution of blood group type in males and females

Blood Group	Male (n=100) Frequency	Percentage	Female (n=100) Frequency	Percentage
A	47	47.0%	41	41.0%
B	22	22.0%	25	25.0%
AB	20	20.0%	22	22.0%
O	11	11.0%	12	12.0%
Total	100	100%	100	100%

In this study in males the majority of the study subjects were found to be Rh positive with 95 (95. 0%) and remaining 5 (5%) Rh negative as shown in **table 2**.

Table 2 : Showing distribution of Rh factor in males

Rh Factor	Blood group A	Blood group B	Blood group AB	Blood group O
Rh +tive	45	22	19	9
Rh -tive	2	0	1	2

And in females the majority of participants were found to be Rh positive 92% (92%) and the remaining 8 (8%) Rh negative as shown in **table 3**.

Table 3 : Showing distribution of Rh factor in females

Rh Factor	Blood group A	Blood group B	Blood group AB	Blood group O
Rh +tive	38	25	18	11
Rh -tive	3	0	4	1

The results of the fingerprint pattern analysis showed that in males the most common type of fingerprint pattern was the loop pattern with 52 (52%) of the total male subjects showing loop pattern. This was followed by Whorl, Arch pattern with frequency of 30 (30%) and 18 (18%) respectively and similarly the commonest fingerprint type in females as found in this study was loop pattern with 59 (59%) and followed by whorl with 26 (26%) and Arch 15(15%) as shown in **table 4**.

Table 4 : Showing distribution of fingerprint type in male and female

Fingerprint type	Male (n=100) Frequency	Percentage	Female (n=100) Frequency	Percentage
Loop	52	52.0%	59	59.0%
Whorl	30	30.0%	26	26.0%
Arch	18	18.0%	15	15.0%
Total	100	100%	100	100%

The chi square test of the male fingerprint and blood group showed that in males with blood group A , the commonest type of fingerprint was loop (25), followed by whorl and arch with 11 each, and blood group O has equal number of loop and whorl pattern of fingerprint as shown in **table 5.**

Table 5 : Showing Male Blood Group * Male Finger Print Cross tabulation

Male Blood Group	Male Finger Print			Total
	Loop	Whorl	Arch	
A Positive	25	11	11	47
B Positive	11	8	3	22
AB Positive	11	6	3	20
O Positive	5	5	1	11
Total	52	30	18	100

In females chi square test of fingerprint pattern and blood group showed that in females with blood group A the commonest type of blood group was loop (29), followed by whorl and arch with 6 in each group as shown in **table 6**.

Table 6 : Showing Female Blood Group *Female Finger Print Cross tabulation

Female Blood Group	Male Finger Print			Total
	Loop	Whorl	Arch	
A Positive	29	6	6	41
B Positive	11	9	5	25
AB Positive	9	9	4	22
O Positive	10	2	0	12
Total	59	26	15	100

The results in this study shows a significant association between male fingerprint and blood group type with p value of 0.034 and in females a p value of 0.042 which also shows a significant association between the female fingerprint and blood group type as shown in **table 7 & 8** respectively.

DISCUSSION:

In this present study the highest number of individuals, both males and females have blood group A as the commonest group and loop pattern of fingerprint was the most common pattern of fingerprint pattern and this is similar to the study of Gowda MST [9], Mada. P [10] and Smitha. R , [11] However, this finding is not in concurrence with earlier findings in studies in India where it was reported that blood group O was the most common type of blood group .[12,13,14] It has been observed that fingerprints have great importance in the field of biological, anthropology and human identification studies. [15] In previous studies of Londhe and Jadhav , it has been observed that blood group type and fingerprint pattern both are inherited traits .[16] The association between the type of fingerprint and diseases of blood cells have been observed by Buketo et al in their study previously . [17] In a previous study by Prateek and Keerthi [18] in Mangalore it was observed that in males whorls was the most common type of fingerprint and in females loops and arches were found to be the commonest type, however in this study it was observed that loop type has emerged as the commonest type of fingerprint in males and whorls were found to tbe commonest fingerprint type in females. In this study the blood group A showed the highest association with loop type fingerprint and this is in disagreement with the findings of Bharadwaja et al [12] who reported loop type of fingerprint to be found more in individuals with blood group O and AB. For the blood group A, B AB and O the highest percentage of subjects in this study showed loop type to be the most common, followed by whorl and arch type and this finding is in agreement with the earlier studies of Mehta and Mehta [8] , Gowda and Rao [9] , Herch [19] Kshirsagar *et al*. [20]

In this study an association between the blood group and fingerprint was observed in both males and females and with p value of .034 and .042 respectively which is in agreement with the study of Bharadwaja et al [10] but differed from the observation of previous authors [21] , Odukama et al [22] who observed no significant association between the fingerprint type and blood group.

CONCLUSION:

Blood group and fingerprint are two extremely important data of personal identification and there have been studies conducted across different countries including India among different ethnic populations. Correlation between blood group and fingerprint pattern has been a possibility based on which various studies have been conducted .The distribution of different fingerprint type in individuals with different blood groups have been observed in this study. The results of this study in an ethnic Tamil population in a rural area shows that there is a relationship between the blood group type and

Table 7 : Showing Female Blood Group *Female Finger Print Cross tabulation

	Value	df	Asymptotic significance (2 sided)	Exact significance (2 sided)	Exact significance (1 sided)	Point Probability
Pearson chi square test	13.590[a]	6	.034	.038	.349	.045
Likelihood ratio	3.580	6	.733	.759		
Linear by linear association	.209[b]		.647	.667		
No of valid cases	N=100					

Table 8 : Showing the chi square test in females

	Value	df	Asymptotic significance (2 sided)	Exact significance (2 sided)	Exact significance (1 sided)	Point Probability
Pearson chi square test	11.985[a]	6	.042	.040	.512	.051
Likelihood ratio	13.840	6	.031	.046		
Linear by linear association	.001[b]		.980	.980		
No of valid cases	N=100					

fingerprint pattern . The results of this study can be useful in establishing a correlation between fingerprint and blood group and shows the association between blood group and fingerprint type which can become applicable to a particular ethnic population, however similar studies should be conducted taking a much larger number of study subjects to show more co relational trend between blood group and fingerprint type.

Conflict of interest: None

Source of Funding : None to declare

REFERENCES:

1. Tsuchihashi Y. (1974). Studies on personal identification by means of lip prints. Forensic Sci 3: 233-48.
2. Cummins H. Palmar And Plantar Epidermal Ridge Configuration (Dermatoglyphics) in Europeans and Americans. Am. J. Phy. Anthrop. 1926;179: 741-802.
3. Jude Hemanth & Valentina Emilia Balas, ed. (2018). Biologically Rationalized Computing Techniques For Image Processing Applications. Springer. p. 116.
4. Cummins H., Kennedy R.W. Physiological Examination of visual organ and of the cutaneous system. Am J Crim Law Criminol.1940; 31:343-356.
5. Pillay VV. Textbook of Forensic Medicine and Toxicology. 15th ed. Paras Medical Publishers. Hyderabad: 2009. p. 53-94.
6. Vij.K. Textbook of Forensic ZMedicine and Toxicology.3rd ed. New Delhi: Elsevier:2005.p. 89-91
7. kanchan.T, Chattopadhyay .S .Distribution of fingerprint pattern among medical students. J. Indian Acad Forensic Med.2006; 28: 65-68
8. Mehta. AA, Mehta AA. Palmar dermatoglyphics in ABO , Rh blood groups Int. J .Biol. Med. Res. 2011; 2: 961-964
9. Gowda MST and Rao CP. A Study To Evaluate Relationship Between Dermatoglyphic Features And Blood Groups. J Anat. Society of Ind. 1996;45: 39
10. Mada. P, Soankar . R. A Cross Sectional Study on association of fingerprints with gender, blood group and handedness and its significance in stablishment of identity. J Punjab Acad Forensic Med Toxicol 2016;16(2): 121-125
11. Smitha R, Balaraj BM. Correlation study between fingerprint pattern and Rh blood group. J Punjab Acad Forensic Med Toxicol.2018; 18 (1): 6-9
11. Bharadwaja A., Saraswat P. K., Aggarwal S. K., Banerji P., Bharadwaja S. Pattern of finger prints in different ABO blood group. Journal of Indian Acad of Forensic Medicine .2004; 26(1): 6- 9
12. RASTOGI P., PILLAI K. R. A study of finger prints in relation to gender and blood group. Journal of Indian Academy of Forensic Medicine. 2010; 32 (1): 11–13.
13. Reddi A. P., Mukherjee B. N., Ramachandraiah T. Distribution of ABO and Rh (D) blood groups among four endogamous groups of Andhra Pradesh. Human Heredity. 1980; 30 (5) : 331–332.
14. Krishan K., Kanchan T., Ngangom C.. A study of sex differences in fingerprint ridge density in a North Indian young adult population. Journal of Forensic and Legal Medicine. 2013; 20,(4): 217–222
15. Londhes . R., Jadhav A. S., 2011: Digital dermatoglyphics and ABO blood groups. Indian Journal of Forensic Medicine and Pathology. 2011 ; 4(2) : 77–81.
16. Bukelo M.J., Kanchan T., Unnikrishnan B., Rekha T., Ashoka B., Rau A. T. A Study of finger print patterns in children with acute lymphoblastic leukemia.Forensic Science, Medicine, and Pathology.2011; 7 (1): 21–25
17. Prateek R., Keerthi R.P. A study of fingerprints in relation to gender and blood group. J Indian Acad Forensic Med. 2010; 32 (1) :11-14.
18. Herch M. Papillarmuster Bei Engeotorenen Der Loyalty Inschm, Berichungan Swischen Papillarmuster and Bluntgrainppen Beidiessen an Liner Dentschem Verglei Chsgrmppe Ztschr F Rasseh Physio. 1932; 5: 163-168
19. Kshirsagar S.V. , Burgul S.N. , Kamkhedkar S.G. , Maharastra A. Study of fingerprint patterns in ABO blood group. J Anat Soc India.2003; 52 (1):82-115
20. Dennis. E.O. Eboh. Fingerprint patterns in relation to gender and blood group among Students of Delta State University, Abraka, Nigeria. Journal of Experimental and Clinical Anatomy.| Jul-Dec 2013; 12 (2):82-86
21. Odokuma E.I., Igbigbi P.S. Emudianughe T.S. A study of thumb print patterns and ABO Blood group distribution. J Exp Clin Anat. 2008; 7 (1):22-26.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00106.5

Original Research Paper

Stature Estimation Using Carrea's Index

1. **E S Nirmal Kumar,** PG Resident 3rd Yr, Department of Forensic Medicine and Toxicology*
2. **Gurvanit Lehl,** Professor & Head, Department of Dentistry*
3. **Amandeep Singh,** Professor, Department of Forensic Medicine and Toxicology*
4. **Dasari Harish,** Professor & Head, Department of Forensic Medicine and Toxicology*

*Government Medical College and Hospital, Chandigarh

ABSTRACT :

Introduction: Identification is the determination of the individuality of a person based on certain physical characteristics that exactly fix the personality. Identifying victims in cases of mass disaster, when limited human remains are present, is quite a challenging task. Usually peripheral extremities of human body are used in estimating stature. In situations where only skull is available, teeth play an important role in personal identification. The present study used Carrea's index in stature estimation using tooth dimensions.

Aim: To compare the accuracy of Carrea's method in estimating height of adult human and to evaluate the difference in the accuracy of stature estimation with respect to sides of dentition, gender and different types of dental alignment.

Materials and Methods: The study consisted of a total of 200 hemiarches from 100 consenting subjects of the age group 18 to 30 years. For this study, data were collected from undergraduate students and volunteers after taking their consent. Estimation of stature was done using Carrea's Index.

Results: When Chi square test was used to test statistical significance in estimating stature using Carrea's index, it was found to be significant with respect to only gender, and not significant with respect to side of hemiarches and type of dentition. The ANOVA of linear regression analysis of height and its predictors (i.e., arch and chord) was tested for statistically significance, chord was found to be more significant than arch.

Conclusion: It was concluded that the Carrea´s index is a reliable method for height estimation in arches with normal and crowded dentition, useful for both sexes, although in our study more accuracy in stature estimation was obtained for female subjects than male, and for both right and left side of the mandibular arch.

Corresponding Author :
Dr Amandeep Singh,
Professor,
Department of Forensic Medicine and Toxicology, Government Medical College and Hospital, Chandigarh
Contact : +91 96461-21610
Email : dramandeep@gmail.com

Article History:
Received: 4 April 2020
Received in revised form: 4 June 2020
Accepted on: 4 June 2020
Available online: 30 April 2021

KEYWORDS : Identification, Mandibular anterior teeth, Hemiarches, Carrea's Index, Stature estimation

INTRODUCTION :

Identification is the determination of the individuality of a person based on certain physical characteristics.[1] Human remains aid in the process of identification of victims in case of mass disasters such as explosions, aircraft and railway accidents, earthquakes, shipwrecks, etc.[2] During post mortem examination, identification of the dead is an important part for the following reasons, (1) the ethical and humanitarian need to know which individual has expired, (2) to exhibit the fact of death in respect of that individual, for official, statistical and legal purposes, (3) to confirm the identity for administrative and ceremonial purposes, (4) to dispense legal claims and obligations in relation to property, estate and debts, (5) to dispense claims for life insurance contracts, survivor's pensions and other financial issues, (6) to permit legal investigations, inquests, and other tribunals and (7) to facilitate police enquiries into criminal or suspicious deaths.[3] When the victim's identity is not established, it becomes hard for the police to figure out the crime. Thus, identification of a dead body or human remains is essential before a sentence is passed.[1]

Forensic anthropology is a branch of forensic medicine that involves the application of physical anthropology in legal issues.[4] The employment of anthropometry in forensic science and medicine dates back to 1882 when a French police expert invented a system of criminal identification based on anthropometric measurements. His system was based on three fundamental ideas- (1) the fixed condition of the bone system from the age of twenty till death, (2) the extreme diversity of dimensions present in the skeleton of one individual as

compared to another and (3) the ease and relative precision with which certain dimensions of the bone structure of a living person can be measured by using simple calipers.[5]

Stature estimation is an important component of forensic anthropology [6] as it greatly helps in narrowing the search for a person who is missing.[7-9] Stature was classified, according to Freire, as an indispensable element in forensic anthropology as it is considered an important pointer in the search for human identification.[10] Stature refers to total height of a person in upright position and has a proportional biological relationship with each and every part of the human body that includes head, face, trunk, extremities.[11,12] This helps a forensic expert to calculate stature from dismembered and mutilated body parts during forensic examination and thus narrows down the investigation by providing remarkable clues.[13,14]

Teeth are special in cases of identification of deceased since teeth and jaws are usually protected from fire and mechanical trauma, and are highly resistant to post-mortem destruction and decomposition. It is believed that no two persons have identical dentition. In many investigations of human remains, whole skeleton or part of skeleton is available. Sometimes just skull and mandible may be recovered. In this case, the examination of skull, mandible[15] and teeth become very important, and the stature of the individual can be estimated using certain methods based on tooth dimensions.[16-19]

Dr. Juan Ubaldo Carrea, professor of Orthodontics and Legal Dentistry, at the School of Dentistry of Buenos Aires, made it possible to calculate stature from the dimensions of the teeth. Professor Dr. Carrea conducted studies to estimate height, based on the fact that there is proportionality between the diameter of teeth and body height, and used it to estimate height from the dimensions of the anterior mandibular teeth.[19-23] In the year 1920 he catalogued sets of relations of proportionality between the individual height and dimensions of the face and head in his doctoral thesis.

In our study we have utilized Carrea's method to estimate height of the person. Hence, this study has used measurements of anterior teeth as suggested by Carrea in mandibular arches to estimate stature of an individual.

AIMS AND OBJECTIVES :

i. To compare accuracy of Carrea's method in estimating height of adult human.

ii. To evaluate difference in the accuracy of stature estimation with respect to sides of dentition, gender and different types of dental alignment.

MATERIALS AND METHODS

On receiving approval from the Institutional Ethics and Research Committee, this study was conducted in the Department of Forensic Medicine and Toxicology in collaboration with Department of Dentistry, Government Medical College & Hospital, Sector 32, Chandigarh and was analytical in nature. This study consisted of a total of 100 consenting subjects from age group of 18 years to 30 years and data were taken from undergraduate students and volunteers.

The stature was measured with an anthropometer, by making the subject stand erect on the horizontal plane, barefooted, in the anatomical position according to the Frankfurt plane, in inspiratory apnoea, aligning the posterior surface of heels, pelvic girdle, scapular girdle, and occipital region to the vertical plane. The stature was measured with the rod of the anthropometer in contact with the vertex. All measurements were performed by a single investigator, in the morning period between 9 am to 12 pm.[1,11]

Impressions of mandibular arches of each subject were obtained by using metal stock impression trays of appropriate dimensions in which alginate mix was placed for making impressions. The alginate mix was prepared using powder / water ratio of 20g : 45ml. Then, dental stone mix was prepared with powder / water ratio of 100g : 30ml and mixing time of 30 to 40 seconds. Dental stone was immediately poured on the impressions and tapped gently for 30 to 45 seconds to remove air bubbles before dental stone mix sets in. After a time period of 30 to 40 minutes, dental stone mix was removed from impression tray to prepare the cast. Examination of these casts was done by considering each hemiarch separately, equalling 200 inferior hemiarches, which were divided according to the dental alignment into two groups: normal and crowded. The measurements of each hemiarch was performed as described by Carrea.[18]

Measuring the "Arch"- The mesiodistal diameters of central incisor, lateral incisor and canine were obtained using a digital calliper. The arch was derived by the sum of these mesiodistal diameters measured by the labial surface. Arch of mandibular teeth was measured and value obtained was plotted against with height of the person to derive regression formula which was used to compare with actual height of the person.

Measuring the "Chord"- The chord is the linear distance between the ends of the arch, represented by the mesial edge of the central incisor and distal end of the canine on the same side. The chord was measured with a digital callipers. Chord measurement of mandibular teeth was done and plotted against the height of the person and regression formula so derived was used to compare with actual height of the person.

Carrea's Index: The estimated height was calculated using the formula below:

Maximum Stature = Arch (in mm) x 6 x 3.1416 x 100/2

Minimum Stature= Chord (in mm) x 6 x 3.1416 x 100/2

RESULTS :

The study was conducted on a total of 100 volunteering subjects, comprised of 200 dental casts from mandibular arches. The distribution of 200 hemiarches with respect to gender were 108 for male and 92 for female respectively.

'HIT' was assigned when the estimated value of stature which fell in the range between minimum and maximum estimated height of the person using Carrea's Index and 'MISS' was assigned when the estimated value of stature which did not fall in the range between minimum and maximum estimated height of the person using Carrea's Index.

Table 1 : Distribution of total hits and misses with respect to gender

		GENDER		Total	Chi-square	p-value
		Male	Female			
Result	Miss	38	3	41	31.067	0.0001**
		35.2%	3.3%	20.5%		
	Hit	70	89	159		
		64.8%	96.7%	79.5%		
Total		108	92	200		
		100%	100%	100%		

As depicted in **Table 1**, while taking into account the mandibular hemiarches, the percentage of hits were more in female (96.7%) than male (64.8%) and the percentage of misses were less in female (3.3%) as compared to male (35.2%). While comparing between total hits and misses of mandibular hemiarches with respect to gender there was statistical significance with p value of 0.0001. Thus more accurate stature estimates using Carrea's index in mandibular hemiarches where obtained from female as compared to male.

Table 2 : Distribution of hits and misses with respect to type of dentition(Normal - N and Crowded - C)

		Dentition		Total	Chi-square	p-value
		N	C			
Result	Miss	29	12	41	3.533	0.060
		17.9%	31.6%	20.5%		
	Hit	133	26	159		
		82.1%	68.4%	79.5%		
Total		162	38	200		
		100%	100%	100%		

Table 2 revealed that out of 162 mandibular hemiarches with normal dentition, the percentage of hits (82.1%) were more than misses (17.9%). Out of 38 mandibular hemiarches with crowded dentition, the percentage of hits (68.4%) were more than misses (31.6%). While comparing between total hits and misses obtained from mandibular hemiarches with respect to dentition there was no statistical significance since the p value was found to be more than 0.005.

Table 3 : Distribution of hits and misses with respect to side

		Dentition		Total	Chi-square	p-value
		N	C			
Result	Miss	29	12	41	3.533	0.060
		17.9%	31.6%	20.5%		
	Hit	133	26	159		
		82.1%	68.4%	79.5%		
Total		162	38	200		
		100%	100%	100%		

As shown in **table 3**, Out of 100 right sided mandibular hemiarches, 78 hits and 22 misses were obtained. Out of 100 left sided mandibular hemiarches, 81 hits and 19 misses were obtained. While comparing between total hits and misses obtained from mandibular hemiarches, no statistical significance with respect to side was observed since the p value was found to be more than 0.005.

Linear Regression Analysis of Height Vs Arch Vs Chord values. (Table 4-9 and figure 1-2)

Regression equations have been calculated by regression analysis of the data with stature (predicted height of the individual) $y = \alpha + \beta x$ and the values of constants 'α' and 'β' were calculated; where 'α' is the constant of dependent variable, i.e. stature and 'β' is the regression coefficient of the independent variable, i.e. arch and chord and 'x' value of parameter used for calculation of stature. The Standard Error of Estimate (SEE) was calculated for each formula, which depicts the deviation of estimated stature from the actual stature. A low value is indicative of the greater reliability of prediction from a particular measurement and the higher value of SEE denotes less reliability of prediction. The regression equation with the least Standard Error (SE) was considered to be the best regressor for the estimation of stature. The inferential statistics of the parameters, arch and chord were recorded. The ANOVA of linear regression analysis of height and its predictors (i.e., arch and chord) was tested for statistically significant.

On linear regression analysis, the regression equations was derived as $y = 107.543 + 3.493x$ and arch was found to be statistically significant predictor of height with $P = 0.0001$

The ANOVA of linear regression analysis of height and its predictor was found to be statistically significant with the P value of 0.0001.

On linear regression analysis, the regression equation was

derived as y = 134.775 + 2.180x and chord was found to be statistically significant predictor of height with P = 0.0001.

Based on the results obtained, the best regressor with lower standard error value of 0.494 was found when chord was considered as independent parameter in univariant linear regression analysis that included mandibular hemiarches all together, the equation derived was y = 134.775 + 2.180x. Thus, this equation can be used to predict more accurate height. Thus, Chord was a better predictor of stature than Arch when linear regression analysis was utilized.

Table 4 : Linear regression analysis between Height Vs Arch in mandibular hemiarches

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
0.378	0.143	0.139	7.219

Table 5 : ANOVA of linear regression analysis between Height Vs Arch in mandibular hemiarches

ANOVA					
	Sum of Sq.	df	Mean Square	F-value	p-value
Regression	1721.061	1	1721.061	33.029	0.0001*
Residual	10317.290	198	52.108		
Total	12038.350	199			

Table 6 : Predicting the height of an individual using Arch value in mandibular hemiarches

Coefficients					
	Unstandardized Coefficients		Standardized Coefficients	t-value	p-value
	B	Std. Error	Beta		
ARCH	3.493	0.608	0.378	5.747	0.0001**
(Constant)	107.543	10.915		9.853	0.0001**

Table 7 : Linear regression analysis between Height Vs Chord in mandibular hemiarches

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
0.299	0.089	0.085	7.441

Table 8 : ANOVA of linear regression analysis between Height Vs Chord in mandibular hemiarches

ANOVA					
	Sum of Sq.	df	Mean Square	F-value	p-value
Regression	1076.181	1	1076.181	19.438	0.0001*
Residual	10962.169	198	55.364		
Total	12038.199	199			

Table 9 : Predicting the height of an individual using Chord value in mandibular hemiarches

Coefficients					
	Unstandardized Coefficients		Standardized Coefficients	t-value	p-value
	B	Std. Error	Beta		
CHORD	2.180	0.494	0.299	4.409	0.0001**
(Constant)	134.775	8.053		16.736	0.0001**

Figure 1 : Scatter diagram of Height Vs Arch in both mandibular hemiarches

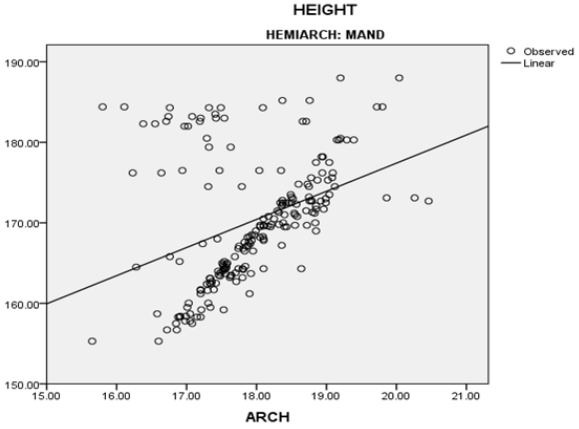
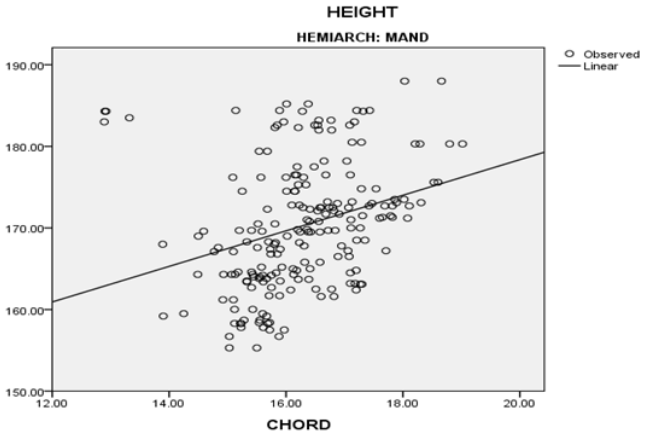


Figure 2 : Scatter diagram of Height Vs Chord in mandibular hemiarches



DISCUSSION :

In our study, Carrea's index has shown evidential success in estimation of stature in normal (82.1%), than crowded (68.4%) dentition, with respect to mandibular hemiarches and there is no statistical significance with respect to type of dentition. Hence, Carrea's index is valid for stature estimation irrespective of type of dentition, with regard to mandibular hemi-arches.

The left sided mandibular hemi-arches (81%) gave marginally more hits as compared to right side (78%), but there was no statistical significance. Carrea's index in our study has shown

significant success in estimation of stature with no statistical significance between the right and left sides of mandibular hemi-arches. As per the study done by Carrea also, any hemi-arch can be used to estimate the stature, taking into account the principle of bilateral symmetry that allows us to accept minor variations as anatomical asymmetries.[18] The statistical insignificance of the variations with respect to side, as found in our study, is similar to Carrea's theory.[18]

Considering gender analysis with respect to mandibular hemi-arches, we found that females showed higher success rate (96.7%) as compared to males (64.8%), with statistical significance.

Based on the results obtained using linear regression analysis, the best regressor with lower standard error value was found when the Chord was considered as independent parameter in univariant linear regression analysis. Thus Chord was a better predictor of stature than arch when linear regression analysis was utilized.

CONCLUSION :

Estimation of stature is a cardinal element in personal identification. After analysing the data from the mandibular hemiarches among volunteers, it was found that Carrea's index achieved a satisfactory success rate among males and females; between right and left dental arches; and between normal and crowded dentition. It can be concluded that Carrea's index is an easy and affordable method for stature estimation and can provide priceless information to narrow down the search for a missing or unidentified person and in case of identification of unknown deceased person when only dental remains are present.

REFERENCES :

1. Reddy KSN, Murthy OP. The essentials of forensic medicine and toxicology. In: Identification. 34th ed. New Delhi: Jaypee Brothers Medical Publishers (p) Ltd 2017. p. 55-97.
2. Dayananda R, Umesh B, Kiran J. Estimation of stature from dimensions of foot. IJMTFM 2014;4:1-5.
3. Bonwill triangle. Available from https://en.wikipedia.org > wiki > William_Gibson_A._Bonwill. Accessed on 20th may 2019.
4. Anita P, MadanKumar PD, Sivasamy S, Balan IN. Validity of carrea's index in stature estimation among two racial populations in India. J Forensic Dent Sci 2016;8:1-5.
5. Moenssens AA. Fingerprinting techniques- in ba law enforcement series, Radnor, Pennsylvania: Chilton Book Company, 1995. p. 200-20. Available from https://www.ncjrs.gov/pdffiles1/nij/225320.pdf. Accessed on 24h may 2019
6. K Krishan. Anthropometry in forensic medicine and forensic science- 'Forensic Anthropometry.' Int J Forensic Sci 2006;2:1-8.
7. O'Connor WG. Briefly unidentified: A study of peculiar source of identification. J Forensic Sci 1999;44:713-5. Available from https://www.ncbi.nlm.nih.gov/pmc/articles//.Accessed on 19th July 2018.
8. Raxter MH, Auerbach BM, Ruff CB. Revision of the full technique for estimating statures. Am J Phys Anthropol 2006;130:374-84.
9. Trotter M, Gleser G. Estimation of stature from long bones of american white and american negroes. Am J Phys Anthropol 1952;10:463-514. Available from www.references.260mb.com/Estatura/Trotter1952.pdf. Accessed on 15th September 2017.
10. Freire JJB. Stature: fundamental data in forensic anthropology [Thesis]. Piracicaba: UNICAMP / FOP; 2000. p. 20-55. Available from https://www.ncjrs.gov/pdffiles1/nij/111608.pdf. Accessed on 18th May 2019.
11. Lima L, Costa Y, Tinoco R, Rabello P, Daruge JE. Stature estimation by carrea's index and its reliability in different types of dental alignment. J Forensic Odontostomatol 2011;29:7-13.Available from https://www.ncbi.nlm.nih.gov › NCBI › Literature › PubMed Central (PMC). Accessed on 15th September 2017.
12. Whittaker DK. Research in forensic odontology. Ann R Coll Surg England 1982;64:175 9. Available from https://www.ncbi.nlm.nih.gov › NCBI › Literature › PubMed Central (PMC). Accessed on 15th September 2017.
13. Bakkannavar SM, Monteiro FN, Arun M, Pradeep Kumar G. Mesiodistal width of canines: A tool for sex determination. Med Sci Law 2012;52:22-6.
14. Chandra Shekar BR, Reddy CV. Role of dentist in person identification. Ind J Dent Res 2009;20:356-60.
15. Bardale R. Estimation of stature from mandible. Indian J forensic odontology 2008;1:29-31.
16. Krishan K. Estimation of stature from cephalo-facial anthropometry in north indian population. Forensic Sci Int 2008;181:1-6.
17. Silva M. Estimation of the height of the individual with the

use of a group of teeth of the mandible. Rev Paul Odontology 1990;12:18-28. Available from

https://www.ncbi.nlm.nih.gov/pmc/articles/. Accessed on 20th May 2017.

18. Carrea JU. Odontometric tests.[Thesis Doctoral]. Buenos Aires; Nat Uni B A 1920. Available from

http://www.scielo.cl/scielo.php?script=sci. Accessed on 15th September 2017.

19. Carrea JU. Individual human size according to the radio cord. Ortodoncia 1939;6:225-7. Available from http://www.scielo.cl/scielo.php?script=sci. Accessed on 15th September 2017.

20. Sampaio CMA. Assessment of Carrea rate compared to Retzius year cephalometric index and facial index. Dissertation. State Univ of Campinas. Piracicaba Fac of Dentistry;1995. Available from

http://repositorio.unicamp.br/bitstream/REPOSIP. Accessed on 15th September 2017.

21. Cavalcanti AL, Porto A, Maia AMA, Melo TRNB. Stature estimation by using the dental analysis: comparative study between Carrea's and the modified methods. Rev Odontology UNESP. 2007;36:335-9. Available from http://www.bioline.org.br/pdf?os08042. Accessed on 12th May 2017.

22. Rekhi A, Marya CM, Nagpal R, Oberoi SS. Estimation of stature in a young adult Indian population using the Carrea's index. J Forensic Odontostomatol 2014;30:15-23.

23. Velázquez AT, Gusieva IM, Acosta GP, Bachá AC. Doctor Juan Ubaldo Carrea, illustrious figure in Latin American dentistry. Stu Sci J Med Sci Cuba. 2008. Available from: http://www.16deabril.sld.cu. Last accessed on 10th Oct 2017.

J Punjab Acad Forensic Med Toxicol 2020;20(1) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00107.7

Original Research Paper

Profile of Medico-legal autopsies at Dr. R. P. Govt. Medical College Tanda, Distt. Kangra, Himachal Pradesh

1. **Tushar Saini,** PG Resident *
2. **Vijay Arora,** Professor and Head*
3. **Susheel Sharma,** Associate Professor*
4. **Vipul Parmar,** PG Resident *
5. **Saurbh Sharma,** PG Resident *
6. **Deepak Kumar,** PG Resident*
7. **Heena Sharma,** Tutor*

*Department of Forensic Medicine, Dr. R.P. Govt. Medical College , Kangra at Tanda.

ABSTRACT :

Introduction: Medico-legal post-mortem cases are dealt by the government institutions in Himachal Pradesh. The profile data of medico-legal autopsies is important to know the cause of deaths in the region and also helps to address the demographic needs according to the data analysed in this study.

Materials and Methods : This autopsy based retrospective study was conducted at DRPGMC Kangra at Tanda (Himachal Pradesh). This study was conducted to determine and evaluate the socio-demographic profile of different types of cases and to assess the nature and cause of their death.

Results: 477 autopsies were conducted in the year 2018 and out of these 346 cases (72.5%) were of males and 131 cases (27.5%) were of females. Poisoning case formed majority followed by accidents.

Corresponding Author :
Dr Vijay Arora,
Professor and Head,
Department of Forensic Medicine, Dr. R.P. Govt. Medical College , Kangra at Tanda
Contact : +91 94180-89939
Email : drvjarora@gmail.com

Article History:
Received: 13 July 2020
Received in revised form: 16 August 2020
Accepted on: 16 August 2020
Available online: 30 April 2021

KEYWORDS : Medico-legal autopsy, cause of death, sex wise, quarter wise.

INTRODUCTION:

Medico-legal autopsies are conducted under the ordinance of legal authority (i.e. Police inquest or magistrate inquest). It is performed to establish the exact cause of death, circumstances of death, identity of deceased and also the manner of death. Unnatural cause of deaths can be attributed to factors such as assault (firearm, lynching, strangulation or other violent asphyxia deaths etc), thermal burns, drowning, road traffic accidents, fall from height, chemical poisoning/intoxication, hanging and electrocution.[1,2] Autopsy means (autos = self, opis = view) to see for oneself. Necropsy (necros = dead, opis = view) is most accurate term for the investigative dissection of the dead body.[3] Due to the legal purposes, forensic autopsies are performed by a medical officer or an expert forensic autopsy surgeon who can accurately give evidence on the cause of death in the court of law *or inquest*. A complete autopsy involves opening all body cavities and all organs of the trunk, chest, and head. In all the cases, a complete and not a partial examination are more necessary in this country on account of the imperfectness of the preliminary evidence as to the possible cause of death.[4] This study aims to describe the demographic profile and analyzes the causes of deaths certified after postmortem examination.

MATERIALS AND METHODS :

The present retrospective study was carried on 477 medico-legal autopsies in the Department of Forensic Medicine & Toxicology, DRPGMC Kangra at Tanda, Himachal Pradesh during the period from 1st January 2018 to 31st December 2018.

Data was collected using a pre-designed format from postmortem registers/records, inquest papers and office copy of Post mortem reports. Details of the cases were collected like age, sex, major cause of death, month wise distribution of the cases, alleged manner of death etc. from the police papers, the inquest reports and hospital records. The information was compiled, tabulated and analyzed.

RESULTS

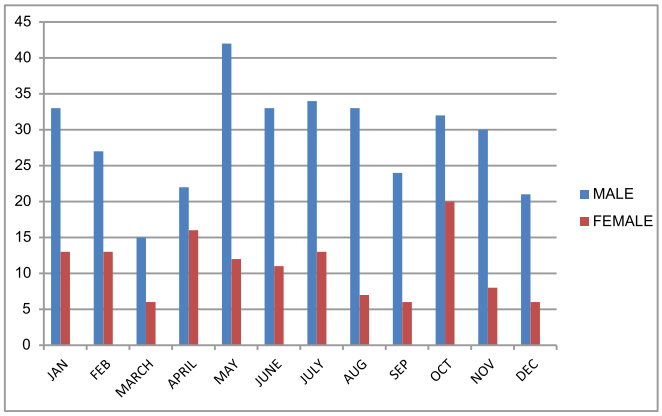
477 autopsies were performed in the calendar year 2018; out of these 477 autopsies, 346 cases i.e. 72.5% were of males and 131 cases i.e. 27.5% were of females. The maximum 54

autopsies i.e. 11.3% of the total number were conducted in the month of May,2018 **(Table 1 & graph 1)**

Table 1: Sex wise distribution of cases in each month

MONTH	MALE	FEMALE	TOTAL	%AGE
JAN	33	13	46	9.6
FEB	27	13	40	8.4
MARCH	15	6	21	4.4
APRIL	22	16	38	7.9
MAY	42	12	54	11.3
JUNE	33	11	44	9.3
JULY	34	13	47	9.8
AUG	33	7	40	8.4
SEP	24	6	30	6.3
OCT	32	20	52	11.0
NOV	30	8	38	8.0
DEC	21	6	27	5.6
TOTAL	**346**	**131**	**477**	**100**

Graph 1 : Cases as mentioned in Table no. 1

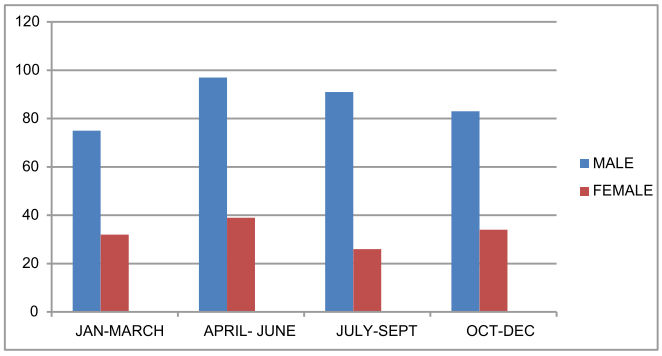


The maximum number of 136 autopsies i.e. 28.5% of the total cases were performed in 2nd quarter of the year i.e. April-June **(Table 2 and graph 2)**.

Table 2: Sex wise distribution of cases in each quarter

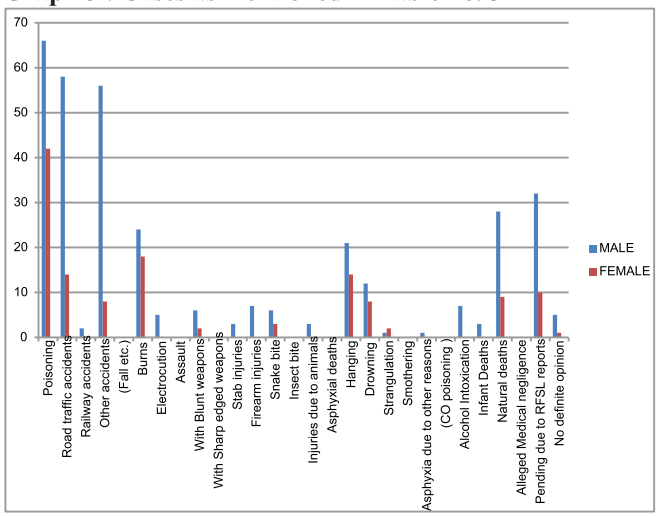
Quarter	MALE	FEMALE	TOTAL	%AGE
Jan-March	75	32	107	22.43
April-June	97	39	136	28.5
July-Sept	91	26	117	24.5
Oct-dec	83	34	117	24.5

Graph 2 : Cases as mentioned in Table no. 2



Maximum i.e. 108 case were of poisoning followed by accidents (road traffic/railway/born etc.) **Table 3 & graph 3**

Graph 3 : Cases as mentioned in Table no. 3

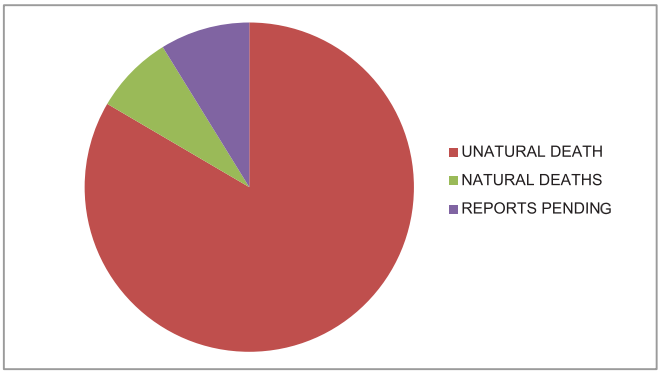


Maximum case were of unnatural death **(Table 4 & graph 4).**

Table 4 : Natural Cause vs. Unnatural Cause

Year	Unnatural Deaths	Natural Deaths	Reports Pending
2018	398	37	42

Graph 4 : Cause as mentioned in Table no. 4



DISCUSSION

In present study total number of postmortem examination conducted was 477 out of which 346 (72.5%) were males and 131 (27.5%) were females as per **table 1** , showing less number of deaths in females as compared to males which was similar to study conducted by Gannur Dayanand G.[5] One more study conducted by Bhullar et al in GMCH Patiala in 1996 shows that more males are brought for post-mortem examination as compared to females.[6]The reason being that as males are bread earners for the family, which makes the males more vulnerable to accidents, violence , stress, addiction and risk taking behavior.

Death due to poisoning cases and its complications formed

Table 3: Distribution of cases as per cause of death

S.NO.	TYPE OF CASES	TOTAL		GRAND TOTAL	%AGE
		M	M	M+F	
1.	Poisoning	66	42	108	22.64%
2.	Road traffic accidents	58	14	72	15.09%
3.	Railway accidents	2	0	2	0.41%
4.	Other accidents (Fall etc.)	56	8	64	13.41%
5.	Burns	24	18	42	8.80%
6.	Electrocution	5	0	5	1.04%
7.	Assault				
A)	With Blunt weapons	6	2	8	1.67%
B)	With Sharp edged weapons	0	0	0	0
C)	Stab injuries	3	0	3	0.62%
D)	Firearm injuries	7	0	7	1.46%
8.	Snake bite	6	3	9	1.88%
9.	Insect bite	0	0	0	0
10.	Injuries due to animals	3	0	3	0.62%
11.	Asphyxial deaths				
A)	Hanging	21	14	35	7.33%
B)	Drowning	12	8	20	4.19%
C)	Strangulation	1	2	3	0.62%
D)	Smothering	0	0	0	0
12.	Asphyxia due to other reasons	1	0	1	0.20%
	(CO poisoning)				
13.	Alcohol Intoxication	7	0	7	1.46%
14.	Infant Deaths	3	0	3	0.62%
15.	Natural deaths	28	9	37	7.75%
16.	Alleged Medical negligence	0	0	0	0
17.	Pending due to RFSL reports	32	10	42	8.80%
18.	No definite opinion	5	1	6	1.25%
	Total	**346**	**131**	**477**	**100%**

majority of cases (22.64%) in our study followed by RTA (15.09%) and other accidents (13.41%). But in other studies RTA was seen as most common cause of death followed by suicide by hanging as the next common cause. This difference may be due to the reason that the autopsies in the cases where death occurred on the spot in road traffic accidents were carried out in their nearest Govt. hospitals while the cases of poisoning from the districts of lower parts of Himachal Pradesh were invariably brought to our institute i.e. DRPGMC Tanda which is the tertiary care centre where the referral cases from various districts are referred and hence the death in cases of poisoning occurred in this hospital and subsequently post-mortem examination was also conducted here.

In month wise distribution, findings of our study showed more cases in the period between April to June and similar findings are seen in a study by Patel et a1, done at New Civil Hospital ,Surat in the year 2012.[7]

CONCLUSION

This study helps to discuss the types of medico-legal autopsy cases coming at the mortuary of the DRPGMC Kangra at Tanda, Himachal Pradesh. This will provide the path for the policy makers, law persons and the community to look into the specific matters and take measures accordingly. Role of NGO's and other organizations to reduce the mortality rate among unnatural deaths. Health awareness about stress regulation and education creating awareness regarding motor vehicle legislations. Improvement in road safety measures, rapid emergency services and establishment of trauma care centers up to the FRU's level in the state. There should be strict law governance in purchasing pesticides and insecticides and there should be online registration for all the shops who are selling as well customers who are purchasing the insecticides/pesticides and there should be an yearly audit. Population explosion, unemployment and stressful environment are the major criterion for unnatural death.

REFRENCES:

1. Modi JP. Post-mortem examination. A Textbook of Medical Jurisprudence and Toxicology. 25th ed. New Delhi: LexisNexis; 2016. p. 285.
2. Reddy KSN, Murty OP. Death and its cause. The

Essentials of ForensicMedicine and Toxicology. 34th ed. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd; 2017. p. 128-43.

3. Perper JA. Time of death and changes after death. Part-1: Anatomical considerations. In: Spitz Wu (ed). Spitz and Fisher's medico legal investigation of death. 3rd ed. USA: Charlas C Thomas Publishers; 1993. p. 14-50.
4. The Punjab Medical Manual. Chapter X. Post-mortem and medico-legal examinations. 2nd ed. Lahore: Civil and Military Gazette Press; 1934. p. 147-56.
5. Dayanand GG, Nuchhi UC, Yoganarasimha K. A study of demography of medico legal autopsies in Bijapur. Indian J Forensic Med Toxicol. 2013;7(1):37-41.
6. Bhullar DS, Oberoi SS, Aggarwal OP, Tuli H. Profile of unnatural deaths (between 18-30 years of age) in Govt. Medical College/Rajindra Hospital, Patiala (India). J Forensic Med Toxicol. 1996;13(3):5-8.
7. Patel JB, Chandegara PV, Patel UP, Parkhe SN, Govekar G. Profile of autopsy cases at New Civil Hopsital, Surat: a retrospective study. Int J Med Sci Public Health. 2016;5(1):10-13.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00108.9

Original Research Paper

A Cross Sectional Observational Study of Homicidal Death Cases At Tertiary Medical Centre of South Gujarat

1. **Chandresh Tailor,** Associate Professor*
2. **Kalpesh Zanzrukiya,** Associate Professor, Department of Forensic Medicine & Toxicology, SBKS MI & RC, Sumandeep Vidyapeeth DU, Piparia, Vadodara.
3. **Ganesh Govekar,** Professor & Head*
4. **Paresh Chandegara,** Assistant Professor*
5. **Jignesh Patel,** Assistant Professor*

*Department of Forensic Medicine & Toxicology, Government Medical College, Surat.

ABSTRACT :

Background : Homicide is one of heinous crimes in any civilized community. Nature of homicide incidence, motives of offence, profile of victims differ from time to time and region wise. It is important to analyze these patterns periodically. This research study is an attempt to have a detailed analysis regarding same at a tertiary medical centre in south Gujarat region.

Objectives – The objective of this study was to analyze the socio-demographical variables in homicide cases reported for autopsy at study place.

Materials & Methods : We conducted a cross sectional descriptive observational study at Department of Forensic Medicine & Toxicology, Government Medical College & New Civil Hospital, Surat. Total 211 homicide cases were analyzed that were autopsied during years 2015 to 2017. We noted and analyzed various variables like age, sex, marital status, time of season, victim-accused relation, area type of community etc. The results were documented with statistics.

Results : The incidence rate of homicide deaths was 3.0% of total autopsy cases. Males were victims in more than 2/3rd times cases compared to females. Young people aged 21-40yrs & married people are more vulnerable for homicidal crimes. More than 2/3rd victims were belonged to urban or suburban areas. In all identified cases, the accused was a known person to the victim and was near relative or friend in 39.33% cases. Chief motive was 'out of control quarrel over daily trivial issues' in nearly 1/3rd cases followed by 'financial or property disputes' 2nd most common. Leading cause of death in victims was 'Hemorrhagic shock due to mechanical injuries'.

Conclusion : Homicide crimes are though rare, indicates peak of iceberg of violent offences. The offenders are mostly known person to the victims. Stranger person as accused and so as planned murder is rare in study region. Event or motives leading to homicide offence are manageable socio-economical issues if addressed in time.

Corresponding Author :
Dr Kalpesh Zanzrukiya,
Associate Professor, Department of Forensic Medicine & Toxicology, SBKS MI & RC, Sumandeep Vidyapeeth DU, Piparia, Vadodara.
Contact : +91 9978337534
Email : kalpeshzrk1987@gmail.com

Article History:
Received: 27 August 2019
Received in revised form: 17 September 2019
Accepted on: 17 September 2019
Available online: 30 April 2021

KEYWORDS : Homicidal death, Murder, Violent offences, South Gujarat.

INTRODUCTION

"Killing don't need no reason. This is ghetto. Reason is for rich people. We have madness."

— Marlon James, A Brief History of Seven Killings[1]

As per World Health Organization, 'Homicide' is 'the killing of a person by another with intent to cause death or serious injury, by any means. It excludes death due to legal intervention and operations of war.'[2] This definition coincides with definition of 'Culpable homicide' prescribed in Section 299 of Indian Penal Code i.e. 'whoever causes death by doing an act with the intention of causing death, or with the intention of causing such bodily injury as is likely to cause death, or with the knowledge that he is likely by such act to cause death, commits the offence of culpable homicide.'[3] Other sections relevant legal definitions to homicide are Section 300 to 304, which are discussed later in discussion part.

The nature of homicides, the motives and the injuries inflicted upon the victim vary from time to time and place to place. Hence it is important to look at these patterns periodically. By this cross sectional observation study, we tried to elaborate

various demographic aspects related to homicide cases as well as we compared them to previous research data available in same region and other regions. The present study aims to look at these variables in a tertiary care government hospital of South Gujarat.

MATERIAL AND METHODS

This was a cross sectional observation study. After getting institutional ethical approval, the homicidal death cases that were autopsied in the Department of Forensic Medicine, Government Medical College & New Civil Hospital, Surat during January 2015 to December 2017 were enrolled in this study as per following criteria:

• Cases that were registered and identified as homicidal deaths and investigated under Section 299 to 304 of Indian penal code by the Police, including infanticides.

Cases of all age groups were included in the study. The date of autopsy, identification, age, gender, reporting police station, marital status, socioeconomic status, the relationship of the offender with the victim and motive for the act, type of injury, organs involved, survival time after injury and cause of death were collected in a proforma from the case records. Descriptive statistics were applied using MS Office(Excel) version 2016 and Epi Info software version 7.1.4.0.

RESULTS :

Table 1. Year wise incidence of homicidal cases

Year	Total Number of autopsies	Number of homcidal cases (%)
2015	2351	66 (2.8)
2016	2484	73 (3.3)
2017	2221	72 (3.2)
Total	7056	211 (3)

A total of 7056 cases were autopsied during the years 2015 to 2017 **(Table 1)**. This includes cases from Surat district as well as referred cases from Ankleshwar, Bharuch, Navsari, Tapi, Valsad and Vapi districts of Gujarat state. Among all these, 211 cases were found to be homicidal by investigating authority or during autopsy and therefore investigated under charges of sections 302 of IPC.

Table 2. Season wise incidence of homicidal cases

Season	2015	2016	2017	Total (%)
Summer(March-June)	27	26	25	78(36.96)
Monsoon(July-Oct.)	20	24	24	68(32.23)
Winter(Nov.-Feb.)	19	23	23	65(30.80)
Total	66	73	72	211(100)

Most cases of homicide (36.96%) were notified during season of Summer which is observed during March to June months in south Gujarat region, while number of cases were noted 4 to 6% less in other seasons **(Table 2)**.

Table 3. Age & sex wise distribution of cases

Age group	Male	Femal	Total (%)
0-10 yrs	6	3	9(4.26)
11-20 yrs	25	5	30(14.21)
21-30 yrs	51	14	65(30.80)
31-40 yrs	40	17	57(27.01)
41-50 yrs	24	6	30(14.21)
51-60 yrs	12	1	13(6.16)
>60 yrs	2	5	7(3.31)
Total	160(75.82)	51(24.17)	211(100)

As per age & sex wise distribution **(Table 3)**, most number of victims belonged to 21-30yrs of age(30.80%) and of Male gender (75.82%). Least number of cases were from extremes of ages, i.e. children and elderly age. No victim noted from third gender.

Table 4. Victim identification wise distribution of cases

Victim identification	Male	Femal	Total (%)
Identified	148	46	194(91.94)
Unidentified	12	5	17(8.05)
Total	160	51	211(100)

According to observations in **Table 4**, we noted that 8.05% dead bodies were unidentified until the autopsy was done and PM report was dispatched.

Table 5. Marital status wise distribution of cases

Marital Status	Male	Femal	Total (%)
Married	83(51.87)	35(68.62)	118(55.92)
Unmarried	49(30.62)	3(5.89)	52(24.64)
Widow	2(1.26)	3(5.89)	5(2.36)
Not Known	14(8.75)	5(9.80)	19(9.0)
Not Applicable	12(7.50)	5(9.80)	17(8.05)
Total	160(100)	51(100)	211(100)

Table 5 depicts the marital status wise distribution of victims of homicide cases.

Table 6. Socio-economical status wise distribution of cases

SE status	No. of cases (%)
Upper	24(11.37)
Middle	72(34.12)
Lower	98(46.44)
Not known	17(8.05)
Total	211(100)

As per Kuppuswamy socio-economical status scale[4], the victims were distributed in Socio-Economical class **(Table 6)**. It was noted that most number of cases belonged to lower socio-economical status followed by middle class socio-economical status.

Table 7. Police station area of community wise distribution of cases

Police station covering community area type	No. of Cases (%)
urban/suburban areas	142(67.29)
small town/ rural/ tribal areas	69(32.70)

The police cases were registered in police stations under which the residential address of victim or the crime scene belongs to the jurisdiction area. As per the police station jurisdiction covers to which community area type distribution of cases **(Table 7)**, it was noted that 67.29% cases were registered from urban or suburban (adjacent to urban) areas of community. Rests of cases were from small town or rural or tribal areas.

Table 8. Relation of Accused person to victim if identified

Relation of Accused person to victim	No of Cases (%)	Total (%)
Near Relative/ Friend	83(39.33)	138(65.40)
Colleague/ Neighbour/ Landlord/ servant/ Far relative	55(26.06%)	
Accused Not identified	73(34.59)	73(34.59)

As per mentioned in **Table 8**, in 34.59% homicidal cases the accused persons were not identified by police till autopsy done or PM report was dispatched. While amongst the identified accused persons, most ones (39.33%) were either near relatives(1st degree)-i.e. father, mother, brother, sister, spouse, son, daughter OR friend of the victims. In rest cases they were colleague from work, neighbor, landlord, servant or far relative(2nd degree or far).

Table 9. Motive for homicide wise cases

Motive for homicide	Male%	Femal%	Total (%)
Financial/Property Dispute	36(22.5)	8(15.7)	44(20.85)
Quarrel	47(29.4)	16(31.4)	63(29.85)
Dowry	0(0.0)	2(3.9)	2(0.94)
Infidelity	0(0.0)	5(9.8)	5(2.36)
Sexual Intercourse	0(0.0)	2(3.9)	2(0.94)
Love Affair	10(6.3)	1(2.0)	11(5.21)
Revenge	11(6.9)	1(2.0)	12(5.68)
Robbery	2(1.3)	1(2.0)	3(1.42)
Kidnapping	1(0.6)	0(0.0)	1(0.47)
Other	0(0.0)	1(2.0)	1(0.47)
Not Known	53(33.1)	14(27.5)	67(31.75)
Total	160	51	211(100)

Most common motive or reason for the homicide was uncontrolled quarrel for daily trivial issues(29.85%) according to the investigating police. Second commonest motive was financial issues or property disputes(20.85%). While in 33.1% cases, the reason or motive was still not known **(Table 9)**.

Table 10. Cause of Death wise cases

Cause of Death	No. of Cases (%)
Hemorrhagic shock	94(44.54)
Intracranial hemorrhage & injuries/ Coma/Neurogenic shock+	63(29.85)
Shock due to burns	8(3.79)
Shock due to electrocution	1(0.47)
Septicemic shock	7(3.31)
Asphyxia	31(14.69)
Decapitation	2(0.94)
Multiorgan failure/ Multiple blunt injuries over body	5(2.36)
Total	211(100)

Most common cause of death in the victims(44.54%) of homicides was hemorrhagic shock due to mechanical injuries like stab wound, laceration, fracture, cut wounds etc. Second most common cause (29.85%) was intracranial hemorrhages, coma or neurogenic shock due to brain injuries. Violent asphyxia and burns were causes of death in 14.69% and 3.79% cases respectively. Rare causes like electrocution shock and decapitation were also noted in 1 and 2 cases respectively **(Table 10)**.

DISCUSSION :

As mentioned in introduction part, Sections 299 to 304 of Indian Penal Code are related to the homicidal offences. Section 299 defines 'Culpable Homicide'. Section 300 defines 'Culpable Homicide amount to Murder'. Section 301 defines 'Culpable Homicide of person other than intended one'. The punishments of them are prescribed in Sections 302 and 303. While Section 304 defines 'Culpable Homicide Not amount to Murder' and its punishment. Subsection 304A of IPC describes 'death of person caused by negligence' and subsection 304B describes 'Dowry death'.[3] Any one or more of these sections are usually mentioned in police requisition and inquest panchnama in homicide cases.

The incidence rate of Homicidal deaths was found out 3.0% of total autopsy cases in our study. It was more or less consistent in these three years. But, It is slightly higher than studies of Zanzrukiya K. et al.[5] and Jhaveri S. et al[6] and lower than studies of Prajapati P et al[7] in Surat & south Gujarat. It is similar to results of Mishra PK et al.'s study in Bhopal.[8]

Season wise distribution of cases showed that more cases were noted in Summer, which correlates to findings of Zanzrukiya KM et al[5], Jhaveri S et al[7], Sheikh MI & Subramanyam BV[9]. Probable reasons might be more temperament, physical-mental stress and frustration in high temperature which may lead to more provocative incidences. While studies of Mishra PK et al[8] found out no seasonal variation but spiking pattern

on festival days or months. Study of Mohanty et al at Manipal[10] noted most homicides in Winter season with significant rise in cases during weekends.

Similer to our study, male gender is found as victim of homicide in more than 2/3rd of total cases in other studies from south Gujarat [5-7,11], Bhopal[8], Rajkot[12], Jamnagar[13], Behrampur[14], Jaipur[15], Varanasi[16], Indore[17], Cuttack[18], Chennai[19], Delhi[20] & Manipal[10]. This might be due to male gender is more involved into violent behavior and outdoor activities with interaction to other people in compare to Females. Study of Mada P & HariKrishna P at Hydrabad[21] noted 58.3% male and 41.7% cases of females which exceptionally noted significant numbers of female homicides there.

Similar to gender, studies from many researchers suggest that the age of twenties i.e.21-30yrs is most vulnerable age to be victim of homicide, followed by 31-40yrs of age bearing 2nd most cases, same as this study findings.[2,5-14,16-22] The reasons of this peak number of cases in youth age may be attributed to aggressive attitude, impatient impulsive behavior towards provocative incidences and good physical capability to take risk to involve in violent scuffles; which is supported by the findings that cases of homicide are noted least from extreme of ages, i.e. children and elderly groups. Children seems to have lighter, non-serious attitude and elderly people seems to show patient, calm & calculative risk taking behavior to violent instances. However, it is noteworthy that no victim might ever predicted death of oneself in any of these cases and in many cases it might be possible that the victim is attacked by accused without any warning event.

Study of Mada P & Krishna PH[21] notes that 11% victims were unidentified which is higher than our findings(8.05%). Victim identification is essential to establish the 'corpus delicti' to charge on accused in any homicidal crime. To establish an individual's identification in unidentified cases, we note down all possible biological identification characteristics during autopsy with preservation of tissue samples for further laboratory investigations e.g. DNA, Blood grouping etc.

Most of victims in our study were married in both genders, i.e. in male(51.87%) and in female(68.62%). Which is comparable to findings of studies of Gupta S et al.[11], Sonvane SS et al.[23], Mada P & Krishna PH[21] and Kumar R[16]. But, in comparison to unmarried female(5.89%), unmarried male cases were quiet high- 30.62% which is also similar to study of Gupta S et al.[11]. The reasons for this might be more socio-economical stressful issues have to be dealt with by married people than unmarried people. Reason for significantly higher number of unmarried male cases than unmarried female cases might be same as for 'why male gender more vulnerable to be homicide victim' as mentioned earlier.

Our study findings that 46.44% cases belong to lower socio-economical class and 34.12% cases belong to middle socio-economical class is comparable to findings of study of Mada P & Krishna PH[21] mentions 50% and 35% cases respectively. But, we noted 11.37% cases were from higher socio-economical class which is significantly higher than theirs(3%). This shows contrast to traditional understanding that higher socio-economical class people are less vulnerable or more protected to violent crimes.

As per community area type distribution, we noted that more than 2/3rd cases(67.29%) were from urban or suburban areas. This might be attributed to population overcrowding, stressful daily workstyles and competitive struggled life in urban & suburban areas compared to rural or tribal areas. Although study of Kumar R[16] in Varanasi mentions marginal difference in cases from urban & suburban areas(56%) and rural areas(44%).

Regarding accused-victim relation, study of Hugar BS et al.[22] noted 3.5% accused were stranger and 6.11% were not identified, rest 90.29% were either close or far relative or friend or acquaintance. Study of Mada P & Krishna PH[21] mentions that 11% accused were not related or not identified, rest 89% were either 1st degree or 2nd degree relative or friend/known person of victim. Study of R Selvakumar & N Karthikeyan[19] also denotes 20% of accused were unknown while 80% were either relative or friend or known person to victim. These all results are supportive to our study findings that in most cases accused are either relative or known person to victim. This finding is shocking in sense that social or community relations might have double faces, protective or deceitful. While some foreign studies by Wahlsten P et al.[24] and Henderson JP et al.[25]mentions strangers as accused in most cases, which seems uncommon in India.

The motive for the homicide offence, our findings that most cases involved quarrel as motive is correlating to studies of Sonvane SS et al.[23], Mada P & Krishna PH[21] and Gupta A et al.[20] which mentions 45.45%, 30.9% and 29% cases were due to quarrel or argument respectively. While study of Shah JP et al.[9] noted financial or property related disputes as most common motive(24%) followed by personal disputes(21%) and study of R Selvakumar & N Karthikeyan[19] noted illegal(love) affair in most cases(25.71%) followed by family problems(20%). The reason or justifications for any of these findings are difficult to explain because these all motives are related to human psychology and behavioural science.

Zanzrukiya KM et al.[5] noted hemorrhagic shock as most common cause(57.14%) of death in homicide victims, Gupta S et al.[11] mentions hemorrhagic shock due to mechanical

injuries in most(77.72%) cases, Rastogi AK et al.[17] noted hemorrhagic shock as cause of death in most(46.34%) cases. R Selvakumar & N Karthikeyan[19] noted shock & hemorrhage as cause of death in most(57.14%) cases. All of these are coincides with our study finding that hemorrhagic shock is most common cause of death in homicides. While Patnaik KK et al.[14] found coma as mode of death in most(38.09%) homicides followed by hemorrhagic shock(34.92%). Cause of death in homicide is directly related to method of homicide used by offender which seems mechanical injuries in most cases in many studies. Although asphyxia and coma are not uncommon, burns and poisoning are rare.

CONCLUSION :

Homicidal death represents key indices of all violent crime in a given community. In south Gujarat, incidence rate of homicide deaths was 3.0% of total autopsy cases. Males were victims in more than 2/3rd times cases compared to females. Young people aged 21-40yrs & married people are more vulnerable for homicidal crimes. More than 2/3rd victims were belonged to urban or suburban areas. In most cases, the accused was a known person to the victim and was near relative or friend in 39.33% cases. The chief motive for homicide incidence was 'out of control quarrel over daily trivial issues' in nearly 1/3rd cases followed by 'financial or property disputes'. The leading cause of death in victims was 'Hemorrhagic shock due to mechanical injuries'.

The offenders are mostly known person to the victims. Compare to developed nations or regions, Stranger person as accused and so as planned murder is rare in study region which is a mixed region in regard to socio-economic development. Event or motives leading to homicide offence are daily social issues or economical needs with emotional greed, which are manageable and the homicide event might be prevented if addressed in time to check the violence.

REFERENCES :

1. Marlon J. A Brief History of Seven Killings. England: Oneworld Publications; 2015.
2. World Health Organization. Homicide-WHO Global Health Estimates (2015 update) .

   http://apps.who.int/violence-info/homicide/ (accessed 10 July 2019)
3. The Indian Penal Code 1860. Ministry of Law & Justice, Government of India. Available at

   http://legislative.gov.in/actsofparliamentfromtheyear/indian-penal-code (accessed 10 July 2019)
4. Kuppuswamy B. Manual of Socioeconomic Status, Manasayan, Delhi, 1981.
5. Zanzrukiya KM, Tailor CI, Chandegara PV, Govekar GP, Patel UP, Parkhe SN. Profile of homicidal death cases at Government Medical College & New Civil Hospital, Surat. Int J Med Sci Public Health 2014;3 (Online First). DOI: 10.5455/ijmsph.2014.170420142
6. Jhaveri S, Raloti S, Patel R, Brahbhatt J, Kaushik V. Profile of Homicidal Deaths: a Three Year Study At Surat Municipal Institute of Medical Education and Research, Surat During 2011 -2013. Natl J Community Med 2014: 5(4);406-9.
7. Prajapati P, Sheikh MI, Patel S. Study of homicidal deaths by mechanical injuries in Surat. Journal of Indian Academy of Forensic Medicine 2010:32(2):139
8. Mishra PK.,Yadav JS, Sandeep S, Dubey BP. Patterns of injuries in Homicidal deaths in Bhopal region, Journal of Indian Academy of Forensic Medicine 2012, Vol.34, No 3, page 195-198
9. Sheikh MI, Subramanyam BV. "Study of homicide in Surat with special reference to changing trends" JFMT, 1994;12(1- 2): 8-15.
10. Mohanty MK, Kumar TM, Mohanram A, Palimar V. Victims of homicidal deaths–an analysis of variables. Journal of Clinical Forensic Medicine. 2005 Dec 1;12(6):302-4.
11. Gupta S, Prajapati P, Kumar S. Victimology of homicide: a Surat,(south Gujarat) based study. Journal of Indian Academy of Forensic Medicine. 2007;29(3):29-33.
12. Shah JP, Vora DH, Mangal HM, Chauhan VN, Doshi SM, Chotaliya DB. Profile of homicidal deaths in and around Rajkot region, Gujarat. Journal of Indian Academy of Forensic Medicine. 2013;35(1):33-6.
13. Singh OG, Gupta BD. Evaluation of Mechanical Injuries in Homicidal Deaths (A retrospective study of 5 years). From Editor's Desk. 2007;29(3):18.
14. Patnaik KK, Das S, Mohanty S, Panigrahi H. Pattern of Isolated Fatal Mechanical Injury in Homicidal Deaths: A Cross-Sectional Study. Journal of clinical and diagnostic research: JCDR. Sep 2017; 11(9):HC01-HC04.
15. Verma L, Punia RK, Sharma DK, et al. An analysis of weapons used in homicides in Jaipur region- a three years study. J. Evid. Based Med. Healthc. 2018; 5(16), 1362-1365. DOI: 10.18410/jebmh/2018/283
16. Kumar R. Study of the pattern of homicidal deaths in Varanasi region of India. J Evol Med Dent Sci. 2013 Oct 28;2(43):8393-419.
17. Rastogi AK, Singh BK, Dadu SK, Thakur PS, Lanjewar AK, Raput PP. Trends of homicidal deaths in Indore (MP)

region: One year retrospective study. Journal of the Indian Academy of Forensic Sciences. 2013 Oct;35(4):343-5.

18. Panda BB, Nayak A, Samantsinghar P. Significance of defence wound in homicidal death. Journal of Indian Academy of Forensic Medicine. 2014;36(3):263-5.
19. R Selvakumar, N Karthikeyan. A retrospective study on homicidal autopsy cases at Government Kilpauk Medical College Hospital, Chennai. MedPulse – International Medical Journal March 2016; 3(3):329-332.
20. Gupta A, Rani M, Mittal AK, Dikshit PC. A study of homicidal deaths in Delhi. Medicine, science and the law. 2004 Apr;44(2):127-32.
21. Mada P, Krishna PH. A comprehensive study on homicidal deaths in hyderabad. J Indian Acad Forensic Med. October-December. 2013;35(4):0971-0973.
22. Hugar BS, YP GC, Harish S, SH J. Pattern of homicidal deaths. Journal of Indian Academy of Forensic Medicine. 2010;32(3):194-8.
23. Sonvane SS, Rajesh BS, Shashank T, Shivkumar RK. Autopsy Evaluation of Homicidal Deaths in Western Mumbai Region -2 Years Prospective Study. Scholars Journal of Applied Medical Sciences 2017; 5(12A): 4840-4846.
24. Wahlsten P, Koiranen V, Saukko P. Survey of medico-legal investigation of homicides in the city of Turku, Finland. Journal of forensic and legal medicine. 2007 Jul 1;14(5):243-52.
25. Henderson JP, Morgan SE, Patel F, Tiplady ME. Patterns of non-firearm homicide. Journal of clinical forensic medicine. 2005 Jun 1;12(3):128-32.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00109.0

Original Research Paper

"Tele – Evidence" OR Traditional method of attending court summons: A Comparative study

1. **Kaushal Kishore,** Assistant Professor, Manipal-Tata Medical College, Jamshedpur
2. **Avinash Kumar,** Assistant Professor, Department of Forensic Medicine & Toxicology, ESIC Medical College and Hospital, Bihta, Patna, Bihar
3. **Gautam Kumar,** Senior Resident*
4. **Nawal Kumar Singh,** Senior Resident*
5. **Amit Patil,** Additional Professor and Head*
6. **Binay Kumar,** Additional Professor*
7. **Ashok Kumar Rastogi,** Assistant Professor*

*Department of Forensic Medicine & Toxicology, All India Institute of Medical Sciences (AIIMS), Patna, Bihar.

ABSTRACT:

Introduction: Tele evidence or video conferencing is an effective tool for serving summons, and is a legitimate method of tendering evidence whenever summoned. Medical professionals are often summoned by the court of law, especially forensic pathologist for testimony as expert witness. Video conferencing If properly installed and used, has proven its mettle in terms of cost effective and other resources, besides serving basic objective, i.e. to provide evidence for legal procedure. The objective of the study was to compare the two methods of attending court for serving summons i.e. physically attending court and testimony via videoconferencing, at AIIMS Patna.

Materials and methods: The available record of summons attended by the faculties and resident doctors of the department of Forensic Medicine & Toxicology, AIIMS, Patna. The data relating to number of days spent, distance travelled, Travelling allowances, and other expenses borne for each cases were collected from the personal files of the respective faculties and resident doctors after obtaining consent from them.

Results: A total of 98 summons were received by the various faculties and resident doctors of Department of Forensic Medicine & Toxicology, AIIMS, Patna in the period of January 2015 till May 2019. 52 summons were attended via videoconferencing, while the remaining 46 cases were attended physically. The total number of days spent while attending court for serving summons was 96 days, which accounted for approximately 2 days spent per cases. For videoconferencing in 52 cases, the hearing was concluded on the same day with average time consumed was roughly around 30 minutes per case. A total of 34,876 Kms of distance was travelled (to and fro) to attend the court to serve summons, and total expenditure was INR 5,72,135.

Conclusion: Tele evidence is a legitimate way of testifying and It is evident from our study that tele evidence via videoconferencing seems to be good option as compared to physical presence at court for attending summons as it has a great potential in enhancing the health care, judicial trial and other key aspects too such as cost, time, physical/mental stress and overall satisfaction.

Corresponding Author :
Dr. Avinash Kumar,
Assistant Professor,
Department of Forensic Medicine & Toxicology, ESIC Medical College and Hospital, Bihta, Patna, Bihar
Contact : +91 9570073048
Email: staravinash008@gmail.com

Article History:
Received: 30 August 2019
Received in revised form: 12 September 2019
Accepted on: 12 September 2019
Available online: 30 April 2021

KEYWORDS : Key words: Summons, Expert witness, Testimony, Legitimate, Resource,Tele-evidence.

INTRODUCTION:

Medical professionals are often summoned by the court of law, especially forensic pathologist for testimony as expert witness, mainly because of the amount of medico-legal cases dealt by them.

Section 61 to 69 of Cr. PC deals with summons, i.e. a document compelling the attendance of a witness in a court of law under penalty, on a particular day, time and place, for the purpose of giving evidence[1].

As per Section 87 of Cr.PC, "Issue of warrant in lieu of, or in addition to, summons"[1] – A court may in any case in which it is empowered by this code to issue a summons for the appearance of any person, issue, after recording its reason in writing, a warrant for his arrest :

(a) If, either before the issue of such summons, or after the issue of the same but before the time fixed for his appearance, the court sees reason to believe that he has absconded or will not obey the summons[1]; or

(b) If at such time he fails to appear and the summons is proved to have been duly served in time to admit of his appearing in accordance therewith and no reasonable excuse is offered for such failure[1].

Hence, it is under obligation that a doctor has to attend court in order to serve summons, although he/she might be having other important assignments at the same time. On several occasions a doctor has to travel to different places, even from foreign countries for attending courts.

Ours,is a developing nation and there is often shortage of health care providers. In order to serve summons they are required to travel to distant places which not only is a costly affair, but also time consuming. This also has undesirable effect on patient care, and other academic and research work.

Tele evidence also known as video conference is an innovation of information and communication technology is an application where audio visual technology helps to establish face to face communication between persons in separate places. It is a form of oral evidence, in electronic form.

The technology have been in use since 1970, but has rapidly progressed since then in terms of gadget used. Australia, Canada, United Kingdom, and India have been using videoconferencing for various court proceedings. The most far-reaching use of videoconferencing, however, has been in Singapore. Singapore is in the midst of developing a "virtual" court system in which videoconferencing plays a major role[2].

Though, there is no data base or any conclusive evidence in Indian scenario depicting the cost effectiveness of tele-evidence as compared to traditional methods of serving summons, but bearing in mind about the convenience it provides in judicial hearings and the usage of other application of videoconferencing in health sector like patient care, it is assumed that this technology might be more efficient.

Admissibility of evidence through video conferencing :

There are certain guidelines issued by the Supreme Court of India, and other high courts in relation to recording of evidence by video conferencing.

1. Wherever possible, proceedings by way of video conference shall be conducted as judicial proceedings and the same courtesies and protocols will be observed. All, relevant statutory provisions applicable to judicial proceedings including the provisions of the Information Technology Act, 2000 and the Indian Evidence Act, 1872 shall apply to the recording of evidence by video conference.[3]
2. Video conferencing facilities can be used in all matters including remands, bail applications and in civil and criminal trials where a witness is located intrastate, interstate, or overseas. However, these guidelines will not apply to proceedings under section 164 of Cr. PC.[3]

Some of the landmark cases where the Apex court and various other court had allowed and denied recording of evidence through video conferencing are:

1. In state of Punjab v Mohinder Singh the state government of Punjab and Haryana, as well as the Chandigarh Administration allowed video conferencing as the preferred mode of medical evidence in criminal trials.[4]
2. The strength of the directions emanates from a decision of the Supreme Court in Dr. J J Merchant v Shrinath Chaturvedi where it had held that foreign medical experts could be examined by video conferencing or internet conferencing.[5]
3. In Md.AjmalMd.AmirKasab @Abu vs State Of Maharashtra, court permitted Kasab to appear through video conferencing.[6]
4. The Bombay High Court taking suo-motu cognizance of a letter written by Shaikh Abdul Naeem, who was one of the accused in the Aurangabad Arms Haul case has directed the Maharashtra government to install video conferencing facilities in all courts in the state by the end of March 2017.[7]
5. Apex court in Asha Ranjan vs State of Bihar and others, transferred Mohammad Shahabuddin from Siwan Jail, district Siwan in Bihar, to Tihar Jail, Delhi directing that pending trials shall be conducted by video conferencing by the trial court.[8]
6. The Division Bench of Madras High Court created history when it conducted the court proceedings over Skype from Chennai for the first time in a case related to 89 inmates of an unauthorized private children's Home for girls run by Mose Ministries in Turuchi. In this case, girls rescued from the brothels in Delhi were repatriated and rehabilitated in their hometowns in several parts of India. To avoid any discomfort to them the court decided to take evidence through video conferencing.[9]
7. But, in Santhini vs VijayaVenketesh, The apex court held that Evidence via video conference not permissible in matrimonial cases[10].

Technical requirements:

In order to tender evidence, via video conference, following equipment may be required[11]:

1. Separate room with adequate light for visibility,insulation/acoustics, uninterrupted power supply and proper sitting arrangement.
2. A computer with high-speed internet connection.
3. Video camera.
4. Microphones and speakers.
5. Monitors/ Display units.
6. Document visualizer.
7. Facility for digital signatures at both the ends.

At our Institute, AIIMS, Patna the department of information technology has installed video conferencing. The initiative was mainly to enhance the health care to the rural areas of the state of Bihar, it also served the purpose of testimony by the doctors to the various court on being summoned, provided that the presiding court too had the facility of video conferencing

Figure 1: Photograph showing tele-evidence served by a doctor in video conference room at AIIMS, Patna

MATERIAL AND METHODS: The present Observational study was conducted on faculty and resident doctors of AIIMS, Patna, who were summoned by the court of law to appear as Expert witness, either physically or through video conference from January 2015 to May 2019. Data was collected from the office of the department of Forensic Medicine & Toxicology and Department of Information Technology, AIIMS, Patna, to study the amount of summons served, time consumed, distance travelled and the expenditure borne. The duration/time consumed in attending court of law, distance travelled and other expenditures like food and lodging were obtained by travelling allowances and dearness allowance (TA/DA) submitted by the concerned faculties and other resident doctor. Also the number of court evidences served via video conferencing were collected from the department of Information Technology. In order to maintain quality assurance, the data were collected in presence of the all the faculties, senior resident, IT cell, and were cross checked with the official files of the concerned faculties and resident doctor.

Data Analysis: Descriptive analysis of the data was done in following terms:

(i) Total number of summons served.

(ii) Total number of summons attended physically.

(iii) Total number of summons served by video conferencing.

(iv) Total number of days consumed in serving summons in attending physically.

(v) Amount of money spent in travelling, food and travelling during serving summons physically.

From these data, total expense incurred during physical appearance was calculated and described to understand the magnitude of possible cost saving with tele-evidence.

RESULTS:

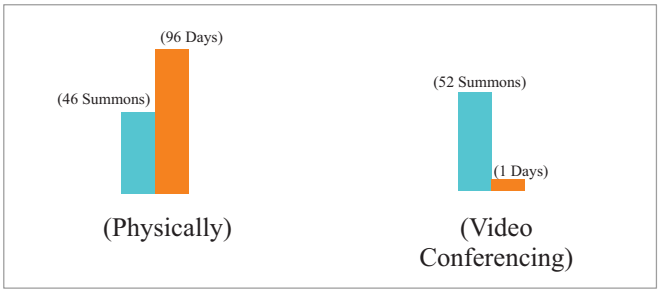
A total of 98 summons were served to the various faculties and senior residents of the department of Forensic Medicine and Toxicology in the study period. Thus on an average, 23 summons were received yearly or roughly 2 summons per month. Out of the total 98 summons, 52 were attended by video conference, which accounted for 53 %, while the remaining 46 summons were attended physically at the respective court and accounted for 47 %. **(Graph 1)**

Graph 1: Showing number of summons attended by different means

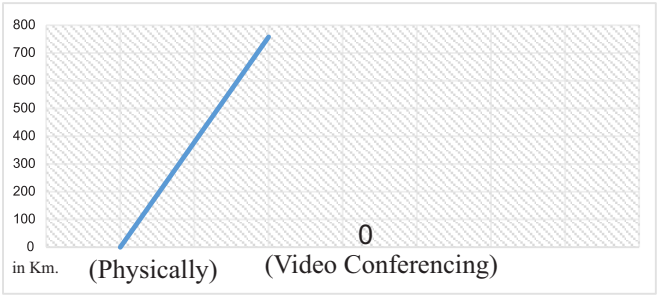
The total number of days spent while attending court for serving summons was 96 days, which accounted for approximately 2 days spent per cases. For videoconferencing in 52 cases, the hearing was concluded on the same day with average time consumed was roughly around 30 minutes per case, which was roughly equivalent to 1 day for total number of cases attended through videoconferencing as shown in **graph 2**. Time consumed in tele-evidence was insignificant as it only included the evidence time presented before the judge. Also there was hardly any waiting time as the schedule of video conference is pre scheduled.

While attending the court for tendering evidence the total distance travelled (to and fro) was 34,876 Kms, which on average accounted for around 758 Kms per case. The maximum distance travelled for a case was 2069 Kms while

lowest was 455 Kms. However, for videoconferencing, the travelling time is insignificant as the facility is available in the academic block of AIIMS, Patna. **(Graph 3)**



Graph 2: Showing comparison between the numbers of days spent while physically attending court and by videoconferencing



Graph 3: Showing distance travelled for physically attending court per case compared with that in videoconferencing

The total expenses borne which includes travelling allowances, food and lodging expenses while tendering the evidence in 43 cases at the respective court of law was INR 5,72,135, which on average accounted for approximately INR 12,438 per case.

DISCUSSION:

Tele-evidence is an application of telemedicine**,** where evidence or witness can be served via videoconferencing. It is an audio visual technology where face to face communication is established[12]. In India, tele-evidence is a legitimate way to testify in the court of law. India is among the few countries in world apart from Australia, Canada, Singapore and United Kingdom where video conferencing is gaining popularity in terms of usage of tele-evidence as a method of testifying in the court of law. Thanks to the judiciary system, especially the High court of Punjab Haryana which has given a go ahead signal in order to escalate the usage of tele-evidence. The high court has provided certain guidelines for serving testimony via video conference. The installation of video conferencing at AIIMS, Patna can be considered as a good initiative, thanks to the department of Information Technology, as it not only serves the purpose of tele- medicine i.e patient care through video conferencing, academic, clinical discussion from other higher tertiary care center but also its usage in tele-evidence.

Our study was done to compare the 2 methods of attending court for serving summons i.e. physically attending court and testimony via videoconferencing at AIIMS Patna and evaluate their effectiveness, time consumed, money spent etc. On analysis of the data, it was observed that on an average, approximately 2 days were spent for attending court in order to testify which is quite high as compared to video conferencing as the facility was available in the academic building of AIIMS, Patna. In order to attend court physically, the distance travelled was 34,876 Kms, which on average accounted for around 758 Kms per case. This again cannot be compared with that of videoconferencing as there was hardly any distance travelled for videoconferencing. Travelling allowances, food and lodging expenses were the extra expenses that were borne while attending court and there was no such expense in video conferencing. Hence evaluation of the data revealed that there is significant decrease in the usage of resources, like time consumed, distance traversed, physical and mental harassment etc., with the usage of tele-evidence.

However exact monetary saving could not be assessed as the infrastructure cost for installation of video conferencing was not available and hence other relative comparison could not be made.Wallace et al had raised the issue of savings due to telemedicine, some 2 decades ago[13]. Recent study done by Mistry has also revealed about the difficulties in arriving at a definite conclusion about the cost effectiveness of telemedicine[14].

The other parameters which needed to be addressed was the disruption of usual routine services like medico legal works, teaching, research related work, physical and mental stress of travelling, satisfaction level and other liabilities that were hampered due to absence from hospital while attending summons personally to the court of law.

CONCLUSION:

It is evident from our study that tele-evidence via videoconferencing seems to be good option as compared to physical presence at court for attending summons. Not only the health sector which is going to gain, but also the judiciary gets boost in terms of speedy trials. The other areas which too gets involved is the environment as telemedicine is a potent carbon reducing strategy. There has been reduction in carbon emission as assessed by the carbon foot print of telemedicine due to reduced need for transportation.[15, 16, 17] Thus, adoption of tele-evidence through integration of telemedicine and tele-justice will go a long way in establishing our objective i.e enhancing our health care and judicial system and also push or nation to Digital India. Prime Minister Narendra Modi had also said that

technology could have a big scope in the judiciary, and urged people in the start-up sector to innovate on aspects where technology can help the judiciary[18].

REFERENCE:

1. Reddy KSN. The essentials of Forensic Medicine and Toxicology. 33rd ed. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.; 2014:8-10.
2. Magnus R. The Confluence of Law and Policy in Leveraging Technology: Singapore Judiciary's Experience, 12 WM. & Mary Bill Of Rts. J.; 2004: 661-75.
3. Ecourt services. High courts of India. [Online]. Available from: http://ecourts.gov.in [Accessed 31 August 2019].Go back and edit info Copy to Clipboard.
4. State of Punjab v Mohinder Singh, 2013 (4) RCR (Civil) 423
5. Dr. J. J Merchant v Shrinath Chaturvedi, 2002 (6) SCC 635:AIR 2002 SC 2931:2002 (Supp-1) SCRB469.
6. Alam A, Prasad C. Indian Kanoon. [Online]. Available from: https://indiankanoon.org [Accessed 31 August 2019].
7. Kashyp, N. Ensure Video Conferencing Facility in All Courts By March End, Bombay HC Tells Maharashtra Government. All about the law. Weblog. [Online] Available from: http://live law.in [Accessed 31 August 2019]
8. Live law news network, N. SC Transfers Shahabuddin From Siwan Jail To Tihar Jail; Orders Trial By Video Conferencing [Read Judgment]. All about the law. Weblog. [Online] Available from: http://live law.in [Accessed 31 August 2019].
9. Cletus, A. Madras HC Division Bench creates history conducting hearing over 'Skype' . All about the law. Weblog. [Online] Available from: http://live law.in [Accessed 31 August 2019]
10. Santhini v VijayaVenketesh, in the supreme court of India transfer petition (civil) no.1278 OF 2016.
11. Knowledge for justice. National Judicial Academy India. [Online]. Available from: http://www.nja.nic.in/CJ [Accessed 31 August 2019]
12. Kahn JM. Virtual visits – Confronting the challenges of telemedicine. N Engl J Med 2015;372:1684-5.
13. Wallace S, Wyatt J, Taylor P. Telemedicine in the NHS for the millennium and beyond. Postgrad Med J 1998;74:721-8.
14. Mistry H. Systematic review of studies of the cost-effectiveness of telemedicine and telecare. Changes in the economic evidence over twenty years. J Telemed Telecare 2012;18:1-6
15. Holmner A, Ebi KL, Lazuardi L, Nilsson M. Carbon footprint of telemedicine solutions – Unexplored opportunity for reducing carbon emissions in the health sector. PLoS One 2014; 9:e 105040.
16. Lewis D, Tranter G, Axford AT. Use of videoconferencing in Wales to reduce carbon dioxide emissions, travel costs and time. Journal of Telemedicine and Telecare 2009;15: 137–138.
17. Wootton R, Tait A, Croft A. Environmental aspects of health care in the Grampian NHS region and the place of telehealth. Journal of Telemedicine and Telecare 2010; 16: 215–220.
18. Sarin J. Videoconferencing can reduce pile-up of cases says PM Modi. Hindustan Times. 2017 April 03.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00110.7

Original Research Paper

Time of fusion of lesser cornu with body of Hyoid bone: Gross and Radiological Study

1. **Avinash Kumar,** Assistant Professor, Department of Forensic Medicine & Toxicology, ESIC Medical College and Hospital, Bihta, Patna, Bihar
2. **Vincent Merry,** Medical Officer, Govt. of Assam
3. **Luv Sharma,** Professor, Department of Forensic Medicine*
4. **Jyotsna Sen,** Professor, Department of Radiodiagnosis*
5. **Binay Kumar,** Additional Professor, Department of Forensic Medicine & Toxicology, All India Institute of Medical sciences (AIIMS), Patna, Bihar

*Pt. B. D. Sharma Post Graduate Institute of Medical Sciences, Rohtak, Haryana

ABSTRACT:

Introduction: The lesser cornua of the hyoid bone fuse with the body at a certain age. The fusion of hyoid bone can be helpful in estimating the age of persons particularly, unknown dead bodies and skeletons when other skeletal remains are missing. Very few investigations have been done for time of fusion of lesser cornu with body of hyoid bone.

Materials and Methods: The present study was aimed at examining the age of fusion of lesser cornu of hyoid bone in population of Haryana and to assess whether fusion is sex dependent. The sample comprised hundred (equal number of male and female) healthy hyoids bones. The hyoid bones were obtained from subjects, aged between 20-70 year, in consecutive autopsies. The X-ray films were examined for the presence of fusion between the lesser cornua and body.

Results: The mean age of unilateral fusion of lesser cornua in females and males were 58.00 and 59.00 years respectively while mean age of bilateral fusion were 63.67 and 64.23 years in females and males respectively.

Conclussion: It was seen from the present study that the mean age of fusion did not significantly differ in the two sexes. Attempt to estimate age from hyoid fusion in Indians would be unreliable owing to the regional variations.

Corresponding Author :
Dr. Avinash Kumar,
Assistant Professor,
Department of Forensic Medicine & Toxicology, ESIC Medical College and Hospital, Bihta, Patna, Bihar
Contact : +91 9570073048
Email: staravinash008@gmail.com

Article History:
Received: 24 August 2019
Received in revised form: 28 August 2019
Accepted on: 28 August 2019
Available online: 30 April 2021

KEYWORDS : Hyoid bone, Cornua, Age Estimation, Fusion, Unilateral, Bilateral

INTRODUCTION :

Ossification of bones provides a very useful method of estimation of age in the living. Most bones develop either from cartilage or from fibro-membranous structures. Different bones begin and complete their ossification at different but almost fixed periods of life. These changes can be studied by X-rays and thus provide the medico-legal specialist with a very strong tool.[1]

The hyoid bone can be designated as the skeleton of the tongue.[2] The mobile hyoid bone lies in the anterior part of the neck at the level of third cervical vertebra in the angle between the mandible and the thyroid cartilage. The hyoid is unique among bones for its isolation from the remainder of the skeleton as it does not articulate with any other bone.[3] It can be palpated above the thyroid cartilage, on the anterior surface of the neck. This bone functions as an anchor for muscles and ligaments in the neck, connecting the cranium, mandible, sternum and shoulder girdle together, along with the larynx, pharynx and tongue.[4]

Hyoid bone comprises a quadrate middle part, the body, and two processes on each side, the greater and lesser horns (cornua).[5]True articulations between the body and the greater horns of the hyoid bone persist for a very long time and the junction between the small horns and the body doesn't fully calcify until about the age of fifty.[6]The **lesser cornua** of the hyoid bone are two small, conical eminences attached by their bases at the angle of junction of the body and greater cornua. They are connected to the body of the bone by fibrous tissue and occasionally to the greater cornua by synovial joints.[4]The lesser horn in younger persons consists entirely of cartilage in which only late in life a centre of ossification appears. The

lesser horn continues, at its apex, into a ligament that reaches to the tip of the styloid process, the stylohyoid ligament.[2] The synovial joints between the lesser cornua and the rest of the bone may be obliterated by ossification in the later decades.[7]

Age of Fusion of lesser cornua of Hyoid bone can be helpful for estimation of age of person after middle age particularly in unknown dead bodies. Variations in climatic, dietetic, hereditary, sex and other factors affects the ossification process so, it cannot be reasonably expected to formulate a uniform standard for determination of the age of fusion of hyoid bone for whole of India.[8]The present study, therefore, is aimed to assess the status of fusion of lesser cornua of hyoid bone in Haryana region so that the same can be used for estimation of age of individuals in this area.

MATERIAL AND METHODS :

The present study was conducted in the Departments of Forensic Medicine and Radio-diagnosis, Pt. B. D. Sharma Post Graduate Institute of Medical Sciences (PGIMS), Rohtak. A total of 100 hyoid bones of known age and sex (50 males and 50 females) were collected from identified dead bodies that were brought to the Department of Forensic Medicine for post-mortem examination. The information of each case was recorded on a Proforma that included PMR number, sex, age, date of birth and gross & radiological findings. Informed consent was obtained from the nearest of the kin accompanying the dead body to the mortuary on a standard Consent Form. The study was conducted on individuals aged between 20-70 years, and for analysis, the cases were divided into 10 groups of five year interval.

Inclusion criteria:

1. Hyoid bones of normal, healthy individuals aged between 20-70 years.
2. Individuals whose exact age was known and verified (duly verified from the Birth Certificates//Matriculation Certificate/AADHAAR Card/Elector's Identity Card/Driving License).

Exclusion criteria:

1. Individuals with any congenital anomalies, partially destroyed, fractured, burnt, diseased, deformed or abnormal hyoid bones.
2. Individuals whose exact age was not known.

The hyoid bone was removed from the cadaver during post-mortem examination by careful dissection of the laryngeal structures. It was removed with extreme caution so as the bone does not break and be confused with fracture of hyoid bone. The hyoid bones thus collected were examined grossly by palpation to examine the status of fusion of the lesser cornu with the body. They were then put in labeled plastic jars containing plain tap water. After 2-3 weeks, the bones were taken out of the jars, dried properly and placed in labeled plastic pouches and taken to the Radiology Department for X-ray examination. Each specimen was radiographed using Siemens Heliophos D 500 mA X-ray machine, with its inferior surfaceresting directly on the cassette, 100 cm from the X-raysource with an exposure of 42 kVp and 5 mAs. The cassettes were processed with digital AGFA CR System.

The films were examined for the presence of fusion between the lesser cornu and body of hyoid. Thereafter the hyoids were classified into the following groups:

1. Those showing no fusion (UF)
2. Those showing partial fusion i.e in the process of fusion (P)
3. Those showing complete fusion (F)

   (i) Unilateral Left (ii) Unilateral Right

   (iii) Bilateral

The statistical analysis of the data was done using SPSS program for windows. The significance of the data was verified using Chi-square test, Student's t-test and ANOVA. The significance was predetermined at $p<0.05$.

RESULTS :

The X-ray films were examined and observations regarding the status of fusion between the lesser cornu and junction of body with greater cornu were noted.

The table 1 depicts the age and sex wise distribution of the hyoid bones taken for the study. In females, the maximum and minimum number of samples were in the age groups 65-70 years (n=7) and 61-65 years (n=3) respectively while in males it was in the age groups 21-25 yrs& 61-65 years (n=7) and 26-30 yrs& 65-70 years respectively

Table 1 : Age and Sex Wise Distribution of Subjects

Age Groups	SEX				Total No.	
	Female (n=50)		Male (n=50)			
	No.	%	No.	%	No.	%
21–25 years	6	46.2	7	53.8	13	100
26–30 years	4	57.1	3	42.9	7	100
31–35 years	5	55.6	4	44.4	9	100
36–40 years	5	45.5	6	54.5	11	100
41–45 years	6	60.0	4	40.0	10	100
46–50 years	4	40.0	6	60.0	10	100
51–55 years	4	50.0	4	50.0	8	100
56–60 years	6	50.0	6	50.0	12	100
61–65 years	3	30.0	7	70.0	10	100
>65 years	7	70.0	3	30.0	10	100
Total	**50**	**50.0**	**50**	**50.0**	**50**	**100**

From the **table 2** it is observed that in females, there was no fusion between the lesser cornuand junction of body with greater cornu in the first 6 age groups.

The earliest complete bilateral fusion was seen in the age group 51-55 years (in 2 out of 4 cases i.e. 50%) and earliest unilateral fusion was seen in the age group 56-60 years (in 2 out of 6 cases i.e. 33.3%). Bilateral non-fusion was observed even in the age group 56-60 years (in 3 out of 6 cases i.e. 50%).

Table 2: Status of Fusion of Lesser Cornua among Females

Age Groups	Bilateral Un-fused (UF)		Unilateral Fused (F)		Bilateral Fused (F)		Total (T)	
	No.	%	No.	%	No.	%	No.	%
21–25 years	6	100	0	0	0	0	6	100
26–30 years	4	100	0	0	0	0	4	100
31–35 years	5	100	0	0	0	0	5	100
36–40 years	5	100	0	0	0	0	5	100
41–45 years	6	100	0	0	0	0	6	100
46–50 years	4	100	0	0	0	0	4	100
51–55 years	2	100	0	0	**2**	50	4	100
56–60 years	**3**	**50**	**2**	**33.3**	1	16.7	6	100
61–65 years	0	100	0	0	3	100	3	100
>65 years	0	100	0	0	7	100	7	100
Total	**35**	**100**	**2**	**4**	**13**	**26**	**50**	**100**

From the **table 3** it is observed that in males, there was no fusion between the lesser cornuand junction of body with greater cornu in the first 6 age groups.

The earliest unilateral fusion was seen in the age group 51-55 years (in 1 out of 4 cases i.e. 25%) and earliest complete bilateral fusion was seen in the age group 56-60 years (in 3 out of 6 cases i.e. 50%). Bilateral non-fusion was observed even in the age group 56-60 years (in 2 out of 6 cases i.e. 33.3%).

Table 3: Status of Fusion of Lesser Cornua among Males

Age Groups	Bilateral Un-fused (UF)		Unilateral Fused (F)		Bilateral Fused (F)		Total (T)	
	No.	%	No.	%	No.	%	No.	%
21–25 years	7	100	0	0	0	0	7	100
26–30 years	3	100	0	0	0	0	3	100
31–35 years	4	100	0	0	0	0	4	100
36–40 years	6	100	0	0	0	0	6	100
41–45 years	4	100	0	0	0	0	4	100
46–50 years	6	100	0	0	0	0	6	100
51–55 years	3	75	**1**	**25**	0	0	4	100
56–60 years	2	**33.3**	1	16.7	**3**	50	6	100
61–65 years	0	0	1	14.3	6	85.7	7	100
>65 years	0	0	0	0	3	100	3	100
Total	**35**	**70**	**3**	**6**	**12**	**24**	**50**	**100**

From the **table 4** it is observed that in males, out of the total 50 cases, non-fusion between the lesser cornu and junction of body with greater cornu was seen in 35 cases (70.0%) bilaterally whilecomplete fusion was seen in 12 cases (24.0%) bilaterally and 3 cases (6.0%)unilaterally.

In females, out of the total 50 cases, non-fusion was seen in 35 cases (70.0%) bilaterally whilecomplete fusion was seen in 13 cases (26.0%) bilaterally and 2 cases (4.0%)unilaterally

From the **table 5** it is evident that no significant sexual differencein the incidence of fusion of Left Lesser Cornu was observed in all the age groups.

From the **table 6** it is evident that no significant sexual differencein the incidence of fusion of Right Lesser Cornu was observed in all the age groups.

The mean age of un-fused lesser cornua in males and females were 38.8 and 38.40 years respectively while mean age of fused (bilateral) lesser cornua were 64.23 and 63.67 years respectively. The mean age of unilateral fusion in males and females were 59.00 and 58.00 years respectively.

No significant difference was found between males andfemaleswho had bilateral non-fusion (p=0.800), unilateral fusion (p=0.766) and bilateral fusion (0.769).

It is apparent from the table 8 that the p value is less than 0.001 and therefore there is very highly significant statistical difference between the ages of fusion of lesser cornua with the body of hyoid in the mentioned age groups.

From the table 9 it is observed that unilateral fusion of lesser cornua in females was seen equally on left (50%) and right (50%) sides, while in males it was seen more on the left side (75%) as compared to the right (25%).

DISCUSSION :

The present investigation was designed to examine the age at which the body of hyoid bone fuses (calcifies) with the lesser cornuin different age groups. The body of the hyoid bone fuses with the lesser cornu as a process of development. This fusion takes place at variable age and is depend on several factors including sex and population, as supported by previous researches, [9.10.11] especially in a multi ethnic country like India. Therefore, it is difficult to follow a single standard data for determination of age for the entire country.

In the present study, the status of fusion of the lesser cornua of the hyoid bone in males and females of Haryana was studied and the results were compared with previous similar studies.

CONCLUSION:

The mean age of unilateral fusion of lesser cornua in females and males were 58.00 and 59.00 years respectively while mean age of bilateral fusion were 63.67 and 64.23 years in females

Table 4: Status of Fusion of Lesser Cornua among Males & Females

Age Groups		Females				Males			
		Bilateral Un-fused (UF)	Unilateral Fused (F)	Bilateral Fused (F)	Total (T)	Bilateral Un-fused (UF)	Unilateral Fused (F)	Bilateral Fused (F)	Total (T)
21–25 years	(n)	6	0	0	6	7	0	0	7
	(%)	100	0.0	0.0	100	100	0.0	0.0	100
26–30 years	(n)	4	0	0	4	3	0	0	3
	(%)	100	0.0	0.0	100	100	0.0	0.0	100
31–35 years	(n)	5	0	0	5	4	0	0	4
	(%)	100	0.0	0.0	100	100	0.0	0.0	100
36–40 years	(n)	5	0	0	5	6	0	0	6
	(%)	100	0.0	0.0	100	100	0.0	0.0	100
41–45 years	(n)	6	0	0	6	4	0	0	4
	(%)	100	0.0	0.0	100	100	0.0	0.0	100
46–50 years	(n)	4	0	0	4	6	0	0	6
	(%)	100	0.0	0.0	100	100	0.0	0.0	100
51–55 years	(n)	2	0	2	4	3	1	0	4
	(%)	50	0.0	50	100	75	25	0.0	100
56–60 years	(n)	3	2	1	6	2	1	3	6
	(%)	50	33.3	16.7	100	33.3	16.7	50	100
61–65 years	(n)	0	0	3	3	0	1	6	7
	(%)	0	0.0	100	100	0.0	14.3	85.7	100
>65 years	(n)	0	0	7	7	0	0	3	3
	(%)	0	0.0	100	100	0.0	0.0	100	100
Total	(n)	**35**	**2**	**13**	**50**	**35**	**3**	**12**	**50**
	(%)	**70**	**4**	**26**	**100**	**70**	**6**	**24**	**100**

and males respectively. There was no statistically significant sexual difference (p value > 0.5) between incidence of fusion of lesser cornua in all the age groups. The present study has attempted to provide a reference for age determination from the hyoid bone for a population of Haryana.The fusion of lesser cornua of hyoid bone can be used as important medico-legal implication of age estimation of an individual, particularly when other skeletal remains are missing.

REFERENCES :

1. Agrawal A. Age Estimation in the living: in matters civil and criminal. J Anat 2009; 1(2): 1-25.
2. DuBrull L E, Harry S. Sicher's Oral Anatomy. 6th ed. Sant Louis: CV Mosby Company;1975. p. 53-4.
3. Moore LK, Dalley FA, Agur RMA. Clinically Oriented Anatomy. 6th ed. New Delhi: Lippincott Williams & Wilkins; 2010. p. 984.
4. Mukhopadhyay PP. Determination of sex from an autopsy sample of adult hyoid bones. Med Sci Law 2012;52(3):152-5.
5. Basmajian VJ. Grant's Method of Anatomy. 10th ed. Baltimore: Williams & Wilkins; 1980. p. 560-1.
6. Doual A, Léger JL, Doual JM, Hadjiat F. The hyoid bone and vertical dimension. J Orthod Fr2003;74(3):333-63.
7. Standring S. Gray's anatomy the anatomical basis of clinical practice. 40th ed. New York: Churchill Livingstone Elsevier;2008. p. 436.
8. Mathiharan K, Kannan K. Modi A Textbook of Medical Juirsprudence and Toxicology. 24th ed. Nagpur: Lexis Nexis ButterworthsWadhwa;2012. p 238-50.
9. O 'Holloran RL, Lundy JK. Age and ossification of the hyoid bone: forensic implications. J Forensic Sci 1987; 32:1655–9
10. Kanetaka, H., Shimizu, Y., Kano, M. Kikuchi, M. Synostosis of the joint between the body and greater cornu of the human hyoid bone. Clinical Anatomy,2011; 24: 837–842.
11. Gupta A, Kohli A, Aggarwal NK, Banerjee KK. Study of age of fusion of hyoid bone. Leg Med 2008; 10:253–6.
12. Parsons FG. The topography and morphology of human hyoid bone. J AnatPhysiol 1909;43(4):279–90.
13. Harjeet K, Synghal S, Kaur G, Aggarwal A, Wahee P. Time of fusion of greater cornu with body of hyoid bone in North-West Indians. J Leg Med 2010;12(5):223-7.

Table 5: Comparison of Status of Fusion of Left Lesser Cornu among Males and Females

Age Groups	Status of Fusion (Left LesserCornu)	Female	%	Male	%	Chi-square value	p-value
21–25 years Female (n=6) Male (n=7)	Un-Fused	6	100	7	100	0.000	1.000
	Total	6		7	13		
26–30 years Female (n=4) Male (n=3)	Un-Fused	4	100	3	100	0.000	1.000
	Total	4		3	7		
31–35 years Female (n=5) Male (n=4)	Un-Fused	5	100	4	100	0.000	1.000
	Total	5		4	9		
36–40 years Female (n=5) Male (n=6)	Un-Fused	5	100	6	100	0.000	1.000
	Total	5		6	11		
41–45 years Female (n=6) Male (n=4)	Un-Fused	6	100	4	100	0.000	1.000
	Total	6		4	10		
46–50 years Female (n=4) Male (n=6)	Un-Fused	4	100	6	100	0.000	1.000
	Total	4		6	10		
51–55 years Female (n=4) Male (n=4)	Fused	2	50	1	25	0.533	0.465
	Un-Fused	2	50	3	75		
	Total	4	100	4	100		
56–60 years Female (n=6) Male (n=6)	Fused	2	33.33	4	66.66	1.333	0.248
	Un-Fused	4	66.666	2	33.33		
	Total	6		6	12		
61–65 years Female (n=3) Male (n=7)	Fused	3	100	6	85.72	0.476	0.490
	Un-Fused	0	0	1	14.28		
	Total	3	100	7	10		
Above 65 years Female (n=7) Male (n=3)	Fused	7	100	3	100	0.000	1.000
	Total	7		3	10		

Table 7: Mean age of Fusion of Lesser Cornua in Males& Females, Standard Deviation and corresponding p-values

Lesser Cornua	Female			Male			
	Mean	Standard Deviation	Standard Error of Mean	Mean	Standard Deviation	Standard Error of Mean	p-value ±
Bilateral Un-fused	38.40	10.89	±1.54	38.80	11.16	±1.57	0.800#
Unilateral Fused	58.00	4.00	±0.56	59.00	1.41	±0.19	0.766#
Bilateral Fused	63.67	3.82	±0.54	64.23	5.46	±0.77	0.769#

Unpaired t-test **#Non-Significant Difference** **p-value > 0.05 is not statistically significant**

Table 6: Comparison of Status of Fusion of Right Lesser Cornu among Males and Females

Age Groups	Status of Fusion (Right Lesser Cornu)	Female	%	Male	%	Chi-square value	p-value
21–25 years Female (n=6) Male (n=7)	Un-Fused	6	100	7	100	0.000	1.000
	Total	6	100	7	100		
26–30 years Female (n=4) Male (n=3)	Un-Fused	4	100	3	100	0.000	1.000
	Total	4	100	3	100		
31–35 years Female (n=5) Male (n=4)	Un-Fused	5	100	4	100	0.000	1.000
	Total	5	100	4	100		
36–40 years Female (n=5) Male (n=6)	Un-Fused	5	100	6	100	0.000	1.000
	Total	5	100	6	100		
41–45 years Female (n=6) Male (n=4)	Un-Fused	6	100	4	100	0.000	1.000
	Total	6	100	4	100		
46–50 years Female (n=4) Male (n=6)	Un-Fused	4	100	6	100	0.000	1.000
	Total	4	100	6	100		
51–55 years Female (n=4) Male (n=4)	Fused	2	50	0	0	2.667	0.102
	Un-Fused	2	50	4	100		
	Total	4	100	4	100		
56–60 years Female (n=6) Male (n=6)	Fused	2	33.34	3	50	1.200	0.549
	In Process	1	16.66	0	0		
	Un-Fused	3	50	3	50		
	Total	6	100	6	100		
61–65 years Female (n=3) Male (n=7)	Fused	3	100	7	100	0.000	1.000
	Total	3	100	7	100		
Above 65 years Female (n=7) Male (n=3)	Fused	7	100	3	100	0.000	1.000
	Total	7	100	3	100		

p-value > 0.05 is not statistically significant

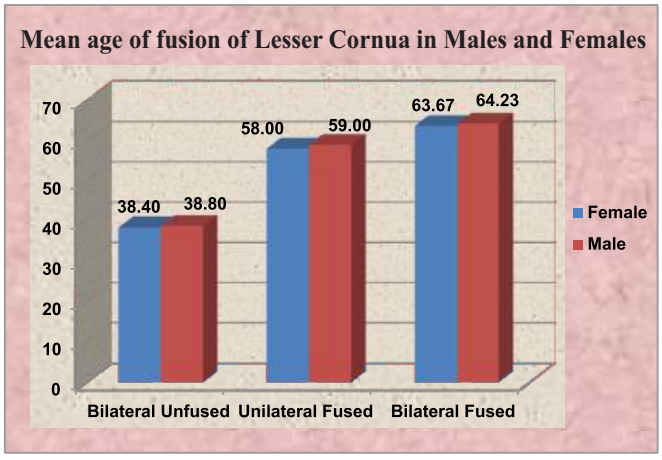


Table 8: Comparison of Status of Fusion of Lesser Cornua according to Gender in Different Age Groups

Lesser Cornua	Mean Age	Standard Deviation
Bilateral Un-fused	38.60	10.95
Unilateral Fused	58.40	2.97
Bilateral Fused	63.96	4.66
p-value	**0.001*** **	

One-way ANOVA test

***** Very Highly Significant difference**

p-value = 0.001 is very highly statistically significant

Table 9: Status of Unilateral Fusion of Lesser Cornua among Males & Females

Unilateral Fusion	Female		Male	
	(n)	(%)	(n)	(%)
Left Side Fusion	1	(50.0)	2	(75.0)
Right Side Fusion	1	(50.0)	1	(25.0)
Total	2	(100.0)	3	(100.0)

Table 10: Comparison of Status of Fusion of Lesser Cornua with Earlier Studies

Study	Earliest Age of Unilateral Fusion of Lesser Cornua (Years)	
	Female	Male
Parsons, 1909(London)[12]	>49	36
Harjeet et al, 2010 (North West India)[13]	41-50	36-40
Present Study	56-60	51-55

Study	Earliest Age of Bilateral Fusion of Lesser Cornua (Years)	
	Female	Male
Parsons, 1909(London)[12]	>49	>49
Harjeet et al, 2010 (North West India)[13]	41-50	36-40
Present Study	51-55	56-60

Table 11: Comparison of Percentage of Fusion of Lesser Cornua with Earlier Studies

Study	Earliest Age of Unilateral Fusion of Lesser Cornua (Years)	
	Female	Male
Harjeet et al, 2010 (North West India)[13]	38.9	36
Present Study	4	6
Study	Percentage of Bilateral Fusion of Lesser Cornua (%)	
	Female	Male
Harjeet et al, 2010 (North West India)[13]	27.8	36
Present Study	26	24

Table 12: Comparison of Fusion of Lesser Cornua among Males and Females

Study	Female			Male		
	(n)	Total	(%)	(n)	Total	(%)
Parsons, 1909 (London)[12]	1	28		7	53	13.2
Present Study	15	50		15	50	30

Table 13: Status of Fusion of Lesser Cornua in Subjects above 60 Years

Study	Age Group (> 60 years)					
	Female			Male		
	(n)	Total	(%)	(n)	Total	(%)
Harjeet et al, 2010 (North West India)[13]	3	3	100	9	9	100
Present Study	10	10	100	10	10	100

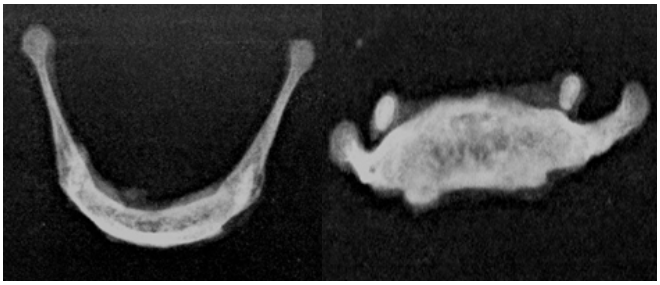


Image 1: Showing Bilateral Fusion of Greater Cornu and Non-fusion of bilateral Lesser Cornua in a 51 year old Male

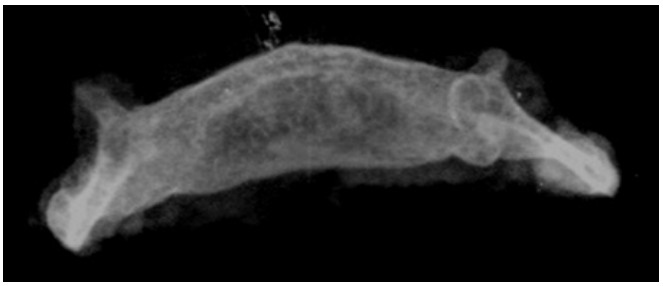


Image 2: Showing Bilateral Fusion of Greater Cornua and Lesser Cornua in a 68 year old Female

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00111.9

Original Research Paper

Effect of Electromagnetic Field Radiation at 2300 MHz on Wistar Rats

1. **Bhushanam Kasukurthi,** Ph.D Research Scholar,Department of Biotechnology,*
2. **VedParkash Sharma,** Senior Scientific Officer (Retd.), Department of Zoology, Panjab University, Chandigarh, India
3. **Ramkesh Dalal,** Ph. D Research Scholar, Department of Zoology, Panjab University, Chandigarh, India -160014.
4. **Harpreet Kaur,** Professor and Chairperson, Department of Zoology, Panjab University, Chandigarh, India -160014.
5. **Ushakiranmayi M,** Post Doctoral Fellow, Department of Botany and Microbiology
6. **Dindial Ramotar,** Maisonneuve-Rosemont Hospital, Research Center, Université de Montréal, Department of Medicine, 5415 Boul. de L'Assomption, Montréal, Québec H1T 2M4, Canada.
7. **Sudhakar Poda,** Assistant Professor, Department of Biotechnology,*

*Acharya Nagarjuna University, Guntur District Andhra Pradesh, India -522510.

ABSTRACT :

Introduction : In the past decades, mobile phones have been increasing the amount of non-ionizing radiations in the form of high electromagnetic field radiations (EMFr) in all of our living surroundings and believed to cause tissue injuries in both animals and plants. Many studies now are exploring the consequences of cellular phone EMFr on physical and chemical changes in animals.

Materials and Methods: We conducted experiments to study the biochemical consequences of 2300 MHz EMFr on wistar rats. Thirty six male albino adults were randomly divided into three sets and each set divided into test and control groups (Each group n=6, total six groups). The set I, II and III groups with controls were exposed to 2300 MHz irradiation for one hour per day according to their body weights for 30, 50 and 70 days, respectively. Blood serum was collected for all the groups to monitor for protein diminution and alkaline phosphatase (ALP) activity.

Results: Our data revealed that exposure to the irradiation caused significant ALP levels, which increased at ≥50 and ≥70 days. The exposed animals showed modest changes in the protein and ALP levels as well as reduced body weights. There were significant deviations observed in physiological parameters of the exposed animals such as food and water intake and body temperature when compared to the controls.

Conclusions: This study raised the possibility that constant usage of mobile phones likely to cause other abnormal tissue related problems.

Corresponding Author :
Dr. Sudhakar Poda,
Assistant Professor
Department of Biotechnology, Acharya Nagarjuna University,
Guntur District Andhra Pradesh, India -522510.
Contact : +91 90001-22929
Email : sudhakarpodha@gmail.com

Article History:
Received: 26 December 2019
Received in revised form: 2 February 2020
Accepted on: 2 February 2020
Available online: 30 April 2021

KEYWORDS : Irradiation complication, EMFr exposure, Protein studies, Alkaline phosphatase (ALP) activity, Physiological parameters, Deviations.

INTRODUCTION :

Cell phones have become an important part of our everyday life. It creates electromagnetic fields and increases electromagnetic pollution. Electromagnetic fields (EMF) produced by such devices affect all organisms regardless of their direction. In fact, chronic fatigue, headaches, cataracts, heart problems, stress, nausea, chest pain, memory, immune systems and sleeping can be affected. It is believed that the EMF interfere with the ionic equilibrium as well as generate reactive oxygen species (ROS) leading to the above symptoms (Jbireal, Azab et al. 2018). In recent years there has been an unprecedented rise in the global communications industry, which has increased the number of wireless devices. People suffer from continuous, low intensity radiation from these towers producing electromagnetic radiation, also called electro smog, which one cannot feel or smell (Sivani and Sudarsanam 2012). The EMF produced by mobile phones does not have direct impact on large bone parameters; however, it changes the bone mineral and the severity of bone turnover processes and thus affects bone mechanical strength. This reduces the content of calcium in bone and can result in harmful effects (Sieroń-Stołtny, Teister et al. 2015). Many clinics in Australia, India, USA and Iran report that mobile phones are often used to reduce sperm size and quality. Thus, EMF can interrupt endocrine signaling and cause infertility (Sepehrimanesh and Davis 2017; Sepehrimanesh,

Kazemipour et al. 2017). An experiment performed for two months from the egg to frog (Rana temporarium) until the advanced phase of tadpole before metamorphosis, showed excessive deaths (90%) in the exposed group (Balmori 2010). In this experiment, the dimensions of the electric field intensity (radio frequencies and microwave) were from 1.8 to 3.5 V/m in the V/m available with three different devices. In a separate experiment, the effects of low-level electromagnetic field (low-level EMF) was explored in rat cornea. Using histological and stereological techniques, the results of this study showed that radiation exacerbated changes in the mouse cornea (Balci, Devrim et al. 2007; Akar, Karayiğit et al. 2013). In addition, it can cause changes in the optic nerves in line with the deterioration observed in glaucoma (Joos, Li et al. 2010).

Constructive changes have been observed by electromagnetic waves (900, 1800 and 2450 MHz) in the brain frontal cortex, brain stem and cerebellum. The brain stem IL-1β was changed in size and contrast was observed (Eser, Songur et al. 2013).In fact these radiation caused injury to the blood generation system and other tissues causing high levels of oxidative stress (Moussa 2009). Since the launch of this technology in the 1990s, there have been concerns on particular brain function, particularly adverse health effects, and general public. The evidence that has been reported so far indicates that EMF can severely affect human health (Taki and Watanabe 2001). Mobile phone exposure has caused unstable changes in the protein expression levels of HSP27 and p38MAPKof cultured human endothelial cell line such as EA.hy926. It also caused alterations in protein phosphorylation levels, resulting in changes in signaling pathways (Leszczynski, Joenväärä et al. 2002).

In this study, we exposed rats to 2300 MHz irradiation over a period of 70 days and observed that the radiation caused physiological changes in the animals. There was a modest but significant reduction in body weigh as well as changes in the level of the oxidative sensitive protein alkaline phosphatase. We proposed that extensive mobile phone use can be detrimental and may lead to long term health problems.

MATERIALS AND METHODS:

Animal and Groups: A total of 36 male one month old Wister albino rats of weighing approximately 180 grams were selected for the study. The selected rates were unsystematically categorized into 6 clusters at the rate of 6 animals in each **(Table 1)**.

The animals were procured as per the animal ethical guidelines form NIN Hyderabad. Cluster 1, 2 and 3 was exposed with an EMFr (2300 MHz) for 1 hour each day up to 30 days (cluster 1), 50 days (cluster 2) and 70 days (cluster 3). All the exposed cluster was analyzed along with control cluster containing 6 animals each. All the test and control animal cluster were housed in cage made of transparent polycarbonate that was equipped with wood shaving bedding with 25°C to 28 °C temperature with light control (12 h of light and 12 h dark cycle) and humidity 64%. The animals were allowed access to food and water. All the test and control clusters were fed with same diet. The experiment was executed after completion of 15 days of the acclimatization period. The ethical clearance was taken from the animal ethical committee of Acharya Nagarjuna University (ANUCPS / IAEC / AH / P / 6/2016). The food pellets to feed the animals was purchased from National Institute of Nutrition (Indian Council of Medical Research), Hyderabad.

Table 1: Grouping of Animals

Cluster-1	(6 Animals)/Hour/30 days/ 2300 MHz	Control (6 Animals)
Cluster-2	(6 Animals)/Hour/50 days/ 2300 MHz	Control (6 Animals)
Cluster-3	(6 Animals)/Hour/70 days/ 2300 MHz	Control (6 Animals)

Here, each Test group n= 6 and; Control group n= 6

EMFr Source and mode of emission: The experiment was executed to analyze the effect of the time exposure of EMFr would cause the effects on the alkaline phosphatase enzyme levels and the total proteins of the animal. Each of the 3 cluster group animals along with the control animals for each cluster were caged separately to avoid the stress of isolation and overcrowding. The EMFr mobile device was fixed at the roof top of the rectangular treatment chamber. Each cluster group animals were exposed to an EMFr of 2300 MHz for 1 h for 30 day, 50 days and 70 days with a specific absorption rate of 0.726 W / kg in an exposure chamber. The treatment studies were executed between 10 am to 1 pm daily until the experiment is completed. **(Figure 1)**

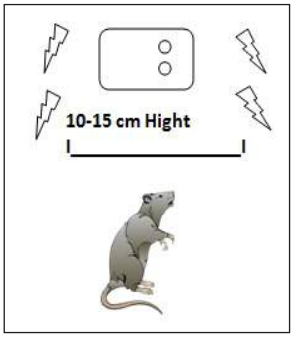


Figure 1 : **The above image shows the application of a 2300 MHz EMFr mobile hotspot at a height of 10-15 cm to rats.**

The exposure chamber is located away from other material that has the capacity to absorb the EMFr and also free from EMFr emitting devises (Awad and Hassan 2008; Al-Damegh 2012; Li, Shi et al. 2012).

The source of EMFr was a SIM (Subscriber Identity Module) card based device that is equipped with connector and battery of perpetual association 12v DC. A network based Wi-Fi

device (Series no. E5573s-606, IMEI No. 866079029004379) approved by Indian Telecom Administration that is industrially accessible and supports 2.5 GHz- 5 GHz.

Treatment chamber: The animal exposure to EMFr exposure is executed in a thermocol chamber that is designed with the air inflow bays and the windows were open with a gap each side so the animal has enough air circulation. The chamber at the top is equipped with lid that can be opened for placing the animals and also the chamber has enough space for free moving of the animals. The chamber on the outer sited is enclosed with Faraday shield. **(Figure 2-3)**

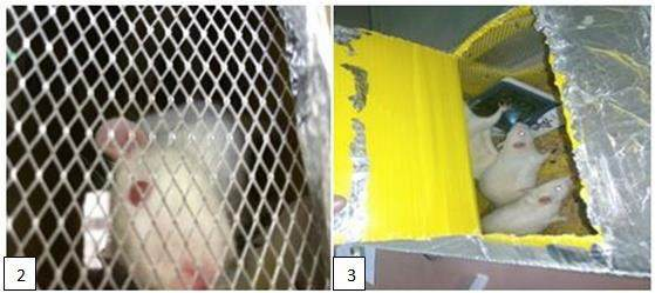


Figure 2 and 3 : Shows the aeration and top lid that can be opened for placing the animal inside the chamber.

The measurement of the treatment chamber 15x26x50 (height x width x length) (Sharma, Singh et al. 2009). **(Figure 4)**

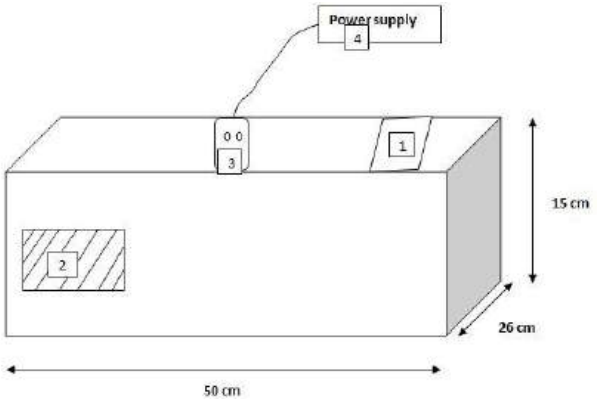


Figure 4 : Experimental chamber for EMR treatment (1) Upper lid for open and closing animals (2) Window for aeration (3) EMR Source (4G mobile Hot Spot) (4) Power Supply

All the test animals along with the control animals were sacrificed after 30, 50 and 70 days of EMFr treatment using gentle diethyl ether as an anesthesia.

EMFr meter and its implementations:

The EMFr detector for measuring the EMFr radiation was used or calculating electric and magnetic fields discharge at near distance in on door conditions only. This device was standardized to achieve the best and most positive test results. The device is equipped with an implicit electromagnetic radiation sensor, calculates the field magnitudes that is displayed on the LCD expressed as volts per meter (V/m) and microtesla (μT). The device can measure EMFr form 50 MHz to 3.5 GHz (Kivrak, Altunkaynak et al. 2017).**(Figure 5)**

Figure 5: The EMFr detector that is equipped on the treatment chamber.

From the sacrificed animals the organs and tissues such as eyes, brain, liver, kidney, and testis was aseptically collected and stored at -20°C for further study (EMFr radiation effect on the organs and tissues). The blood was collected employing the jugular vein, with the aid of sterile suction, and followed by separation of serum at 700 g for 10 min and stored at -20°C (Coleman, Spellman et al. 2000; Ragy 2015; Sharma and Shukla 2017).

Estimation of the protein by Lowry's method

The total protein assay of the serum collected from the blood of the test and control animals were deduced by employing the Lowry's method. Bovine serum albumin (BSA) powder (protein standard) was dissolved in distilled water and diluted to a concentration of 1 μg/μl. A series of dilutions (0, 1, 2.5, 5, 10, and 20 μg/well) were made in replicates of 4 with a final volume of 100 μl. Samples were diluted such that they would fall within the BSA standard range (0-25 μg / 100 μl) and 100 μl placed in each well. The micro plate with standards and samples were dispensed with 200 μl of biuret reagent and mixed thoroughly with repeated pipetting. The reaction suspension was incubated 10-15 minutes at room temperature which is followed by the addition of 20 μl per well of 1N FolinCiocalteu's reagent and incubated for 30 min for the development of the color. The color developed was measured at 650 nm in a micro plate reader (Eppendorf plate reader AF2200) while keeping the molecular grade water as blank. The reading were recorded immediately (Aitken, Bennetts et al. 2005; Agarwal, Desai et al. 2009; De Iuliis, Newey et al. 2009; Desai, Kesari et al. 2009; El-Bediwi, El-kott et al. 2011;

El-Bediwi, Saad et al. 2013).

Alkaline phosphatase assay:

The serum alkaline phosphatases (ALP) activity is determined by using p-Nitrophenol-phosphate as substrate and 0.02 N NaOH as inhibitor of the enzyme activity. The Phosphatase activity is directly proportional to the amount of p-nitrophenol liberated per unit time which is expressed in IU/L units. The total reaction suspension is having 0.1 ml of serum, 1.0 ml of buffer substrate solution (0.05 M glycine buffer and 5.5 x 10-3 M p-nitrophenyl-phosphate at pH 10.5). Then the reaction mixture was incubated at 37°C for 30 min. After incubation period, a yellow colored solution was observed. This is due to liberation of phosphate groups from substrate and form p-nitrophenol by the action of ALP. Then the reaction was inhibited by adding 10 ml of 0.02 N NaOH. Immediately the absorbance was measured at 400 nm in a micro plate reader (Eppendorf plate reader AF2200). The standard curve of absorbance versus p-nitrophenol concentration was generated and used to determine the concentration of phosphatases in sample (Bergmeyer, Bergmeyer et al. 1983; Dasgupta and Ghosh 1993; Parasuraman, Raveendran et al. 2010).

Statistical analysis:

Statistical analysis carried with Statistical Program of windows Microsoft Excel, version 7.0. Additional support has taken with online GraphPad Quick Calcs t- testCalculator. All the values of the measured parameters were expressed as mean value ± SD and the difference between the two groups was determined using unpaired student's t-test, and the statistically significance was considered at p values <0.05 (Daniels, Pitout et al. 2009; Noeman, Hamooda et al. 2011).

RESULTS:

Body temperature assessment:

Body temperature is a critical parameter to evaluate the wellbeing of laboratory animals (Vogel, Wagner et al. 2016; Mei, Riedel et al. 2018). For these experiments, the animals were first habituated for exploratory condition. The impartial encompassing temperatures for rats were below 30°C. In this study, a digital thermometer (DT) with a precision of ±0.1°C/0.2°F was used, which is a good alternative to the traditional glass mercury thermometer (GMT). Animal were taken into the hand and the DT sensor pointer embedded into the rectum with impressive profundity. Core rectal body temperatures were recorded before and after the treatment. Readings were noted each time on each treated group with an interval of one minute (Gerensea and Murugan 2016). The body temperatures did not show any significant differences in the exposed vs. the control animals, except for some small fluctuations that are considered to be within range. **(Figure 6)**

Figure 6: Monitoring body temperatures of the animals before and after exposure of EMFr.

2300 MHz did not affect the food and water intake, but decreases the body weight of the animals.

For the duration of the experiments, we recorded the food and water intake, as well as the body weight every three to four days under stress free condition by providing sufficient food and water (Smith 2000; Nayak and Chatterjee 2003; Ragy 2015). The rats chow/husk for all groups were consistently changed. **Figure 7 and 8** showed that exposure to the 2300 MHz of EMFr did not affect the animals food or water intake, respectively, but it started to cause a decrease in the animals weight after about 40 days **(Figure 9)**.

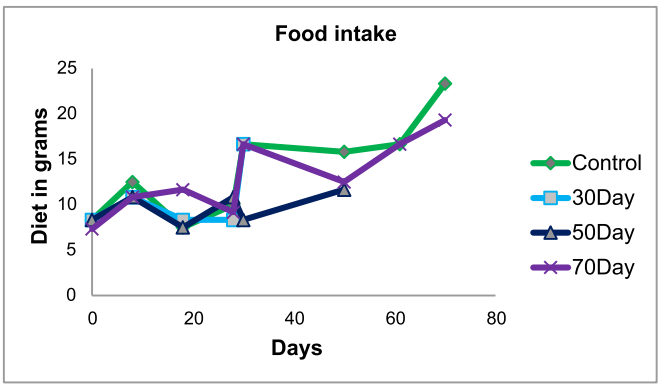


Figure 7: Comparison of the food intake between three studied groups versus control

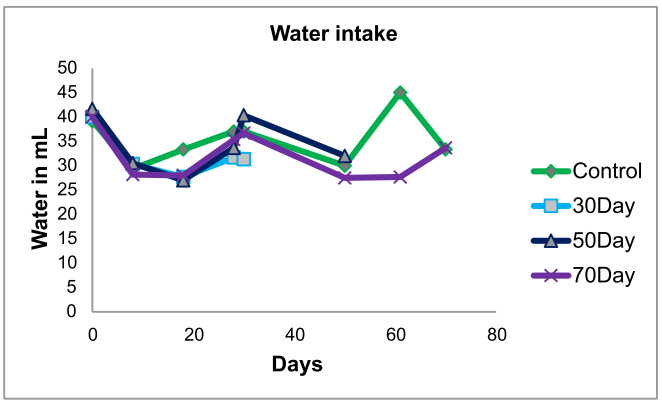


Figure 8: Comparison of the water intake between three studied groups versus control.

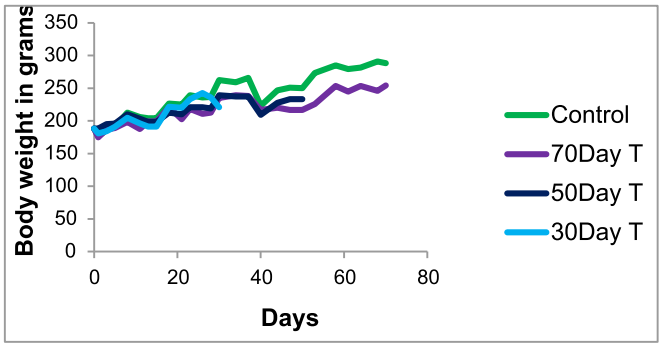


Figure 9: Comparison of the body weight between three studied groups versus control

Total protein in blood serum is unaffected by 2300 MHz.

Since the animals exposed to 70 days of EMFr showed a small but significant reduction in body weight, we checked if the radiation would alter the levels of the total protein in the serum. The data revealed that the total protein in the serum was unchanged, even after the 70 days of exposure to the radiation as compared to the untreated animals **(Table 2 and Figure 10)**. Thus, the radiation does not cause a general diminution of serum proteins.

Table 2 : Protein concentration in blood serum following EMFr exposure

Parameters	Protein estimation[a]	
No. of days	30 days	70 days
Control	4.2±0.9	4.0±0.4
EMR treated	4.5±0.2	3.9±0.4

Values are means of six observations ± SEM; [a]g/dL of blood serum.

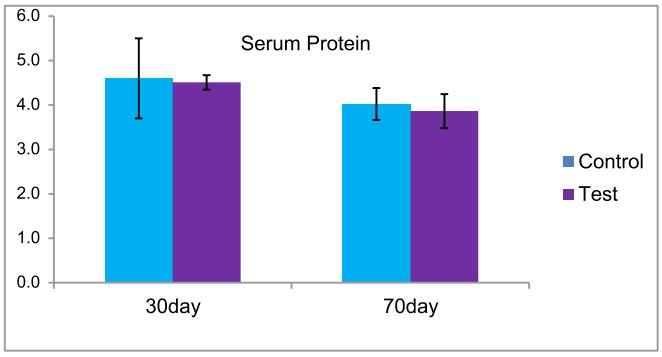


Figure 10: Comparison between the two studied groups as regards serum proteins.

Alkaline phosphatase level is induced by exposure to 2300 MHz.

Many cellular proteins are sensitive to oxidative stress caused by radiation and chemical oxidants. Upon oxidative stress, some proteins can change their cellular distribution, as well as increase or decrease their expression levels. One such protein is alkaline phosphatase (ALP) and its level has been reported to increase upon oxidative stress. ALP has the advantages over other damaged proteins because of relatively early formation, greater stability and reliability and longer half-life. As such, we examined whether the level of ALP would be altered following exposure to EMFr. **Table 3 and Figure 11** clearly showed that when the animals were challenged with 2300 MHz EMFr, the level of ALP increased more than 2-fold after 70 days of exposure.

Table 3 : EMFr exposure increases oxidation of alkaline phosphatase in the blood serum.

Parameters	Alkaline phosphatase[b]	
No. of days	30 days	70 days
Control	3.0±0.1	3.0±0.1
EMR treated	4.3±0.1*	6.7±1.0****

Values are means of six observations ± SEM. [b]mmoles units in serum.

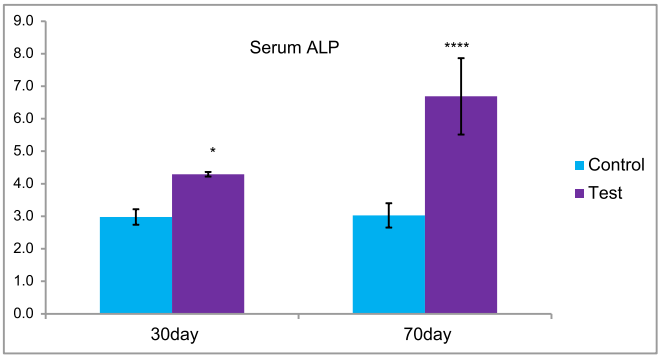


Figure 11: Comparison between the two studied groups as regards serum alkaline phosphatases.

DISCUSSION:

The observation that the rats showed a slight but significant decrease in body weight might be explained if the animals are diverting energy to re-synthesize proteins that are damaged by the radiation. We do not know if the consequences of the radiation would be more severe if the experiments were designed to extend beyond the 70 days, perhaps the animals could age faster.

EMFr does not have an instantaneous impact on organ failure on its own and it results in protein depletion tardily with the comparative parameters of physiological studies. However, EMFr alters the expansion and changes in the animal masses compared to sham-operated ones. The identical method, it affected different catalyst and biological reactions together with protein product formation. Hyperbolic body temperatures were not much varied. The best temperature, we have noted at ≥ 99.6°F, within the same method, 90 - 95.9°F before treatment of animal. We thought that this can be a very important

parameter for comparisons to different catalyst levels within the organs, with the impact of the daily treatment with EMR heat. EMFr recognized meter used for withdrawn of readings of average electric field value at 553.60 volts per meter (V/m) and magnetic field values are at 29.00 microtesla (μT). The average temperature and humidity in the treatment chamber noted regularly with digital temperature while on treatment continuously measured at 35.85°C with humidity of 13.09 %. As compared to the room temperature, it has shown at 33.3°C and humidity of 38.64%. We suggest that finding additional serum proteins could lead to a set of specific targets that can be collectively used to monitor the effects of EMFr.

Acknowledgments:

The authors acknowledge the support provided by UGC-RGNF, New Delhi, and late Prof. Upma Bagai, Department of Zoology, Panjab University, Chandigarh, 160014, India.

REFERENCES:

1. Jbireal, J., A. Azab, and A. Elsayed, Disturbance in haematological parameters induced by exposure to electromagnetic fields. Hematol Transfus Int J, 2018. 6(6): p. 242-251.
2. Sivani, S. and D. Sudarsanam, Impacts of radio-frequency electromagnetic field (RF-EMF) from cell phone towers and wireless devices on biosystem and ecosystem-a review. Biology and Medicine, 2012. 4(4): p. 202.
3. Sieroń-Stołtny, K., et al., The influence of electromagnetic radiation generated by a mobile phone on the skeletal system of rats. BioMed research international, 2015. 2015.
4. Sepehrimanesh, M. and D.L. Davis, Proteomic impacts of electromagnetic fields on the male reproductive system. Comparative Clinical Pathology, 2017. 26(2): p. 309-313.
5. Sepehrimanesh, M., et al., Proteomic analysis of continuous 900-MHz radiofrequency electromagnetic field exposure in testicular tissue: a rat model of human cell phone exposure. Environmental Science and Pollution Research, 2017. 24(15): p. 13666-13673.
6. Balmori, A., Mobile phone mast effects on common frog (Rana temporaria) tadpoles: the city turned into a laboratory. Electromagnetic Biology and Medicine, 2010. 29(1-12): p. 31-35.
7. Akar, A., et al., Effects of low level electromagnetic field exposure at 2.45 GHz on rat cornea. International Journal of Radiation Biology, 2013. 89(4): p. 243-249.
8. Balci, M., E. Devrim, and I. Durak, Effects of mobile phones on oxidant/antioxidant balance in cornea and lens of rats. Current Eye Research, 2007. 32(1): p. 21-25.
9. Joos, K.M., C. Li, and R.M. Sappington, Morphometric changes in the rat optic nerve following short-term intermittent elevations in intraocular pressure. Investigative ophthalmology & visual science, 2010. 51(12): p. 6431-6440.
10. Eser, O., et al., The effect of electromagnetic radiation on the rat brain: an experimental study. Turkish neurosurgery, 2013. 23(6): p. 707-715.
11. Moussa, S., Oxidative stress in rats exposed to microwave radiation. romanian J. Biophys, 2009. 19(2): p. 149-158.
12. Taki, M. and S. Watanabe, Biological and health effects of exposure to electromagnetic field from mobile communications systems. IATSS research, 2001. 25(2): p. 40-50.
13. Leszczynski, D., et al., Non-thermal activation of the hsp27/p38MAPK stress pathway by mobile phone radiation in human endothelial cells: molecular mechanism for cancer-and blood-brain barrier-related effects. Differentiation, 2002. 70(2-3): p. 120-129.
14. Al-Damegh, M.A., Rat testicular impairment induced by electromagnetic radiation from a conventional cellular telephone and the protective effects of the antioxidants vitamins C and E. Clinics, 2012. 67(7): p. 785-792.
15. Awad, S.M. and N.S. Hassan, Health Risks of electromagnetic radiation from mobile phone on brain of rats. J. Appl. Sci. Res, 2008. 4(12): p. 1994-2000.
16. Li, Y., et al., Effects of electromagnetic radiation on spatial memory and synapses in rat hippocampal CA1. Neural regeneration research, 2012. 7(16): p. 1248.
17. Sharma, V.P., et al., Mobile phone radiation inhibits Vigna radiata (mung bean) root growth by inducing oxidative stress. Science of the Total Environment, 2009. 407(21): p. 5543-5547.
18. Kivrak, E.G., et al., Effects of 900-MHz radiation on the hippocampus and cerebellum of adult rats and attenuation of such effects by folic acid and Boswellia sacra. Journal of Microscopy and Ultrastructure, 2017. 5(4): p. 216-224.
19. Coleman, T., et al., The 1′-hydroxylation of Rac-bufuralol by rat brain microsomes. Drug metabolism and disposition, 2000. 28(9): p. 1094-1099.
20. Ragy, M.M., Effect of exposure and withdrawal of 900-MHz-electromagnetic waves on brain, kidney and liver oxidative stress and some biochemical parameters in male rats. Electromagnetic Biology and Medicine, 2015. 34(4): p. 279-284.
21. Sharma, S. and S. Shukla, Effect Of Electromagnetic Radiation On Vital Organs In Rats. Octa Journal of

Biosciences, 2017. 5(1).

22. El-Bediwi, A., et al., Effects of electromagnetic radiation produced by mobile phone on some visceral organs of rat. J Med Sci, 2011. 11(6): p. 256-260.
23. El-Bediwi, A.B., et al., Influence of electromagnetic radiation produced by mobile phone on some biophysical blood properties in rats. Cell biochemistry and biophysics, 2013. 65(3): p. 297-300.
24. Agarwal, A., et al., Effects of radiofrequency electromagnetic waves (RF-EMW) from cellular phones on human ejaculated semen: an in vitro pilot study. Fertility and sterility, 2009. 92(4): p. 1318-1325.
25. Aitken, R.J., et al., Impact of radio frequency electromagnetic radiation on DNA integrity in the male germline. International journal of andrology, 2005. 28(3): p. 171-179.
26. De Iuliis, G.N., et al., Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. PloS one, 2009. 4(7): p. e6446.
27. Desai, N.R., K.K. Kesari, and A. Agarwal, Pathophysiology of cell phone radiation: oxidative stress and carcinogenesis with focus on male reproductive system. Reproductive Biology and Endocrinology, 2009. 7(1): p. 114.
28. Parasuraman, S., R. Raveendran, and R. Kesavan, Blood sample collection in small laboratory animals. Journal of pharmacology & pharmacotherapeutics, 2010. 1(2): p. 87.
29. Bergmeyer, H., J. Bergmeyer, and M. Grassl, Methods of enzymatic analysis vol. VI, 3rd edn. Verlag Chemie. 1983, Weinheim.
30. Dasgupta, S. and S. Ghosh, Nicotine induced alterations in brain acid and alkaline phosphatase activities. Ind J Physiol Allied Sci, 1993. 47: p. 200-6.
31. Daniels, W.M., et al., The effect of electromagnetic radiation in the mobile phone range on the behaviour of the rat. Metabolic brain disease, 2009. 24(4): p. 629-641.
32. Noeman, S.A., H.E. Hamooda, and A.A. Baalash, Biochemical study of oxidative stress markers in the liver, kidney and heart of high fat diet induced obesity in rats. Diabetology & metabolic syndrome, 2011. 3(1): p. 17.
33. Mei, J., et al., Body temperature measurement in mice during acute illness: implantable temperature transponder versus surface infrared thermometry. Scientific reports, 2018. 8(1): p. 3526.
34. Vogel, B., et al., Touch-free measurement of body temperature using close-up thermography of the ocular surface. MethodsX, 2016. 3: p. 407-416.
35. Gerensea, H. and R. Murugan, Is There Significant Difference between Digital and Glass Mercury Thermometer? Advances in nursing, 2016. 2016.
36. Nayak, P. and A.K. Chatterjee, Dietary protein restriction causes modification in aluminum-induced alteration in glutamate and GABA system of rat brain. BMC neuroscience, 2003. 4(1): p. 4.
37. Smith, G.P., The controls of eating: a shift from nutritional homeostasis to behavioral neuroscience. Nutrition, 2000. 16(10): p. 814-820.
38. Guo, Z., et al., ATM activation by oxidative stress. Science, 2010. 330(6003): p. 517-521.
39. Azam, S., et al., Human glyceraldehyde-3-phosphate dehydrogenase plays a direct role in reactivating oxidized forms of the DNA repair enzyme APE1. Journal of biological chemistry, 2008. 283(45): p. 30632-30641.
40. Elwasife, K.Y., et al., Analysis of the Biochemical Parameters of Liver, Kidney Functions and Thyroid Stimulated Hormone in Children after Exposure to Mobile Phone Base Station Radiation and Therapeutic Action of Olive Oil. Analysis of the Biochemical Parameters of Liver, Kidney Functions and Thyroid Stimulated Hormone in Children after Exposure to Mobile Phone Base Station Radiation and Therapeutic Action of Olive Oil, 2017. 25(2).

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00112.0

Original Research Paper

Analysis of Fatal Road Traffic Accidents In A Township of South India

1. **Ashwini Kumar,** Associate Professor, Department of Forensic Medicine & Toxicology*
2. **Baishwanar Banerjee,** Post Graduate Student, Department of Forensic Medicine & Toxicology*
3. **Arjun M S,** Tutor, Department of Forensic Medicine & Toxicology*
4. **Anitta Joseph,** Tutor, Department of Forensic Medicine & Toxicology*
5. **Vinod C Nayak,** Professor and Head, Department of Forensic Medicine & Toxicology*
6. **Sowmya Shashidhara,** Assistant Professor, Department of Paediatrics*

*Kasturba Medical College, Manipal, Manipal Academy of Higher Education, Manipal

ABSTRACT:

Road traffic accidents have been one of the most significant public health issue due to its frequency of occurrence and increasing vehicle density, worldwide. With the aim of considering the socio segment profile of road traffic casualties, the forerunner factors influencing road traffic accidents and to decide the different components influencing demise rate following road traffic accidents, this retrospective study of medico – legal autopsies was conducted during October 2014 and October 2016 at the Department of Forensic Medicine & Toxicology, Kasturba Medical College Udupi District, Karnataka, South India. For the purpose of this study, autopsy files and inquest documents provided by the investigating officer were studied in detail and the data collected was analyzed using the statistical software SPSS version 11.0. Among the victims, 62.9% were males and 37.1% were females with male: female ratio of 2:1. The mean age of the casualties were 43.73 years and age bunch between 21 to 60 years were considered as casualties for the significant portion of road traffic fatalities. 31.13 % of the victims were pedestrians and 68.87% were vehicular occupants. 64.57 % of the victims travelled in the vehicle without using any safety measures. It was observed that tertiary health care (68.54%) had major effect on death rate followed by secondary (29.14%) and then primary health care (2.32%). Head injury alone was liable for nearly three-fourth of road traffic loss of life followed by abdominal injuries (29.8%) and wounds to the limbs (0.33%). The above findings show that road traffic accidents are a public health concern and there is a need to address this with health education, betterment of the roads, stricter enforcement of the traffic laws and expanding the system responding to health care emergencies.

Corresponding Author :
Dr. Ashwini Kumar
Associate Professor,
Department of Forensic Medicine & Toxicology, Kasturba Medical College, Manipal, Manipal Academy of Higher Education, Manipal
Contact : +91 99641-39848
Email:kumar.ashwini@manipal.edu

Article History:
Received: 26 May 2020
Received in revised form: 12 August 2020
Accepted on: 12 August 2020
Available online: 30 April 2021

KEYWORDS :

INTRODUCTION :

Road traffic accidents have been one of the most significant public health issue due to its frequency of occurrence and increasing vehicle density, worldwide. Road accidents have been on the radar of international agencies like the World Health Organization which designated the theme of World Health Day in 2004 as "Road Safety is no accident". "The Global status report on road safety 2018, launched by WHO in December 2018, highlights that the number of annual road traffic deaths has reached 1.35 million. Road traffic injuries are now the leading killer of people aged 5-29 years. The burden is disproportionately borne by pedestrians, cyclists and motorcyclists, in particular those living in developing countries. The report suggests that the price paid for mobility is too high, especially because proven measures exist"[1].

It has been found that "nearly 97% of road traffic accidents globally" occur in low and middle income nations which have only around 48% of the registered vehicles.[2] Being a developing country, the health resources in India are overburdened under the double weight of communicable diseases and non-communicable diseases like road traffic accidents. [2] Presently, road traffic accidents occupy the 9th position among 100 important causes of death. However, future predictions indicate that road traffic accidents will move up to 6th place in this list and as a contributor to mortality and in terms of Years of Life Lost and disability adjusted life years will occupy the second and third slots by the year 2020. [2]

Road traffic accidents occur due to a variety of factors involving the driver, road, vehicle and sometimes an unsuspecting innocent victim. A combination of various

factors relating to the roads, environment, vehicles, road users and the way they interact with each other contributes to the occurrence of road traffic accidents. Few factors contribute to the cause of the accident and some others to the severity of trauma. Some others are immediate causes and might not be attended to due to other short and long term structural causes. Identifying the factors that contribute to road traffic accidents is important in identifying interventions that can reduce the risk associated with those factors.

In developing nations like India, increasingly huge growth in the number of motor vehicles and infrastructural constraints such as unequal accessibility to health care services and bad road conditions influence the mortality rates from road traffic accidents. In India there is an accident every minute and death every 8 minutes with variations between different states of India. Hence, a detailed analysis of the various aspects in the epidemiology of road traffic accidents is of paramount importance. [2] A detailed analysis of age and gender based variations in the pattern of road traffic accidents has been reported. [2] The present dissertation presents a detailed profiling of fatal road traffic accident victims in the region and provides insights into the cause of death of victims in road traffic accidents, type of injuries sustained, age and sex distribution of the victims, period of survival and type of offending vehicle involved. [2]

AIMS AND OBJECTIVES :

- To study the socio demographic profile of Road traffic accident victims.
- To determine the various factors affecting mortality following Road Traffic Accidents.
- To recommend measures to reduce mortality rates following Road Traffic Accidents.

MATERIALS AND METHODS :

The present research is a retrospective analysis of medico-legal autopsies conducted during October 2014 and October 2016 at the Department of Forensic Medicine & Toxicology, Udupi District, Karnataka, South India. Institutional ethics committee approval was taken prior to the study. For the purpose of study, a victim of road traffic accident was defined as "Persons involved in an accident which took place on road (including the sidewalk or footpath) between two or more objects, one of which must be any kind of moving vehicle".

Medico-legal autopsies in India are carried out on requisition by the police or the magistrate with a primary aim to reveal the cause of death and to decide if the cause of death is in accordance with the postulated manner of death. All the medico-legal autopsies are recorded in post-mortem register. Recorded details include name, age, sex, address, information, furnished by the police in the inquest papers, autopsy findings, investigations if any, and cause of death. All the fatal road traffic accidents were included in the study. The inclusion and exclusion criteria are as follows:

Inclusion criteria: Victims of road traffic accidents seeking care at Kasturba Hospital, Manipal.

Exclusion criteria: Victims brought dead due to road traffic accidents.

The autopsy files and inquest documents provided by the investigating officer were studied in detail. The following details were captured in the proforma for data collection - name, age, sex, victims vehicle, safety measures used, health care facility utilized, type of injury and cause of death. The information obtained from the autopsy case files and information furnished by the police was registered in a database and analysed using the statistical software (SPSS version 11.0).

RESULTS & DISCUSSION :

An aggregate of 302 medico legitimate post-mortem examinations were performed during the investigation time frame (October 2014-October 2016). Road traffic accidents accounted for most cases and their measure of central tendency for age is shown in **Table 1**. The mean age of the victims were 43.73 years, median age was 44 years and the mode were 52 years with a standard deviation of 13.91. The minimum age was found to be 3 and the maximum age was found to be 76 for the present study.

Table 1: Measure of Central Tendency for Age of RTA Victims

		AGE
N	Valid	302
Mean		43.73
Median		44.00
Mode		52.00
Std. Deviation		13.91
Minimum		03.00
Maximum		76.00

The frequency distribution of the age of the RTA casualties is appeared in **Table 2**. In the current examination, number of casualties beneath 10 years were 2 in number (0.7%), victims between 11 to 20 years were 7 in number (2.3%), victims between 21 to 30 years were 48 in number (15.9%), victims between 31 to 40 years were 69 in number (22.8%), victims between 41 to 50 years were 67 in number (22.2%), victims between 51 to 60 years were 73 in number (24.2%), victims between 61 to 70 years were 33 in number (10.9%) and the victims between 71 to 80 years were 3 in number (1%).

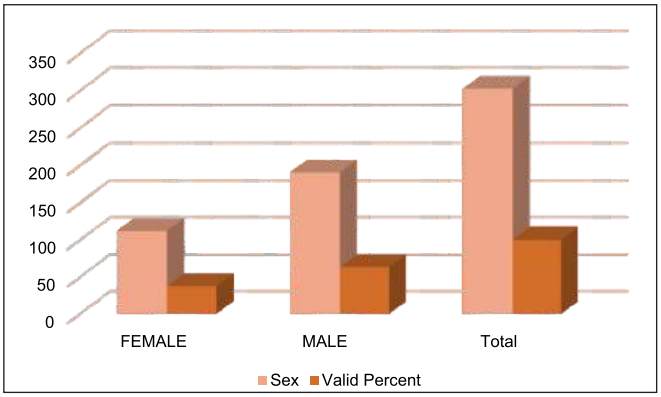
Table 2: The Frequency Distribution of Ages of the RTA victims

AGE	Victims	Valid Percent
<10	2	0.7
11-20	7	2.3
21-30	48	15.9
31-40	69	22.8
41-50	67	22.2
51-60	73	24.2
61-70	33	10.9
71-80	3	1
Total	302	100

The investigation led by ministry of road transport research wing in the year 2012 uncovers that the age gathering (25-65 years) represented the biggest portion of 53.1 percent of complete road traffic mishap setbacks, trailed by the age gathering (15-24 years) with a portion of 32.3 percent. The greater part of the road traffic casualties are in the wage earning age group. The loss of the principle procuring part can be lamentable, prompting fall in salary of the family and settle for what is most convenient option. This investigation is in consonance with the current examination for the age gathering (21-60 years) which uncovers that the age bunch between 21 to 60 years represented the biggest portion of road traffic accident casualties. The people of the utmost active and productive age bunch are associated in road traffic incidents. Comparable remarks were likewise seen in the investigations made by Mishra B et al [3], Bener A [4], Ghimamire et al [5], Guru raj G et al [6], Rakhi Dandona et al [7], Jirojwang S [8], WHO [9] in the Injury Chart Book and Agarwal et al [10], Khare N et al [11]. This can be credited to the way that this specific age bunch is an increasingly visit street client because of instructive and job-related purposes. Comparative outcomes were additionally seen in studies done at by Hangar N et al [12] and Nilambar Jha et al [13] in the year 1991 and 2004 separately. In this investigation, individuals belonging to old age group contained the minimum number of cases. Least cases in old individuals might be because of more information and knowledge, aptitude, experience, more traffic sense, less inclination to face pointless challenges and might be remained for the most part inside ideally at homes and lead less active life. Lesser involvements of children below 10 years may be because some senior or elder member of the family might have accompanied them on road. Drivers and riders belonging to young age are in more danger of crash mishaps. Young individuals continually will in general be presumptuous, haughty, over hopeful, less experienced, run with rapid. Pointless travel and moonlight trip and decision of less protected travel modes are a propensity with youths. Our findings in this study were not in agreement with the study conducted in the year 1964 by Gissane and Bull [14] who watched higher event of street auto collisions in people over 60 years. Generally, the greater part of casualties (half) were in the age gathering of 21-60 years in present examination. This might be because of the condition that individual of this age bunch drives progressively enthusiastic life, increasingly transportable and go out for work and keep themselves out-of-entryways more often than not.

Gender wise distribution of road traffic accident victims are shown in **chart 1**. In the current examination, the number of male casualties were 190 (62.9%) and the number of female casualties were seen as 112 (37.1%). This demonstrates the way that the greater part of the road traffic mishap casualties were prevalently male (62.9%) and male: female proportion was 2:1. Female casualties in the present investigation represented 37.1 % exhibiting the male pre-predominance of greater versatility in the Indian Context.

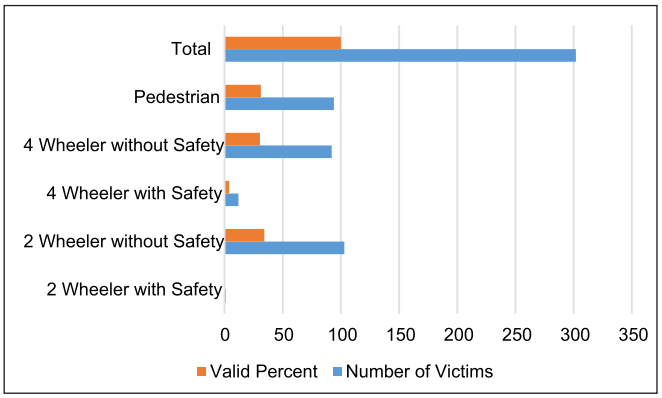
Chart 1: Graphical Representation of Gender Wise Distribution of RTA Victims



Trauma victims were mostly male (84.3%) in a study conducted by Meyyappan et al [15] in the year 2018. There were 92 male victims (40.89%) and 32 female victims (14.22%) of road traffic accidents and the males outstripped the females in totality and male to female proportion was 3.60:1 in an investigation conducted by Shruthi P et al [16] in the year 2013. Choudhary, B. L et al [17] in the year 2005 conducted a study in Maharashtra and concluded that maximum cases of road traffic accidents were among males (83.20%). A study by Kanchan T et al [18] on road traffic mishaps in the year 2012 also revealed that 89.2% victims were male, and 10.8% victims were females and the male-female proportion in road traffic accidents was 8.3:1. These facts from various investigations are perfect with the current examination which shows the male transcendence in road traffic collisions. Males being the breadwinner in standard of family are exposed more frequently to outside work than females. This explains the association of most extreme number of males in road traffic collision deaths.

Factors at the incident site affecting mortality is shown in **chart 2**. In the present study, the factors at the incident site refers to those factors which victims might have followed or not followed as a safety measures during their travel. 'With Safety' denotes that the victim might have followed safety measures by wearing helmet /seat belt or any other thing during the travel. 'Without Safety' denotes that the victim might have not followed safety measures (no helmet or seat belt). 'Pedestrian' denotes a person walking rather than travelling in a vehicle. The number of victims for 'Two wheeler with safety' were 1 (0.33%), 'Two wheeler without safety' were 103 (34.11%), 'Four wheeler with safety' were 12 (3.97%), 'Four wheeler without safety' were 92 (30.46%) and for 'Pedestrian' were 94 (31.13%).

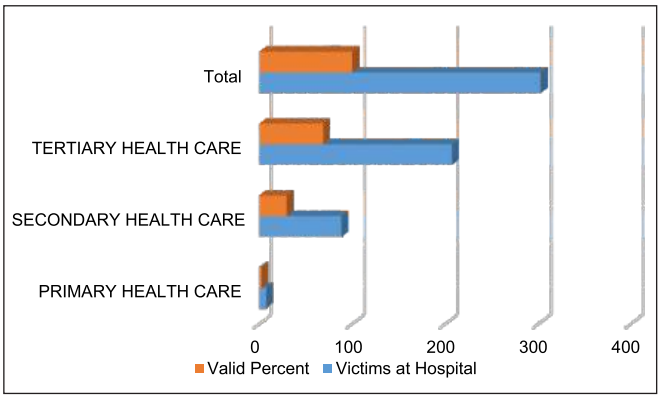
Chart 2: Graphical Representation of Factors at the Incident Site Affecting Mortality



A research study, in the year 2013, conducted by Shruthi P et al [16] showed indicated that among the kinds of culpable vehicle engaged with RTA, four-wheeler was seen to be the perpetrator. It revealed the irresponsible driving of four-wheeler vehicle by untrained people (without security). An expansion in the quantity of substantial engine vehicles (government city transports and others) and stuffed limited streets add to a similar actuality. The second significant executioner was the bikes. One more important aspect of the study showed that most victims were pedestrians. Studies led by Khajuria B et al (2008) [19] and Singh R et al (2011) [20] additionally announced people on foot as the one of the standards of casualties associated with road traffic collisions, as detailed in the present examination. Also, few similar findings related to the reckless driving of four-wheeler vehicle was reported in a research conducted by Vorel F et al [21] in the year 1993. Another examination by Kanchan T et al [18], in the year 2012, clarified that occupants of mechanized bikes and people on foot were the most well-known casualties of deadly road traffic mishaps followed by inhabitants of light engine vehicles (LMVs), substantial engine vehicles (HMVs) and pedal cyclists. The LMVs included cars, vehicles, vans and jeeps, while the HMVs included transports, trucks, lorries, tractors and big haulers. The most well-known felonious specialists in road traffic mishaps were overwhelming engine vehicles followed by light engine vehicles and bikes. Morais Neto OL et al [22] conducted a study in the year 2010 which revealed that nearly 50% of motorcycle riders were not wearing helmets as a safety measure at the time of road traffic accidents. The study in the year 2011 was conducted by Rawal D [23] on road traffic accidents and found that only few people (11.5%) are using helmets habitually while driving bikes (two wheelers) that mean 88.5 % were not following safety measures during driving. Another study conducted by Jha et al [24] had shown that 29% of the 2-wheeler riders were wearing helmets as safety measures and majority (71%) of them were not wearing helmet as protective measure. The vast majority of the vehicle inhabitants had not worn any safety belt. Research Studies in Bangalore by Guru Raj G et al [6] in the year 2005 and, Ganveer G B, Tiwary R [25] in the year 2005 and Harnam S and Dhattarwal SK [26] in the year 2004 had likewise indicated that drivers were not utilizing security measures. About 52% drivers don't have the information and insights about security measures and this might be one of the clarifications for not utilizing the wellbeing measure before the road traffic crashes. The intentions in not utilizing security measures might be nonappearance of reality about the utilization, feels awkward, numbness, absence of firm execution of enactment. These realities reflect the obliviousness of wellbeing measures, traffic rules and traffic signal, talking over the cell phones, absence of appraisal of speed of the vehicle by the people on foot and poor lighting of lanes.

Level of health care and its effect on mortality is depicted in **chart 3**.

Chart 3: Graphical Representation of Level of Health Care and its Effect on Mortality

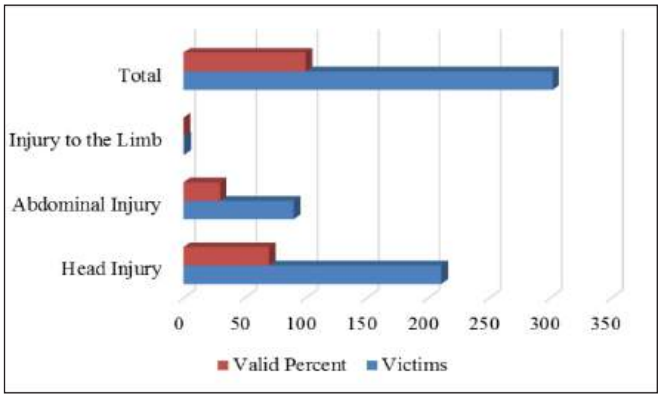


The victims of road traffic accidents were divided into three levels of health care for their treatment based on the severity and risk – primary, secondary and tertiary health care. The

number of victims under primary health care were 7 (2.32%), secondary health care was 88 (29.14%) and tertiary health care were 207 (68.54%). It was observed that tertiary health care had major effect on death rate followed by secondary and then primary. This indicates that victims with severe trauma like head injury, abdominal injury and limb injury were referred to secondary and tertiary health care for treatment. With reference to the study conducted by Shruthi P et al [16] , among 151 casualties, more than three-fourth of them experienced explicit operational techniques (secondary and tertiary health care services) in light of hazard elements and seriousness (removal, break decrease, ICD and so on) and 18.54 % of the casualties got general treatment (essential and primary medicinal services). These outcomes are as per the accordance of the current examination.

A total of 302 medico legal autopsies were performed during the study period (October 2014-October 2016) and was categorized into three divisions namely head injury, abdominal injury and injury to the limb. In this study, about 211 victims reported head injuries, 90 victims reported abdominal injuries and 1 victim reported injury to the limb which means the valid percent of the incidence of head injury was 69.87%, abdominal injury was 29.8% and injury to the limb was 0.33% respectively as shown in **chart 4**.

Chart 4: Graphical Representation of Autopsy Findings in the Victims



A study conducted by Meyyappan, A., Subramani, P., & Kaliamoorthy, S. [15] in the year 2018 on 'A comparative data analysis of 1835 road traffic accident victims' revealed that the incidence of head injury was 47.5% (872 victims out of 1835 victims) and this is in consonance with the findings of the present study. Another study by Chaudhary B L, et al [17] revealed that injury to two and in excess of two body regions(head, chest and appendages) were found in greater part of cases (37.33%).On considering injury to one body locale as the significant reason for death, head injury cases exceeded the rest (30.22%). A study on "Analysis of Fatal Road Traffic Accidents in a Metropolitan City of South India" was conducted by Shruthi P et al [16] in the year 2013 and it was seen that wounds to two and further body areas (head, chest and appendages) were found in a large portion of the cases (37.33%) trailed by head injury (30.22%) of the complete number of cases. The origin of death was preached to be hemorrhagic stun in 142 cases (63.11%), trailed by head injury (30.22%). Head injury alone remained the most well-known reason for death, that was answerable for three-fourth of road traffic fatalities followed by stomach wounds and wounds to the appendages that were liable for 6.7% and 5.2% fatalities respectively in an examination directed by Kanchan T et al [18] in the year 2012. This investigation is in consonance with the current examination.

SUMMARY AND CONCLUSION :

Road traffic accidents are on the intensification, globally. To summarize, the mean age of the casualties were 43.73 years and age bunch between 21 to 60 years were considered as casualties for the significant portion of road traffic fatalities though more elderly individuals represented least number of road traffic accident cases. The maximum cases of road traffic accidents were among males compared to females. Factors at the incident site affecting mortality was found to be 'Two-wheeler without safety ,four-wheeler without safety and pedestrian' which mirror the obliviousness of wellbeing measures, traffic rules and traffic signal, talking over the cell phones, absence of evaluation of speed of the vehicle by the people on foot and poor lighting of boulevards. It was observed that tertiary health care had major effect on death rate followed by secondary and then primary health care. Head injury alone remained the most widely recognized reason for death, that was liable for three-fourth of road traffic loss of life followed by stomach wounds and wounds to the limbs.

Acknowledgement :

Dr Honnegowda Thittamaranahalli Muguregowda, Associate Professor, Department of Anatomy, Kannur Medical College, Kannur, Kerala.

REFERENCES:

1. https://www.who.int/publications-detail/global-status-report-on-road-safety-2018 as accessed on 20-05-2020
2. Kanchan, T., Kulkarni, V., Bakkannavar, S. M., Kumar, N., & Unnikrishnan, B. (2012). Analysis of fatal road traffic accidents in a coastal township of South India. Journal of forensic and legal medicine, 19(8), 448-451.
3. Badrinarayan Mishra, Nidhi D Sinha (Mishra), SK Sukhla, AK Sinha. Epidemiological Study of Road Traffic Accident Cases from Western Nepal: Indian Journal of

Community Medicine 2010 January;35(1).

4. Bener A, Burgut HR, Sidahmed H, Albuz R, Sanya R, Khan WA. Road traffic injuries and risk factors. Californian journal of Health Promotion 2009; 7(2):91-100.
5. Ghimire A, Nagesh S, Jha N, Niraula SR, Devkota s. An epidemiological study of injury among urban population, Kathmandu university medical Journal 2009.
6. Guru raj G, Kolluri SVR, Chandramouli BA, Subbakrishna DK, Kraus JF. Traumatic Brain Injury. National Institute of Mental Health & Neuro Sciences 2005; Publication no. 61.
7. Dandona R, Mishra A. Deaths due to road traffic crashed in Hyderabad city in India: need for strengthening surveillance. *Natl Med J India*. 2004;17(2):74-79.
8. Jirojwong S, Rudtanasudjatum K, Watcharavitoon P, Sathitsathien W, Sangjun S. Non-Fatal Injuries Sustained In Road Traffic Accidents: A Pilot Study Inprovincial Hospitals In Chon Buri, Thailand. Southeast Asian J Trop Med Public Health 2002;33(1):193-200.
9. World Health Organization. World report on road traffic injury prevention. Geneva: WHO 2004: 3-29
10. Agarwal A et al. Sociodemographic profile of road traffic accident victims admitted at emergency surgical OPD of a tertiary care hospital. Journal of post graduate medicine, education and research 2012 January-March; 46(1):15-18.
11. Khare N, Gupta SK, Varshney A, Athavale AV. Epidemiological Study of Road Traffic Accident Cases Attending Tertiary Care Hospital, in Bhopal Madhya Pradesh. Natl J Community Med 2012;3(3):395-9.
12. Hangar N, Khan MY, Zaheer M, Sinha SNS, Khan A, Dhingra M. Road traffic management- A national strategy 1991. Proceedings of the International Conference on Traffic Safety, New Delhi, India 1991:27-30.
13. Nilambar Jha et al. Epidemiological study of road traffic accident cases: a study from south India. Indian Journal of Community Medicine 2004 Jan- Mar;29(1).
14. Gissane, W., & Bull, J. (1964). Study of Motorway (M. 1) Fatalities. British medical journal, 1(5375), 75.
15. Meyyappan, A., Subramani, P., & Kaliamoorthy, S. (2018). A Comparative Data Analysis of 1835 Road Traffic Accident Victims. *Annals of maxillofacial surgery*, *8*(2), 214–217. https://doi.org/10.4103/ams.ams_135_18
16. Shruthi, P., Venkatesh, V. T., Viswakanth, B., Ramesh, C., Sujatha, P. L., & Dominic, I. R. (2013). Analysis of fatal road traffic accidents in a metropolitan city of South India. Journal of Indian Academy of Forensic Medicine, 35(4), 317-320.
17. Choudhary, B. L., Deepak, S., Tirpude, B. H., Sharma, R. K., & Veena, M. (2005). Profile of road traffic accidents cases in Kasturba hospital of MGIMS, Sevagram, Wardha, Maharashtra, India. Med Legal Update, 5, 1-12.
18. Kanchan, T., Kulkarni, V., Bakkannavar, S. M., Kumar, N., & Unnikrishnan, B. (2012). Analysis of fatal road traffic accidents in a coastal township of South India. Journal of forensic and legal medicine, 19(8), 448-451.
19. Khajuria, B., Sharma, R., & Verma, A. (2008). A profile of the autopsies of road traffic accident victims in Jammu. Journal of clinical and diagnostic research, 2(1), 639-642.
20. Singh, R., Bhatnagar, M., Singh, H. K., Singh, G. P., & Kumar, Y. (2011). An epidemiological study of victims of road traffic accidents cases: A study from national capital region (Ghaziabad), India. Indian J Prev Soc Med, 42(1), 28-33.
21. Vorel F. Traffic injuries in the pedestrians. Journal of Czeck-Slovac Forensic Medicine. 1993; 38 (4): 32-36
22. Morais Neto OL, Malta DC, Mascarenhas MD, Duarte EC, Silva MM, Oliveira KB, et al. Risk factors for road traffic injury among adolescents in Brazil: National Adolescent School-based Health Survey (PeNSE) 2010;15Suppl 2:3043-52.
23. Trivedi A, Rawal D. Prevalence of road traffic accidents and driving practices among young drivers. Health line 2011; 2(2).
24. Ghimire A, Nagesh S, Jha N, Niraula SR, Devkota s. An epidemiological study of injury among urban population, Kathmandu university medical Journal 2009.
25. Ganveer G B, Tiwary R. Injury pattern among non fatal road traffic accident
26. Harnam S and Dhattarwal SK. Pattern and distribution of injuries in fatal road traffic accidents in Rohtak, Haryana. JIAFM 2004;26(1):20-3.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00113.2

Original Research Paper

Profile of suicidal ideation among depressed patient in Malwa region of Punjab: A Retrospective study

1. **Gupreet Singh Gill,** Professor, Department of Surgery*
2. **Anil Goyal,** Associate Professor, Department of Psychiatry*
3. **Himanshu Gupta,** Assistant Professor, Department of Psychiatry*

*Adesh Institute of Medical Sciences and Research, Bathinda

ABSTRACT :

Introduction: Suicide is a complicated health problem and is a leading cause of death in the world. Depression is found to be most common cause of suicide. Suicidal ideation is precursor and predictor of suicide. So study was conducted to assess socio-demographic and clinical profile of depressed patient with suicidal ideation

Materials and Methods: A Retrospective study was conducted among 136 depressed patients, which fulfill selection criteria. Socio-demographic variables, psychiatric and medical history of the patients were recorded in semi-structured Performa and were analyzed using descriptive statistical methods.

Results: Suicidal ideation was found in 33.8% of depressed patients. Suicidal ideation was found significantly higher among males and working class subjects. Past history of depression and suicidal ideation, family history of depression were also found significantly associated with prevalence of suicidal ideation.

Conclusion: Suicidal ideation was highly prevalent among depressed patients. Being aprecursor of suicide, assessment of its risk factors and treatment can prevent future suicide.

Corresponding Author :
Dr Anil Goyal,
Associate Professor, Department of Psychiatry, Adesh Institute of medical research and sciences, Bathinda
Contact : +91 98141-28345
Email : dragbti@gmail.com

Article History:
Received: 10 July 2020
Received in revised form: 10 August 2020
Accepted on: 13 August 2020
Available online: 30 April 2021

KEYWORDS :Suicide, Depression, Ideation, Malwa

INTRODUCTION :

Suicide is defined as act of intentionally ending one's own life.[1] Nonfatal suicidal thoughts and behaviors are classified more specifically into three categories: suicide ideation, which refers to thoughts of engaging in behavior intended to end one's life; suicide plan, which refers to the formulation of a specific method through which one intend to die; and suicide attempt, which refers to engagement in potentially self-injurious behavior in which there is at least some intent to die.[2-6]

Suicide is a complicated health problem and is a leading cause of death in the world and carrying high mortality rates.[7] A total of 1,39,123 suicides were reported in India during 2019 showing an increase of 3.4% of suicide in comparison to 2018. Punjab is among states which have reported significant increase in percentage of suicides in 2019 over 2018 i.e.37.5%.[8]

Suicidal ideation is a predictor of committing suicide in the general society.[4] McAuliffe stressed on the clinical utility of suicidal ideation as a sign for the assessment of risk factors and its prevention.[4] Depressive disorders were found to be one of the commonest diagnosis in a sample of patients who tried to attempt or completed suicide.[5] Precise basic data on the prevalence and risk factors for suicide and its immediate precursors: suicidal ideation, plans, and attempts, are not available in many countries in the world, especially those that are less developed.[6] Also risk factors for suicide vary from region to region. There is a need to obtain data relevant to a particular region, especially in the current environment where suicide is considered a major public health concern. The present study aimed to investigate the various factors (socio-demographic and clinical characteristics of suicide ideation among depressed person in Mawla region of Punjab, India.

OBJECTIVES:

1. To study prevalence of suicidal ideation among depressed patient
2. To study association of various factors (socio-demographic and clinical characteristics) with suicidal ideation in depressed patients.

MATERIALS AND METHODS :

A retrospective study was conducted on 136 patients attending the Psychiatry department of Adesh institute of medical sciences and research from May 2019 to November 2019.

Patients, who presented for treatment of a major depressive episode and had given written informed consent, were included in the study. The exclusion criteria were current substance or alcohol abuse, history of bipolar disorder and other psychiatric illnesses.

A semi-structured proforma was used to record the socio-demographic variables, psychiatric and medical history of the patients. They were clinically assessed for depression. Diagnosis of the current depressive episode was based on the ICD-10.[9] Results are presented in frequencies, percentages and mean±SD. The Chi-square test was used to compare categorical variables. The multivariate binary logistic backward regression analysis was carried out to find the significant factors associated with prevalence of suicidal ideation. The adjusted odds ratio with its 95% confidence interval (CI) was calculated. The p-value<0.05 was considered significant. All the analysis was carried out on SPSS 16.0 version (Chicago, Inc., USA).

RESULTS :

The prevalence of suicidal ideation was found to be in 33.8% subjects **(Table 1 & Figure 1).**

Table 1: Prevalence of suicidal ideation among depressed patient

Suicidal ideation	No. (n=136)	%
With suicidal ideation	46	33.8
Without suicidal ideation	90	66.2

Figure 1 : Prevalence of suicidal ideation.

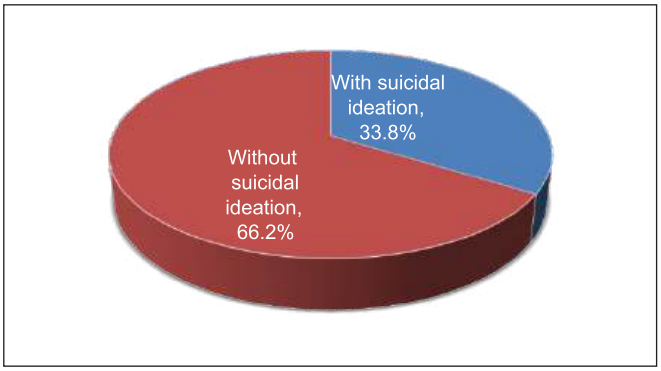


Table-2 shows the distribution of demographic profile of subjects and its association with prevalence of suicidal ideation among depressed patient. About one third of subjects were between 30-40 years of age (33.1%). More than half of subjects were females (55.9%). About half of subjects belonged to rural area (51.5%). More than one third of subjects were educated up to high school (42.6%). The prevalence of suicidal ideation was higher among males (50%) than females (21.1%) and the association was statistically significant (p=0.0001). The prevalence of suicidal ideation was significantly (p=0.01) associated with occupation of subjects.

Comorbid medical disorder was present in 22.1% subjects. Family history of depression was present in 22.1% subjects. Past history of depression and suicidal ideation was in 40.4% and 5.1% respectively. The prevalence of suicidal ideation was higher among whom comorbid medical disorder was present (50%) than absent (29.2%) with significant (p=0.03) association. The prevalence of suicidal ideation was also

Table 3 : Distribution of clinical profile of subjects and its association with prevalence of suicidal ideation among depressed patient

Clinical profile	No. of subjects (n=136)		With suicidal ideation		Without suicidal ideation		p-value[1]
	No.	%	No.	%	No.	%	
Comorbid medical disorders							
Present	30	22.1	15	50.0	15	50.0	0.03*
Absent	106	77.9	31	29.2	75	70.8	
Family history of depression							
Present	30	22.1	19	63.3	11	36.7	0.0001*
Absent	106	77.9	27	25.5	79	74.5	
Past history of depression							
Present	55	40.4	29	52.7	26	47.3	0.0001*
Absent	81	59.6	17	21.0	64	79.0	
ast history of suicidal ideation							
Present	7	5.1	6	85.7	1	14.3	0.003*
Absent	129	94.9	40	31.0	89	69.0	

Table-2: Distribution of demographic profile of subjects and its association with prevalence of suicidal ideation among depressed patient

Demographic profile	No. of subjects (n=136)		With suicidal ideation		Without suicidal ideation		p-value[1]
	No.	%	No.	%	No.	%	
Age in years							
<30	26	19.1	5	19.2	21	80.8	0.16
30-40	45	33.1	13	28.9	32	71.1	
41-50	30	22.1	12	40.0	18	60.0	
51-60	16	11.8	6	37.5	10	62.5	
>60	19	14.0	10	52.6	9	47.4	
Mean±SD	41.94±14.24		46.17±14.05		39.78±13.93		
Gender							
Male	60	44.1	30	50.0	30	50.0	0.0001*
Female	76	55.9	16	21.1	60	78.9	
Locality							
Rural	70	51.5	24	34.3	46	65.7	0.90
Urban	66	48.5	22	33.3	44	66.7	
Education							
Illiterate	24	17.6	7	29.2	17	70.8	0.21
High school	58	42.6	16	27.6	42	72.4	
Graduate	54	39.7	23	42.6	31	57.4	
Occupation							
Businessman	18	13.2	10	55.6	8	44.4	0.01*
Employed	22	16.2	10	45.5	12	54.5	
Farmer	22	16.2	8	36.4	14	63.6	
Housewife	64	47.1	14	21.9	50	78.1	
Retired	4	2.9	2	50.0	2	50.0	
Student	4	2.9	0	100.0	4	100.0	
Unemployed	2	1.5	2		0	0.0	
Marital status							
Married	110	80.9	34	30.9	76	69.1	0.06
Unmarried	14	10.3	4	28.6	10	71.4	
Divorced	2	1.5	2	100.0	0	0.0	
Widow	10	7.4	6	60.0	4	40.0	

significantly (p<0.01) associated with family history of depression, past history of depression and suicidal ideation **(Table-3).**

The factors found to be significantly associated with prevalence of suicidal ideation were entered in multivariate binary logistic model. The analysis revealed that males had 2.96 times significantly higher prevalence of suicidal ideation than females adjusted for family history of depression and past history of depression (Adjusted OR=2.96, 95%CI=1.28-6.82, p=0.01). Family history of depression and past history of depression were also significantly (p<0.01) associated with prevalence of suicidal ideation **(Table-4).**

Table-4: Significant factors associated withprevalence of suicidal ideation among depressed patient

Variables	Adjusted or (95%CI)	p-value
Gender		
Male	2.96 (1.28-6.82)	0.01*
Female	1.00 (Ref.)	
Family history of depression		
Present	4.10 (1.60-10.52)	0.003*
Absent	1.00 (Ref.)	
Past history of depression		
Present	2.99 (1.31-6.85)	0.009*
Absent	1.00 (Ref.)	

DISCUSSION:

Suicide research has mainly focused on suicide attempts and completed suicides and relatively few studies have focused on suicide ideation. Suicidal ideation is precursor of suicide and is a predictor of committed suicide. So this study was conducted to assess prevalence and factors affecting suicidal ideation among depressed patients.

In our study, prevalence of suicidal ideation was found to be in 33.8% of depressed patients. Similar result was found in study conducted by Zisook S et al., in which one-third of patients with major depression had actual plans to kill themselves.[10]

The prevalence of suicidal ideation was found higher among males than females in this study. This finding was not in consistent with other studies.[11,12,18,19] However, few studies showed that the level of suicidal ideation among male was higher compared to female.[13,14] this can be explained by men nature of sharing less personal and work related stress with others and are less likely to attend psychological services compared to women.[15,16] There are also gender differences in terms of expression of emotion across cultures. In some Asian culture, men are expected to be reserved in terms of expression of sad emotion compared to women. This reflects to masculine identity of men in Asian cultures where they are expected to be strong not only physically but also emotionally.[17] Therefore in any stressful situation, they can be overwhelmed by irrational thought, negative emotion, feeling of hopelessness, and lack of social support, problem solving, and coping skills in dealing with their stressful life events.[16]

It was found in our study that suicidal ideation is higher among businessman and employed person in comparison to housewives. This finding is contrary to the finding of National crime record bureau (NCRB) of suicide in 2019.[8] But NCRB includes general population in their report and in this we included depressed patient. And it is difficult for depressed patients to manage work related stress and fear of loss of job. This can lead to higher suicidal ideation among them as compared to housewives.

The prevalence of suicidal ideation was also significantly higher among subjects with past history of suicidal ideation. This finding is in concurrence with other studies.[20,25]

Physical illness along with depression was found to be associated with significantly higher incidence of suicidal ideation. Similar finding was found in other studies, as physical illness lead to more functional impairment.[21,22]

Family history of depression was found important risk factor for higher suicidal ideation and this finding was also found in other studies.[23,24] Above point emphasis need of detailed psychiatry history to evaluate suicidal ideation.

We didn't find an association with other socio-demographic factors like age, employment, education and marital status. Our results are in agreement with other studies.[26,27]

So it was concluded that suicidal ideation was highly prevalent among depressed patients. Male gender, Working class, Co-morbid medical illness, past history of depression and suicidal ideation, family history of depression were associated with suicidal ideation. This study stressed on need of detailed assessment of depressed patients to identify risk factors to prevent future suicide.

CONCLUSION:

Suicidal ideation was highly prevalent among depressed patients. Being a precursor of suicide, assessment of its risk factors and treatment can prevent future suicide.

REFERENCE :

1. O'Carroll PW, Berman AL, Maris RW, et al. Beyond the Tower of Babel: a nomenclature for suicidology. Suicide Life Threat Behav. 1996;26:237–52.
2. Silverman MM, Berman AL, Sanddal ND, et al. Rebuilding the Tower of Babel: a revised nomenclature for the study of suicide and suicidal behaviors. Part 1: background, rationale, and methodology. Suicide Life Threat Behav. 2007;37:248–63.
3. Joiner TE, Steer RA, Brown G, Beck AT, Pettit JA, Rudd MD. Worst-point suicidal plans: a dimension of suicidality predictive of past suicide attempts and eventual death by suicide. Behaviour Research and Therapy. 2003;41(12):1469-80.
4. Mcauliffe CA. Suicidal Ideation as an Articulation of Intent: A Focus for Suicide Prevention?. Archives of Suicide Research. 2002;6(4):325-38.
5. Cheng IC, Hu FC, Tseng MC. Inpatient suicide in a general hospital. General Hospital Psychiatry. 2009;31(2):110-15.
6. Vijayakumar L, Nagaraj K, Pirkis J, Whiteford H. Suicide in developing countries: frequency, distribution, and association with socioeconomic indicators. Crisis. 2005;26(3):104-11.
7. Norra C, Richter N, Juckel G. Sleep disturbances and suicidality: a common association to look for in clinical practise and preventive care. EPMA J. 2011;2(3):295-307.
8. National crime record bureau(IN). Accidental Deaths & Suicides in India 2019. New Delhi: National crime record bureau, 2019.
9. World Health Organization. The ICD-10 Classification of Mental and Behavioural Disorders: Clinical Descriptions

and Diagnostic Guidelines. Geneva: World Health Organization; 1992.

10. Zisook S, Arleen G, Sledge P, Schuchter SR. Reported suicidal behavior and current suicidal ideation in a psychiatric outpatient clinic. Ann Clin Psychiatry. 1994;6(1):27-31.
11. Grøholt B, Ekeberg Ø, Wichstrøm L, Haldorsen T. Sex differences in adolescent suicides in Norway, 1990–1992. *Suicide Life Threat Behav*. 1999;29(4):295–308.
12. Lewinsohn PM, Rohde P, Seeley JR, Baldwin CL. Gender differences in suicide attempts from adolescence to young adulthood. J Am Acad Child Adolesc Psychiatry. 2001;40(4):427–34.
13. Mustaffa S, Aziz R, Mahmood MN, Shuib S. Depression and suicidal ideation among university students. *Procedia Soc Behav Sci*. 2014;116:4205–08.
14. Ibrahim N, Amit N, Din NC, Ong HC. Gender differences and psychological factors associated with suicidal ideation among youth in Malaysia. Psychology Research and Behavior Management. 2017;10:129–35.
15. Galdas PM, Cheater F, Marshall P. Men and health help-seeking behaviour: literature review. J Adv Nurs. 2005;49(6):616–23.
16. Verma R, Balhara YPS, Gupta CS. Gender differences in stress response: role of developmental and biological determinants. Ind Psychiatry J. 2011;20(1):4.
17. Naghavi F, Redzuan M. The relationship between gender and emotional intelligence. World Appl Sci J. 2011;15(4):555–61.
18. Schaffer A, Levitt AJ, Bagby RM, Kennedy SH, Levitan RD, Joffe RT: Suicidal ideation in major depression: Sex differences and impact of comorbid anxiety. Can J Psychiatry. 2000;45: 822-826.
19. Pages KP, Russo JE, Roy-Byrne PP, Ries RK, Cowley DS. Determinants of suicidal ideation:The role of substance use disorders. J Clin Psychiatry. 1997;58:510-15.
20. Alexopoulos GS, Bruce Ml, Hull J, Sirey JA, Kakuma T: Clinical determinants of suicidal ideation and behavior in geriatric depression. Arch Gen Psychiatry. 1999:56;1048-53.
21. Conwell Y, Duberstein PR, Caine ED. Risk factors for suicide in later life. Biol Psychiatry. 2002;52:193–204.
22. Stenager EN, Stenager E. Physical illness and suicidal behaviour. In: Hawton K, van Heeringen K, editors. International handbook of suicide and attempted suicide. 1st. Chichester, United Kingdom: John Wiley & Sons; 2000. pp. 405–20.
23. Mann JJ, Bortinger J, Oquendo MA, Currier D, Li S, Brent DA. Family history of suicidal behavior and mood disorders in probands with mood disorders. Am J Psychiatry. 2005;162(9):1672–79.
24. Brent DA, Mann JJ. Family genetic studies, suicide, and suicidal behavior. Am J Med Genet C Semin Med Genet. 2005;133(1):13–24.
25. Joiner TE, Jr, Conwell Y, Fitzpatrick KK, et al. Four studies on how past and current suicidality relate even when "everything but the kitchen sink" is covaried. J Abnorm Psychol. 2005;114(2):291–303.
26. VanGastel A, Schotte C, Maes M. The prediction of suicidal intent in depressed patients. Acta Psychiatr Scand. 1997; 96(4):254-9.
27. Saeed BA. Suicidal ideation among a group of depressed outpatients.Zanco J. Med. Sci.2017;21(3).1907-14

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00114.4

Original Research Paper

Age Estimation By Dentin Translucency Length- A Comparative Pilot Study Between Conventional And Digital Method

1. **Vidhya Arumugam,** B.D.S, M.Sc (FOD), Post graduate student*
2. **Nagabhushana Doggalli,** M.D.S, M.Sc (FOD), Reader, Department of oral medicine and Radiology*
3. **Abirami Arthanari,** B.D.S, M.Sc (FOD), Post graduate student, Department of Forensic Odontology*

*JSS Academy of Higher Education and Research (JSSAHER), JSS Dental College and Hospital, SS Nagar, Mysuru, Karnataka – 570015

ABSTRACT:

Objectives: 1) to estimate chronological age of the individuals using dentin translucency length, 2) To compare ages from two different methods, Direct visual on unsectioned tooth (Conventional) and Indirect (Digital-GIMP 2.8 version software) on sectioned tooth and further to analyse which method is reliable for age estimation.

Materials and Methods: Sample consists of 40 freshly extracted single rooted permanent teeth from 40 different individuals' age ranging from 25 to 70 years irrespective of sex and those extracted teeth samples were kept in 10% neutral formalin to prevent dehydration. The length of the translucent zone i) on unsectioned teeth were viewed in X-ray viewer and the measurements were done by using divider and ruler. ii) Followed by, the same teeth samples were mounted separately using modelling wax and sectioned buccolingually using carborundum disc, further the thickness of 250 µm (0.25 mm) ground sections were made by using Arkansas stone, the sectioned teeth were scanned and measured on GIMP software. Statistical analyses were done to derive Regression formula and which was applied on 10 test samples of the same age group.

Results: A strong positive correlation between age and length of the translucency of dentin was noted. Correlation coefficients of translucency measurements for age estimation was statistically significant for both the methods (P= 0.001) and moderately higher for the digital approach (R= 0.79). The length of the translucent zone correlated more with age in the digital method with the error of 3.4 years.

Conclusion: Translucency of the root dentin length increases with age, Accuracy of age estimation in test sample was shown better in **Digital method with MAE = 3.46, when compared with Conventional MAE = 4.49**, here the both methods were showing nearly 3-4 years error rate, though conventional method shows only 4.4 years which is also minimal error, almost one year difference when compared to digital (3.4 years) method, Hence one can also prefer for conventional method while considering for evidence preservation in future use, thus it can be used as a reliable parameter for the age estimation.

Corresponding Author :
Dr. Nagabhushana Doggalli,
M.D.S, M.Sc (FOD), Reader,
Department of oral medicine and Radiology,
JSS Academy of Higher Education and Research (JSSAHER),
JSS Dental College and Hospital, SS Nagar, Mysuru, Karnataka – 570015
Contact : +91 9844413396
Email: dr.nagabhushand@jssuni.edu.in

Article History:
Received: 19 July 2020
Received in revised form: 19 August 2020
Accepted on: 19 August 2020
Available online: 30 April 2021

KEYWORDS : Dentin translucency, Age estimation from dentin length, Conventional method, Digital method, Ground section, GIMP software.

INTRODUCTION:

Identification of living individual or deceased is very important in forensic sciences. Nowadays age estimation is also very important in forensic science, and forensic odontology has played a key role in this. Dental age estimation and forensic odontology have been successfully employed in ethical and humanitarian grounds as well as in legal aspects and criminal investigations[1].

There are different methods for estimation of dental age such as by morphological, radiographic, and histological and biochemical means[2]. Among these, histological methods are considered as important for dental age estimation, the reason being that, the teeth are one of the major sources of evidence as it can withstand various environmental changes and insults for longtime[3].

Dentin forms the major bulk of the tooth. Dentin develops uniformly from the infancy to adolescence. After adolescence

or in the third decade of human life, the dentin undergoes physiological changes such as sclerosis. This process of sclerosis in dentin is known as dentin translucency that gradually increases as age advances. Thus, these changes can help possibly us to estimate age[2].

Lamendin in 1992 estimated age with the help of the following two criteria; extension of the root dentin translucency and periodontal height on the labial surface of single rooted teeth [4]. Gustafson included six parameters for dental age estimation such as attrition, Cemental angulations, attachment of cemento enamel junction, dentin translucency, secondary dentin deposition and root resorption. All these parameters he considered were in intact teeth[5]. Among these parameters, dentin translucency is the sole significant parameter for dental age estimation as dentin translucency is considered to be less inclined to deviate in pathologic processes and resists environmental changes and other age-related changes[6].

Statement of the Hypothesis of this study is: This method can be adopted in the age estimation of an individual using the formula by length. However after the age of 70 years there seems to be a static point in dentinal translucency, which may be due to complete blockage of all dentinal tubules, beyond which it may be difficult to find the age of a person[14].

MATERIALS AND METHODS

A comparative pilot study done on 40 freshly extracted permanent teeth from 40 individuals extracted for valid reasons such as orthodontic treatment, periodontal disease and for prosthesis were obtained with their consent from the Department of Oral and Maxillofacial Surgery. Any pathological condition, root fracture, external root resorption were excluded from the study and this study was accepted by the Ethical committee and this study was done in the period of three months from May 2019 to July 2019. This study was to assess the length of dentin translucency in single rooted permanent teeth. The forty samples were collected in the age group of 25 - 70 years irrespective of sex with their consent, the teeth samples were collected immediately after the extraction and it was cleaned and kept it in 10% neutral formalin until the ground sections were prepared in order to prevent dehydration.

The following methods were including

1) Conventional unsectioned tooth method: Direct visual method by placing the whole tooth on x-ray film viewer (Negatoscope) and measuring the root dentin translucency length by divider and calibrated by ruler. The measurements were taken between the root apical limit and the most coronal extent of translucency within the root **(Figure 1)**.

2) Digital sectioned tooth method: All conventionally measured teeth samples were mounted separately and sectioned buccolingually using carborundum disc, followed by sectioning, 250 μm thick ground sections were made by using Arkansas stone, the sectioned teeth were scanned and the dentin translucency length was measured on GIMP 2.10 version software **(Figure 2, 3, 4)**.

A) Measuring Translucency length from conventional unsectioned teeth method using X-ray viewer and divider

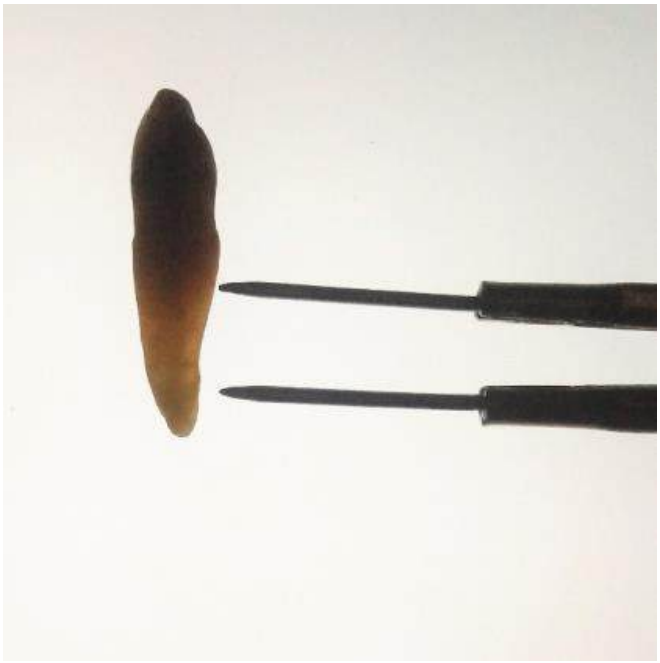


Figure 1 : Unsectioned single rooted tooth shows, translucency length measured by divider and later calibrated with ruler.

B) Measuring Translucency length from Digital sectioned teeth method using GIMP 2.10 version software

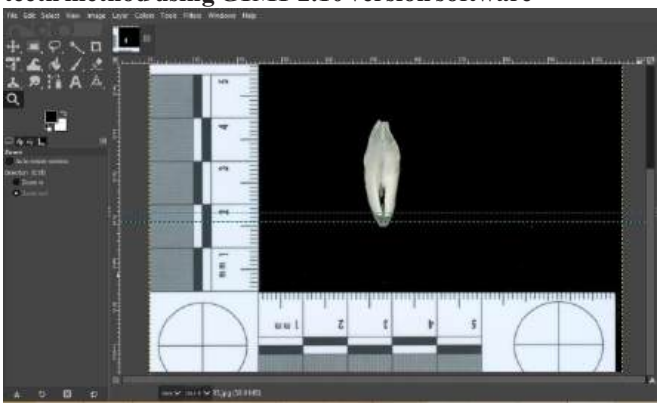
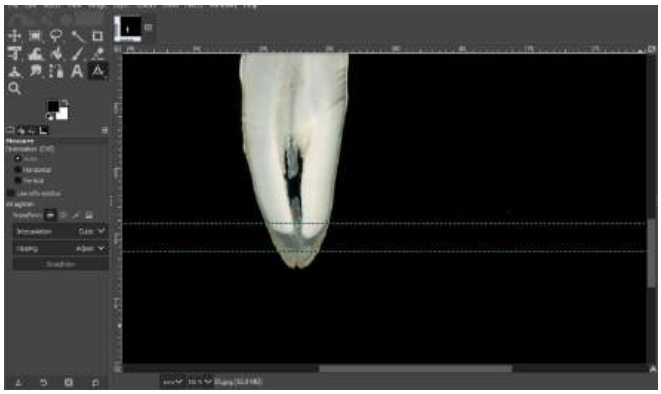


Figure 2 : Shows the scanned sectioned tooth image imported in the GIMP 2.10 version software for measuring dentin translucency length.

Each tooth was scanned using Hp Laser jet M1005 MFP scanner along the long axis of the section, which was aligned parallel to the y-axis of the scale. Prior to scanning, the scanner

Figure 3 : Using zoom tool, zoom in image shows clear coronal and apical limit of root dentin translucency.



setting was verified to be 100% of the original to ensure life-size scanned images.

Scanned images were imported to GIMP 2.10 software, (**GIMP- GNU Image Manipulation Program,** freely available legal software**)** for visualizing and measuring the extent of translucency length. The different dental tissues were generally appreciable on the image and dentinal translucency, in particular, appears as a dark region on the section **(Figure 2)**.

Translucency length was measured using a number of tools available on GIMP 2.10 software, this method has been adapted from different steps described by Acharya 2010)[21].

For convenience of measuring apical and coronal extent of translucency, "guides" were placed on the image. When the desired image is opened (a scanned section of tooth with ABFO No.2 Scale) , ensure that the in-built Rulers of Gimp are activated on the top of the image window; if you do not see it, hold down Ctrl+Shift+R (Command Shift R in Macintosh systems) to activate it. Click and drag the cursor/mouse pointer from within the Rulers to create a line (called "Guide") (blue colour dotted lines) **(Figure 2)**, which should be placed along the apical limit of dentinal translucency and coronal limit of dentinal translucency, we can move the Guides using the 'Move Tool' in the Toolbox. When the cursor is placed on the Guide, it changes colour, note that one of the Guides is blue colour dotted lines, now click and drag/move the Guide to the desired location. Once the Guides are in the proper location, ensure that the units are in "mm" in the Status Bar. Next, click on the 'Measure Tool' in the Toolbox and click and drag the cursor to draw a line vertically between the two Guides. Once you have drawn the line using the 'Measure Tool', note down the measurement (in mm) in the Status Bar **(Figure 4)**[15].

Here, by using the 'Zoom Tool' in the Toolbox, 'Zoom in' to verify if you have placed the Guides exactly at the apical and coronal limits of translucency; you can Zoom in or Zoom out, as desired, in the 'Zoom Tool' options (given in the left side).

Figure 4 : Shows, Guide lines for coronal and apical limit, Move tool for changing position of guide lines, Measure tool for measuring translucency length in millimeters. (Note: These measurements are substituted in the regression formula in order to obtain the age).

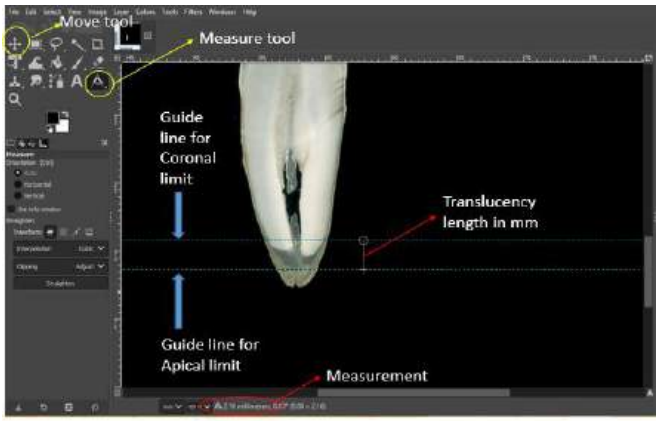


Figure: 4 shows, Guide lines for coronal and apical limit, Move tool for changing position of guide lines, Measure tool for measuring translucency length in millimeters. (Note: These measurements are substituted in the regression formula in order to obtain the age).

All the data's were entered into Microsoft Excel Spreadsheet and statistical analyses were done using SPSS Software version 23.0, Pearson correlation analysis and Regression analyses formulae were derived for age estimation. The formula was applied to the randomly selected 10 test sample other than the study sample in the age group of 25-70 years irrespective of sex, this study used age as an only variable for two methods.

Accuracy between estimated and known age for both methods were tested and compared in the Test samples.

RESULTS:

Table 1: shows Correlation coefficients between three variables are all significant at 0.01 level. Positive correlation was observed in both conventional (0.75) and Digital (0.77) method.

Table: 2 Regression equation formula for Age depending on TL- Conventional unsectioned Teeth,

Age = constant + (Coefficient value * conventionally measured TL in mm).
AGE = 29.070 + (3.329 * Measured Translucency Length from Conventional unsectioned tooth in millimeters)
S.E is ± 3.4 years

Table 3 : Regression equation formula for Age depending on TL- Digital sectioned Teeth, Age = constant + (Coefficient value * digitally measured TL in mm)
AGE = 24.647 + (3.214 * Measured Translucency Length from Digital Sectioned tooth in millimeters) S.E is ± 3.7 years

Table 1 : correlations

Correlations		AGE	TL-conventional, unsectioned Teeth	TL-digital Sectioned Teeth
AGE	Pearson Correlation	1	0.75	0.77
	Sig. (2-tailed)	40	0.00	0.00
	No. of samples	0.75	40	40
TL-conventional, unsectioned Teeth	Pearson Correlation		1	0.93
	Sig. (2-tailed)	40	0.00	0.00
	No. of samples		40	40
TL-digital Sectioned Teeth	Pearson Correlation	0.77	0.93	1
	Sig. (2-tailed)		0.00	0.00
	No. of samples	40	40	40

TL- Translucency Length

Table 2 : Regression Analysis for conventional unsectioned tooth method

Method used	Unstandardized Coefficients	
	B	Standard Error (S.E) (years)
Constant value	29.07	3.4
TL-CONVENTIONAL UNSECTIONED TEETH Coefficient value	3.32	

TL- Translucency Length

Table 3 : Regression Analysis for Digital sectioned tooth method

Model	Unstandardized Coefficients	
	B	Standard Error (years)
Constant value	24.647	3.7
TL-DIGITAL SECTIONED TEETH Coefficient value	3.214	

TL- Translucency Length

Table: 4, Accuracy was checked in **10 Test samples in the age group of 25 – 70 years irrespective of sex,** showed better accuracy was obtained from Digital sectioned method showing lesser error (MAE is 3.46) when compared with conventional method (MAE is 4.49).

Moreover, the computer hardware and software used in the present study is freely available and easy to use. Considering these advantages, the report recommends the use of the digital method to assess translucency length for age estimation.

Table 4 : Accuracy obtained from Test samples

Error Rate	Actual Age Vs Estimated age from Conventional unsectioned teeth method	Actual Age Vs Estimated age from Digital sectioned teeth method
MEAN ABSOLUTE ERROR (MAE)	**4.49**	**3.46***

DISCUSSION :

Age estimation by measuring transparent dentin is one of the Gustafson's six criteria. Transparent dentin has been studied in the intact tooth in order to correlate with the age of the person as done by earlier reports of Solheim[6]. Alternatively transparent dentin had been studied in different thickness of sectioned tooth by Bang and Ramm[7]. This increase in mineralization has same refractive index as that of peri-tubular dentin giving translucent appearance within dentin[16]. This translucency is first noted in the apical part of the tooth because of lesser diameter of dentinal tubules in the root dentin compared to the coronal part. Also lesser number of dentinal tubules are noted per unit area in apical part as stated by Nalabandian[17]. The increase in translucency is generally considered as a physiological change with aging process as proved by Azaz[18].

In the present study, there is a strong correlation between the translucencies with advancement of age which is supported by previous reports[6]. It is interesting to note that there is a gradual and definitive increase in the ratio of this translucency (length as a parameter) with that of increase in age. This was particularly prominent when noted in different decades of age.

The correlation coefficient obtained in the study was 0.75 and 0.77 **(Table 1)** which was similar to that obtained in previous studies[18].

The results of this study correlate with the previous studies [6, 16, 17, 18] Thomas et al[3] further suggested that dentin translucency using linear vernier measurement is more reliable than area plotting.

As an advantage of conventional method used on unsectioned teeth, which aids in preservation of evidence in any necessary legal cases, thus the study was aimed to estimate the age without destroying the evidence in conventional and compared with digital method, the software program used was commercially available and a widely used image-editing digital aid. Also, digitizing tooth sections is straight forward with current computer hardware and software.

Furthermore, Accuracy of age estimation in test sample was shown better in **Digital method with MAE = 3.46, when compared with Conventional MAE = 4.49**, here the both methods were showing nearly 3-4 years error rate, though conventional method shows minimal difference of MAE= 4.4 years which is almost one year difference when compared to digital (MAE =3.4 years) method **(Table 4)**. This could imply that the digital method reported here is superior and in accordance to the conclusion drawn previously that translucency can be assessed either by digital or conventional methods[12]. The equipment required to analyse the translucency is readily available and tooth sections can be digitized easily. The images can be stored and conveniently retrieved for future use, irrespective of the condition of the actual tooth section.

Table: 5 : Various studies Error rate denoted in years (Actual Age Vs Estimated age) [20].

Gustafson (1950)	±3.63
Dalitz (1962)	±8.41
Miles (1963)	±8.87
Bang and Ramm (1970)	±10.07
Johanson (1971)	±8.92
Present study	±3.46

Table: 5, shows the comparison of error rate in different studies, the present study provides better accuracy.

CONCLUSION:

Translucency of the root dentin length increases with age, Accuracy of age estimation in test sample was shown better in **Digital method with MAE = 3.46, when compared with Conventional MAE = 4.49** (Table: 4) and thus, it can be used as a reliable parameter for the age estimation.

In conclusion, a new and relatively simple method for measuring dentin translucency has been developed using commercially available digital aids. The measurements obtained using this method is more refined, better correlated to age, and produce superior age estimates when compared with conventional based quantification. Considering that computer systems and software continue to develop rapidly, one can expect further improvements for translucency assessment in the future. In consideration of evidence preservation conventional method is a better option, when the present study declares only minimal error of about 1year difference when compared to digital method.

Acknowledgement: We wish to thank Prof. Mahadevayya V. Muddapur, retired professor of statistics, S.D.M. College of Dental Sciences and Hospital, Dharwad, Karnataka, for providing statistical support.

Ethical clearance: Received from Ethical committee

Conflict of interest: Nil

Self-funding

REFERENCES:

1. Baccino E, Ubelaker DH, Hayek LA, Zerilli A. Evaluation of seven methods of estimating age at death from mature human skeletal remains. J Forensic Sci 1999; 44(5):931-6.
2. Rajendran R, Sivapathasundaram B. Shafer's Text Book of Oral Pathology, 5th ed. Delhi: Elsevier Publication; 2005.
3. Metska E, Stavrianos C, Vsiliadis L. Estimation of dental age using root dentin translucency. Surg J 2009; 4: 21-8.
4. Lamendin H, Baccino E, Humbert JF, Tavernier JC, Nossintchouk RM, Zerilli A. A simple technique for age estimation in adult corpses: The two criteria dental method. J Forensic Sci 1992; 37(5):1373-9.
5. Gustafson G. Age determination on teeth. J Am Dent Assoc 1950; 41: 45-54.
6. Solheim T. Dental root translucency as an indicator of age. Scand J Dent Res 1989; 97(3):189-97.
7. Bang G, Ramm E. Determination of age in humans from root dentin transparency. Acta Odontol Scand 1970; 28(1):3-35.
8. Sabarad P, Kalburge J. Chronological Age Estimation Using Transparent Root Dentin: A Stereomicroscopic Study. J Adv Med Dent Scie 2014; 2(2):23-32.
9. Sushma Bommannavar, Meena Kulkarni, Comparative study of age estimation using dentinal translucency by digital and conventional methods , Journal of Forensic Dental Sciences / January-April 2015 / Vol 7 / Issue 1

10. Puneeth HK, Nandini DB, Praveen SB, Selvamani M, Mandana D, A Comparative Study of Efficacy of Single Rooted and Double Rooted Teeth in Age Estimation Using Dentin Translucency journal of forensic odonto-stomatology volume 34 number 2 December 2016
11. Kiran Kumar Kattappagari, Radhika Kalyani Kommalapati, Age Estimation by Assessment of Dentin Translucency in Single Rooted Permanent Teeth, journal of International Oral Health 2014; 6(6):37-40
12. Drusini A, Calliari I, and Volpe A. Root dentine transparency: age determination of human teeth using computerized densitometric analysis. Am J Phys Anthropol. 1991; 85: 25-30.
13. Bernd Brinkmann, Christoph Hartmann, Determination of the mineral content and the transparency of the root dentine of human teeth, forensic science international, volume 15 issue 2, march –April 1980, Pg no: 93-101
14. Anita Singhal, Ramesh V,Balamurali PD, A comparative analysis of root dentin transparency with known age Journal of Forensic Dental Sciences / January-June 2010 / Vol 2 / Issue 1
15. Steps in Measuring Root Dentinal Translucency Length & Area Using Tools of Gimp 2.8 Developed and prepared by Dr. Ashith B. Acharya, Department of Forensic Odontology, SDM College of Dental Sciences & Hospital, Sattur, Dharwad – 09, Karnataka (July 2016).
16. Tencate AR, Antonio Nanci. Oral histology, Development, Structure and Function. 7th edition. New Delhi: Elsevier Publishers; 2008.
17. Nalabandian J, Gonzales F, Sognnaes RF. Sclerotic age changes in root dentin of human teeth as observed by optical, electron and X-ray microscopy. J Dent Res 1960; 39: 598-607.
18. Azaz B, Michaeli Y, Nitzan D. Aging tissues of the roots of nonfunctional human teeth (impacted canines). Oral Surg Oral Med Oral Pathol 1977; 43: 572-8.
19. Thomas GJ, Whittaker DK, Embery G. A comparative study of translucent apical dentine in vital and non-vital human teeth. Arch Oral Biology 1994; 39(1):29–34.
20. Singh N, Grover N, Puri N, Singh S, Arora S. Age estimation from physiological changes of teeth: A reliable age marker?. J Forensic Dent Sci 2014; 6: 113-21.
21. Ashith B. Acharya, BDS, GDFO, A New Digital Approach for Measuring Dentin Translucency in Forensic Age Estimation, Am J Forensic Med Pathol Volume 31, Number 2, June 2010

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00115.6

A Case Report

Autopsy diagnosis of Broken Heart Syndrome : Two Case Reports

1. **Ishita Manral,** Assistant Professor, Command Hospital, Eastern Command, Kolkata
2. **Thippesh Kumar,** Assistant Professor, ACMS, Delhi
3. **KV Radhakrishna,** Professor, AFMC, Pune, Maharashtra

ABSTRACT:

Within an hour to a day, of onset of terminal symptoms, if death of an individual occurs, it is termed as sudden death. Incidence of sudden cardiac death has been increasing worldwide. Autopsy surgeon have to deal with the daunting task of finding out the cause of death in such cases. We observed two cases of patients doing well and no known associated co-morbidities. On autopsy, no previous infarct or pathological changes were seen, however, thinned out ventricular wall with a tear and blood collection in pericardial sac were the consistent findings in both the cases.

Corresponding Author :
Dr. Ishita Manral,
Assistant Professor,
Command Hospital, Eastern Command, Kolkata
Contact : +91 72630-77907
Email: atihsi532@gmail.com

Article History:
Received: 8 April 2020
Received in revised form: 8 May 2020
Accepted on: 9 May 2020
Available online: 30 April 2021

KEYWORDS : Hemopericardium, Ventricular rupture, sudden death

INTRODUCTION :

Forensic practitioners are often faced with the daunting task of giving the cause of death in sudden cardiac death. Usually, there are no medical documents and death is unwitnessed. Sudden cardiac death refers to death which is unexpected in nature and onset of symptoms to terminal event varies between one [1,2] to twenty-four hours [3,4] in case of unwitnessed death. Usually such patients have no history of cardiac co-morbidities. Few cardiac cases leave no trace on post mortem examination like coronary artery spasm, arrhythmia and myocardial bridging. Acute coronary syndrome includes myocardial ischemia, unstable angina, or ischemic sudden death [5,6] William Harvey first described cases of rupture of heart on autopsy. Rupture of heart as a complication of myocardial ischemia is a rare event[7,8]. Takotsubo Cardiomyopathy or stress cardiomyopathy is an acquired reversible cardiomyopathy that occurs in postmenopausal females or due to stress [9]. Electrocardiography, angiography and blood tests are used to make its clinical diagnosis. If not recognised early, it can be fatal due to rupture of heart [9].

Cases: following two cases were seen on autopsy

CASE 1

A 75 year old female, with no known co-morbidities had history of low grade fever for three days without any systemic complaints. She collapsed at home and was brought for autopsy. On gross examination, the body was averagely built and nourished. There were no external signs of injury. On dissection: Pericardial sac was distended. Pericardial cavity: contains 200mL of blood in clotted state as in **Figure 1**. On Gross Examination: Right ventricle shows two tears, one on its anterior wall measuring 03cmx03cmx cavity deep as in **Figure 2**. Pale patch measuring 1cm x 1 cm on anterior wall of right ventricle, in its upper one third. On the posterior wall of right ventricle, tear measuring 1cmx 0.2cmx muscle deep seen in lower one third as in **Figure 3**. Thickness of right atria measures 1mm. Thickness of right ventricle thickness measures 3 mm, left atria is 1mm and left ventricle thickness12mm. Heart weighs : 280g. Coronary artery Dissection- Left Coronary artery: narrowing of lumen of 50% with thickened arterial walls, Right Coronary artery and branches: more than 90 % narrowing of its lumen. Valves are patent, no abnormality detected. Lumen of ascending aorta shows multiple atheromatous plaque. Large blood vessels: No abnormality detected. Lungs were normal on examination and weight.

Figure 1: Clotted blood on opening pericardial cavity

Figure 2 : Tear on anterior wall (3cm x 3cm x cavity deep)

Figure 3 : Tear on posterior wall of right ventricle, (1cm x 0.2cm x muscle deep) seen in lower one third

CASE 2

A 39 year old male, while playing basketball, collapsed suddenly and was declared dead in the hospital. The deceased had no known history of co-morbidities. On examination, patient was well built and nourished.

a split laceration measuring 7cm x 0.5cm x bone deep on right parieto-occipital area with irregular, uneven margins and crushed hair bulbs with no underlying fracture of the skull.

Heart and Pericardial Sac: Pericardial sac : No abnormality detected. Pericardial cavity: contains 200mL of blood in fluid state as in **Figure 4**. On Gross Examination: Right ventricle showed three tears in its anterior wall measuring 1cm x 0.2cm x cavity deep, 0.7cm x 0.2cm x cavity deep, 0.4cm x 0.2cm x cavity deep as in **Figure 5**. Right ventricle thickness measures 0.3cm, left ventricle thickness 2cm. Heart weighs: 450g. Coronary artery Dissection- Left Coronary artery: narrowing of lumen of 25% with thickened arterial walls, Right Coronary artery and branches: No abnormality detected. Large blood vessels: No abnormality detected. Lungs- no abnormality detected.

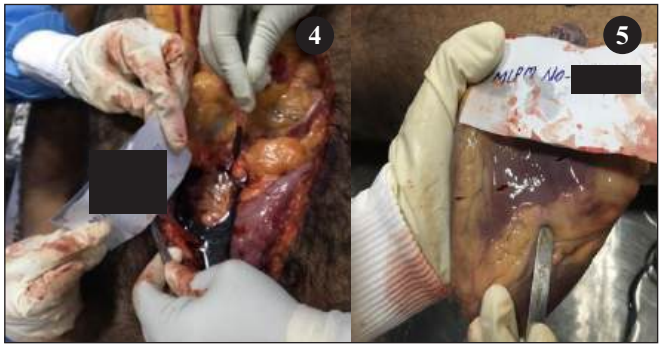


Figure 4: blood in pericardial cavity
Figure 5: tear on the anterior surface of heart

DISCUSSION :

In both the cases, patients had no known co-morbidities. Post cardiac injury syndrome, chronic pericardial effusion, tuberculosis had been ruled out. There was no history of trauma in both cases. Differential diagnosis included acute myocardial infarction-like syndrome with normal coronary arteries", viral or post-viral cardiomyopathy.

Cases have been described[9] where signs and symptoms of acute myocardial infarction without demonstrable coronary artery stenosis or spasm are present. The heart takes on the appearance of a Japanese octopus fishing pot called a takotsubo. This was studied earlier also as sudden cardiac death. After reporting of Takotsubo cardiomyopathy, many cases have then been studied worldwide [10,11].

Myocardial rupture is a disastrous complication of myocardial infarction that causes sudden death. It causes rapid hemodynamic impediment due to the tamponade. In most of the cases, it is difficult to salvage the patient due to rapidly developing hemopericardium [8, 12, 13]. This complication is fatal if not recognised. Rapid collection of 200 ml can cause death or slow collection of more than 2000ml can cause death. The volume of fluid required to produce tamponade varies directly with the thickness of the ventricular myocardium[8, 12]. Rupture occurs through the infarct as necrotic muscles yield under systolic blood pressure.

Thickness of the ventricles varies between 1-2cm. It is least at the apex. The heart stops in asystole after death. After remission of rigor mortis, the thickness of ventricular wall subsides. Caution should be used in eliciting the cause of death depending on the thickness of the myocardium [8,12].

In case of resuscitation, the pericardial blood is typically unclotted and less than 100 milliliters-150 milliliters[14]. Thus artefact was ruled out in our cases.

Most commonly the anterior surface of the heart is common site of rupture of heart. The thin walls, terminal blood supply or necrosed muscles have been cited as pre-disposing factors [15]. In our cases, tears on anterior and posterior surface of heart was noted.

Post-mortem appearances of hemopericardium is often described as bruised area of epicardium overlying an infarct with slit or multiple exit tears and a zig-zag tear with bruised muscles [16]. We had used the above mentioned in our cases to study the hemopericardium.

Intramyocardial hemorrhage and ventricular wall rupture are seen in stress cardiomyopathy. It reflects severe paracellular ischemia-reperfusion injury. Incidence of these cases are very rare, and are generally diagnosed post-mortem. Factors associated with hemorrhage and rupture are advanced age, hypertension[17-19]. In our cases, both the history had no medical relevance.

Rupture of myocardium may be classified into three types[20]:

1) blow-up rupture with sudden death
2) small rupture or leak which with proper and timely intervention can be salvaged
3) chronic rupture which leads to gradual accumulation of large amount of fluid. Sudden cardiac death may be due to blow up rupture.

The Diagnosis of broken heart or ruptured heart was made on post mortem examination. The cases were of advanced age and the other was participating in games. They had no relevant medical history and were declared dead due to sudden collapse at home. Takotsubo cardiomyopathy is diagnosed by coronary

angiography with left ventriculography. We saw rupture of heart in both the cases with hemopericardium. As histology was not done, we cannot comment upon catecholamine induced injury or mononuclear cell infiltrates. The cause of death was shock due to hemopericardium consequent upon ventricle rupture possibly due to myocardial infarction which is a natural cause of death (ICD 10 I 23).

REFERENCES :

1. Report of a Working Group on Ischaemic Heart Disease Registers. Euro 5010 1969. Copenhagen: 1969. Parts I and II. Regional Office for Europe WHO.
2. Myerburg, RJ.; Castellanos, A. Cardiac Arrest and Sudden Cardiac Death. In: Zipes, DP.; Libby, P.; Bonow, RO.; Braunwald, E. (eds). Braunwald's Heart Disease. A Textbook of Cardiovascular Medicine. Philadelphia. Elseiver. 2005. p. 865-908.
3. Fishman GI, Chugh S, DiMarco JP et al. Sudden cardiac death prediction and prevention report from a National Heart, Lung, and Blood Institute and Heart Rhythm Society workshop. Circulation. 2010; 122:2335–2348
4. Zipes DP, Camm AJ, Borggrefe M et al . ACC/AHA/ESC 2006 guidelines for management of patients with ventricular arrhythmias and the prevention of sudden cardiac death: A report of the American College of Cardiology/American Heart Association task force and the European Society of Cardiology committee for practice guidelines. Circulation. 2006; 114 :p385–484. [PubMed: 16935995]
5. Fuster V, Badimon L, Badimon JJ, Chesebro JH. The pathogenesis of coronary artery disease and the acute coronary syndromes (1). N Engl J Med. 1992;326:242–250.
6. Fuster V, Badimon L, Badimon JJ, Chesebro JH. The pathogenesis of coronary artery disease and the acute coronary syndrome. N Engl J Med. 1992;326:310–318.
7. London RE, London SB. Rupture of the heart: A critical analysis of 47 consecutive autopsy cases. Circulation. 1965 Feb;31(2):202-8.
8. Byard RW. Pekka Saukko, Bernard Knight: Knight's forensic pathology 4th ed.: New York. CRC press, Taylor and Francis Group, 2016.
9. Akashi YJ, Goldstein DS, Barbaro G, Ueyama T. Takotsubo cardiomyopathy: a new form of acute, reversible heart failure. Circulation. 2008;118(25):2754–2762.
10. Wittstein IS, Thiemann DR, Lima JA, Baughman KL, Schulman SP, Gerstenblith G, et al. Neurohumoral features Neurohumoral features of myocardial stunning due to sudden emotional stress. N Engl J Med 2005;352:539-48.
11. Sharkey SW, Lesser JR, Zenovich AG, Maron MS, Lindberg J, Longe TF, Maron BJ. Acute and reversible cardiomyopathy provoked by stress in women from the United States. Circulation 2005;111:472-9.
12. Boyd, William : Pathology of Internal Diseases. Ed. 4. Philadelphia: Lea and Febiger, p . 322, 1944
13. Fauci AS, Kasper DL, Hauser SL, Jameson JL, Loscalzo J. Harrison's principles of internal medicine. Longo DL, editor. New York: Mcgraw-hill; 2012.
14. Davison R, Barresi V, Parker M, Meyers SN, Talano JV. Intracardiac injections during cardiopulmonary resuscitation. Alow-risk procedure. JAMA 1980;244:1110–1112
15. Edmondson, H. A., And Hoxie, H. J.: Hypertension and cardiac rupture. Clinical and pathologic study of 72 cases in 13 of which rupture of interventricular septum occurred. Am. Heart J. 24: 719, 1942.
16. Davey P, Gwilt D, Forfar C. Spontaneous rupture of a saphenous vein graft. Postgraduate medical journal. 1999 Jun 1;75(884):363-4.
17. Del Buono M.G., O'Quinn M.P., Garcia P.et al. (2017) Cardiac arrest due to ventricular fibrillation in a 23-year-old woman with broken heart syndrome. Cardiovasc Pathol **30**:78–81.
18. Kumar S., Kaushik S., Nautiyal A.,et al.(2011) Cardiac rupture in takotsubo cardiomyopathy: a systematic review. Clin Cardiol **34**:672–676
19. Iga K, Gen H, Tomonaga G, Matsumura T, Hori K. Reversible left ventricular wall motion impairment caused by pheochromocytoma: a case report. Jpn Circ J. 1989;53:813– 818.
20. Bashour T, Kabbani SS, Ellertson DG, Crew J, Hanna ES. Surgical salvage of heart rupture: report of two cases and review of the literature. Ann Thorac Surg 1983;36:209–13.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00116.8

A Case Report

Suicidal Poisoning with Imidacloprid Insecticide : A Case Report

1. **IshwerTayal,** Assistant Professor, Department of Forensic Medicine*
2. **Parul Garg,** Department of Pathology, Baba Farid University of Health Sciences, Faridkot
3. **Amarnath Mishra,** Assistant Professor, Amity Institute of Forensic Sciences, Amity University, Noida, Uttar Pradesh, India
4. **Shilekh Mittal,** Professor, Department of Forensic Medicine*
5. **Rajiv Joshi,** Professor and Head, Department of Forensic Medicine*
6. **Nidhi Pandey,** Amity Institute of Forensic Sciences, Amity University, Noida, Uttar Pradesh, India

*Guru Gobind Singh Medical College and Hospital, Faridkot, Punjab, India

ABSTRACT :

Introduction : Imidacloprid (IMI) is a new class of insecticide. It can replace highly toxic organophosphorus compounds and can save lives. It acts on the nervous system of insects and mammalian receptors. It has low lethality to human beings even in large doses, so considered safe for humans.

Case presentation : 45-year-old farmer was brought dead to the mortuary complex of Guru Gobind Singh Medical College, Faridkot with history of one episode of vomiting, nausea and abdominal pain. As per police inquest papers, he committed suicide by drinking poisonous liquid with trade name "SENMEX". The container was taken into custody. Dead body was subjected to postmortem examination. On chemical analysis imidacloprid chemical was detected and same chemical was detected from container.

Conclusion : Imidacloprid can be toxic if consumed orally for committing suicide, as is being reported in the present case report. Due to higher tendency it binds with nerve receptors, generally it is considered as save for human beings. The expected sign and symptoms of Imidacloprid are nausea, vomiting, fatigue, spasms, cramps, muscles weakness and difficulty in breathing.

Corresponding Author:
Dr. IshwerTayal,
Assistant Professor,
Department of Forensic Medicine, Guru Gobind Singh Medical College and Hospital, Faridkot, Punjab, India
Contact : +91 8568845500
Email : drtayal@ggsmch.org, ishwer.tayal@gmail.com

Article History :
Received : 30 May 2020
Received in revised from : 11 July 2020
Accepted on : 11 July 2020
Available online : 30 April 2021

Key words : Forensic Toxicology, Imidacloprid; Insecticide; Neonicotinoids;Human poisoning.

INTRODUCTION :

In agriculture the drastic use of insecticides to increase the yield of crop became one of the major problems on human health. Imidacloprid insecticide comes under the class of neonicotinoids that acts on the vertebrates[1]. In recent years, this insecticide also showed severe health effects in birds and mammals and also on nervous system of insects. These chemicals mainly block the neuronal pathway and interfere in the stimuli transmission in insect's nervous system. This results in preventing the impulses transmission by acetylcholine that leads to paralysis[2]. Imidacloprid and Chloro-nicotinyl insecticide are used to kill the insects like rice hoppers, whiteflies, soil insects, aphids, beetles and fleas present on pet animals. This insecticide is mainly used for the treatment of seeds or soil which is used for potatoes, sugar beets, cotton and turf. It works by interfering in the transmission of stimuli in the nervous system of insects. It affects Nicotinergic pathway which are numerous in insects and present in warm- blooded animals. The blockage leads to the accumulation of acetylcholine, an important neurotransmitter, resulting in the insect's paralysis, and eventually death.[3-5]. However, it is known to be nonfatal to humans, but such insecticides are being marketed without adequate research on human toxicity and data available is based on animal studies which may not be applicable to humans.

This study reports a rare case in which a deceased was subjected to medico legal autopsy under section 306 of Indian Penal code with alleged history of suicide by consumption of insecticide from India which is an agricultural country having easy availability of pesticides and its extensive use in rural areas.

Characteristics:

The insecticide formulations based on imidacloprid are available as adjustable granular powder, dressing for seeds (concentrate in fluid suspension), soluble concentrate, suspension concentrate and wettable powder[4].Typical application rates range from 0.05 to 0.125 lbs/ acre. Due to its

high toxicity and low potency, application rates are significantly lower than those of the oldest traditionally used insecticides. It can be phytotoxic if not used in accordance with the manufacturer's specifications and has been shown to be compatible with fungicides if used as a seed treatment to control insect pests[6].

Toxicological Profile

Imidacloprid is absorbed very fast from the gastrointestinal tract and is eradicated through the urine (75%) and feces (25%) separately within 48 hours. The most important metabolic phases include the degradation of 6-chloronicotinic acid. 6-chloronicotinic acid acts on the nervous system[3]. Imidacloprid is known for low human fatality even in high doses. With a dose of one hundred fifty milligram per kilogram body weight, there was observed tremor (1/12 female rats) with decreasing of body temperature and red nasal spot. The dose effect is marked at higher doses. Three hundred seven milligram per kilogram body weight doses of imidacloprid caused mortality within four to twenty-four hours in two of twelve males and eight of twelve rats. The four hours survivors showed severe tremor, sudden reduction in body temperature, unable to hold any object and depression of central nervous system[7-8].

Two years feeding study in rats fed up to 1800 ppm resulted in an NOEL of 100 ppm. Adverse effects included a decrease in body weight, gain in female rats at 300 ppm and an increase in thyroid injury in male rats at 300ppm and in female rats at 900ppm. On year feeding study in dogs fed up with 2,500 ppm produced a NOEL of 1,250 ppm. Adverse effects included elevated blood cholesterol levels and some liver stress[9-11].The low-dose toxicity of Imidacloprid in the reproductive organ systems of adult male rats. IMI treatment at NOAEL dose levels resulted in deterioration of sperm parameters, decrease in T level, increase in germ cell apoptosis, fragmentation of seminal DNA, depletion of antioxidants and modification of altered fatty acid composition[10].

Case presentation:

A 45-year-old male farmer of Malwa region was brought dead to the modern mortuary complex of Guru Gobind Singh Medical College, Sadiq Road, Faridkot, Punjab, India with history of one episode of vomiting, nausea, abdominal pain. As per police inquest papers he committed suicide by drinking poisonous liquid with trade name “SENMEX” and the container was taken into custody along with suicide note. Dead body was subjected to Postmortem examination under section 306 of Indian penal code. Sealed Viscera samples after autopsy along with container of insecticidal spray recovered by police was subjected to chemical analysis. No significant Pathological abnormality detected on gross as well as microscopic histopathological examination.

On Chemical analysis Imidacloprid chemical detected in the exhibits labeled as II, III and IV i.e. stomach and intestines, Liver with Gall Bladder and Blood container respectively. On chemical analysis of the remnants of the container (the plastic pack named 'SENMEX' sealed and subjected to chemical analysis by investigating officer, same chemical detected but quantitative analysis not done.

Considering findings of the Autopsy report, Pathological examination and chemical analysis, the cause of death opined to be Imidacloprid poisoning based on exclusion method.

CONCLUSION:

Due to high toxicity of organochlorines, new chemicals of high potency but low toxicity to humans are being developed. As Imidacloprid is having higher tendency to bind with nerve receptors of insects than to mammalian receptors and is reported to have low lethality to human beings even in large doses, it is considered safe for Humans. However, it can be toxic if consumed orally for committing suicide as is being reported in the present case. Cases of attempted suicide using imidacloprid has been reported earlier also. Due to limited availability of data the toxic effects are often attributed to other ingredients of the product which can lead to similar symptoms. This study conducted in Punjab, India majority of the cases reported GIT Discomfort with no death. However, compared to 5-30% fatality with organophosphorus compounds it has favorable profile.

IMI can replace highly toxic Organophosphorus compounds in rural areas and can save precious lives from accidental deaths during spray in fields. Due to limited clinical information about its toxic effects, there is need to create awareness among the clinicians and public about its toxicity. Quantitative analysis must be done in cases especially reported under section 306 IPC.

List of abbreviations:

lbs/ acre: **Pounds Per Acre**

LOEL: Lowest Observed Effect Level (LOEL

NOEL: Non observable effect level

ppm = Part per million

IMI: Imidacloprid

NOAEL: No Observed Adverse Effect Level

REFERENCES :

1. Tomizawa, M., & Casida, J. E. (2005). Neonicotinoid insecticide toxicology: mechanisms of selective action. *Annu. Rev. Pharmacol. Toxicol.*, *45*, 247-268.
2. Matsuda, K., Buckingham, S. D., Kleier, D., Rauh, J. J.,

Grauso, M., & Sattelle, D. B. (2001). Neonicotinoids: insecticides acting on insect nicotinic acetylcholine receptors. *Trends in pharmacological sciences*, *22*(11), 573-580.

3. Kidd, H. and James, D. R., Eds. The Agrochemicals Handbook, Third Edition. Royal Society of Chemistry Information Services, Cambridge, UK, 1991 (As Updated).10- 2.
4. Meister, R.T., (ed.). 1994. Farm Chemicals Handbook 1994. Meister Publishing Company. Willoughby, OH.
5. Mohamed, F., Gawarammana, I., Robertson, T. A., Roberts,M. S., Palangasinghe, C., et al. (2009). Acute human self- poisoning with imidacloprid compound: a neonicotinoid insecticide. PloS one, 4(4), e5127
6. Pike, K.S., G.L. Reed, G.T. Graf and D. Allison. 1993. Compatibility of Imidacloprid with Fungicides as a Seed-Treatment Control of Russian Wheat Aphid (Homoptera: Aphidae) and Effect on Germination, Growth, and Yield of Wheat Barley. J.Econ.Entomol. 86(2): 586-593.
7. Sheets L. Imidacloprid: a neonicotinoid insecticide. In: Kreiger R, editor. Handbook of pesticide toxicology, 2nd ed., Vol.2. New York, Academic Press; 2001. p. 1-8.
8. Tomlin CDS, editor. The pesticide manual. 11th ed. Surrey (UK): British Crop Protection Council; 1997. p. 706-8.
9. Kapoor U., Srivastava, M. K., & Srivastava, L. P. (2011). Toxicological impact of technical imidacloprid on ovarian morphology, hormonesand antioxidant enzymes in female rats. *Food and chemical toxicology*, *49*(12), 3086-3089.
10. Bal, R., Türk, G., Tuzcu, M., Yilmaz, O., Kuloglu, T., et al. (2012). Assessment of imidacloprid toxicity on reproductive organ system of adult male rats. *Journal of Environmental Science and Health, Part B*, *47*(5), 434-444.
11. Federal Register. Imidacloprid; Pesticide Tolerances. July 5, 1995. 60(128): 34943- 24945.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00117.X

A Case Report

Phenytoin Induced Steven Johnson Syndrome/Toxic Epidermal Necrolysis (SJS/TEN) Overlap.

1. **Ramit Gupta,** Assistant Professor, Department of Psychiatry, Adesh Institute Medical Sciences & Research, Bathinda.
2. **Gunjan Bala,** Assistant Professor, Department of Pathology, Adesh Institute Medical Sciences & Research, Bathinda.
3. **Anu Gupta,** Associate Professor, Department of Dermatology, Adesh Institute Medical Sciences & Research, Bathinda.
4. **Poojan Marken,** Junior Resident, Department of Psychiatry, Adesh Institute Medical Sciences & Research, Bathinda.

ABSTRACT:

Steven Johnson Syndrome is an acute life threating, fatal drug reaction presenting as severe mucosal erosions with widespread erythematous, cutaneous macules or atypical targets. Majority of the cases are drug induced affecting oral and perioral region. A case of SJS/TEN overlap following treatment with phenytoin is being presented here. A 30 year old male was put on phenytoin for epilepsy; he developed rashes, vesicle, bullae all over body associated with pain, itching, fever and purulent discharge from both eyes and ears after 10 days of treatment. The patient was managed by withdrawing of phenytoin immediately and treated with systemic corticosteroids, antimicrobial, antifungal and antihistamines.This case has been presented here to highlight the necessity of judicious use of widely prescribed antiepileptic phenytoin to prevent life threatening adverse drug reaction.

Corresponding Author :
Dr. Gunjan Bala,
Assistant Professor,
Department of Pathology, Adesh Institute Medical Sciences & Research, Bathinda.
Contact : +91 9417090616
Email: 30.gunjan@gmail.com

Article History:
Received: 1 August 2019
Received in revised form: 1 September 2019
Accepted on: 1 September 2019
Available online: 30 April 2021

KEYWORDS : Steven Johnson Syndrome, Toxic Epidermal Necrolysis, phenytoin, adverse drug reaction.

INTRODUCTION:

Steven Johnson Syndrome (SJS) and Toxic Epidermal Necrolysis (TEN) are mucocutaneous cell-mediated hypersensitivity reactions that are generally rare, but potentially life-threatening and commonly drug induced.[1,2]The incidence of SJS and TEN is 0.4-1.2/million and 1.2-6/million person-years respectively.[3,4]Stevens Johnson Syndrome is marked by sudden onset, symptoms consisting of high fever, malaise, myalgia, arthralgia and extensive erythema multiforme like lesions and subsequent skin blisters and erosions. TEN is the most severe form of drug-induced skin reaction and is defined as epidermal detachment of >30% of body surface area. SJS presents with epidermal detachment of <10% of body surface area, whereas involvement of 10%-30% of body surface is defined as SJS/TEN overlap.[5]SJS and TEN are severe and life-threatening conditions with mortality rates of 15% and 2535%, respectively.[6]

Here we present a case of 30 year old male patient who developed phenytoin induced SJS/TEN overlap instituted for epilepsy which is very widely used drug.

CASE REPORT : The case developed SJS/TEN overlap after receiving phenytoin for generalized seizures in the department of Psychiatry at Adesh medical college and hospital. The patient is 30 year old male weighing 62 kgs attended OPD with history of repeated episodes of unresponsiveness, up rolling of eye balls and stiffness in the body since 6 months. Patient was taking valproate from local clinic but to no relief. The patient had no previous history of diabetes, hypertension, tongue bite, post ictal confusion or any drug allergy.

Patient visited Psychiatry OPD with similar episode of unresponsiveness associated with injury due to fall during the episode. EEG was abnormal.Previous CT head done showed no evidence of space occupying intracranial lesions. From history, clinical examination and EEG reports diagnosis of generalized seizures was established. Patient received tablet phenytoin 300mg HS for 15 days; after 10 days of intake of medication patient developed rashes on the back **(Figure 1)** and fever with no episode of unconsciousness.

Slowly rashes were present all over body along with skin lesions associated with itching and pain. Severe reaction was seen with multiple painful oral ulceration **(Figure 2)** which restricted his oral intake along with painful burning micturition, purulent discharge per urethra and pus from both the eyes and ears. Case was referred todermatology for expert opinion.

Routine investigations were done on the day of admission which showed increased leucocyte count of 12,600cells/cumm and urine routine showed 40- 45 pus cells/hpf but urine culture sensitivity report did not show any growth of organism.

On examination by dermatologist; patient was well oriented with hyperpyrexia (102˚F), petechial lesion forming purpura,

fluid filled lesions over retro auricular region, face **(Figure 3)**, arms, trunk, legs and abdomen region. Greenish yellow discharge was coming from both eyes and ears **(Figure 4)**. Nikolsky sign was positive. Intraoral examination revealed irregular, hemorrhagic and tender ulcers.

Ulcers were also present on genital area. In our case 10- 30% of body surface area was involved.

Figure 1 : Erythematous rash over trunk

Figure 2 : Depicting oral lesions

Based on our clinical examination, diagnosis of Steven Johnson Syndrome/Toxic Epidermal Necrolysis(SJS/TEN) overlap was made induced by phenytoin. Phenytoin was immediately stopped and the treatment was started aggressively with i.v. fluids. Injection of hydrocortisone 100mg TDS and avil 2ml BD for 7 days was started. Paracetamol infusion and meropenam 500mg was started thrice a day through i.v. route for fever.Patient was advised to use alcohol free KMNO4 cleaning, mouth paint containing

Figure 3 : Maculopapular rash over face, forehead and chest (front view)

Figure 4 : Showing discharge from eyes.

clotrimazole and beclomethasone; tablet fluconazole for oral lesions to heal quickly. Normal saline was used to clean eyes and genital area. Moisturizing cream containing momentasone, Vaseline andparaffin gauze was used for skin lesions. On 4th day of admission, patient did not improve considerately although no new lesions were there; so patient was put on cyclosporine 300mg per day in divided doses to augment the response of steroids.

All the lesions healed within 4 weeks; there was absence of burning micturition and improvement of general condition.Steroids were gradually tapered and all other medications were also discontinued. He was advised a routine checkup with continuation of medication (clobazam and levetricitam) for seizure.

The SCORTEN Score (a severity of illness score for toxic epidermal necrolysis) calculates the risk for death in both SJS/TEN based on the following variables:

1. Age >40 years
2. Malignancy
3. Heart rate>120
4. Initial percentage of epidermal detachment >10%
5. Blood urea nitrogen(BUN) >10 mmol/L
6. Serum glucose level >14 mmol/L
7. Bicarbonate level < 20 mmol/L

Each variable is assigned a value of 1 point. Mortality rates are as follows:-

- 0- 1 points ≥ 3.2%
- 2 points ≥ 12.1%
- 3 points ≥ 35.3%
- 4 points ≥ 58.3%
- 5 or more points ≥ 90%

In our case score was only 1 on the day of admission as initial percentage of epidermal detachment >10%; so mortality rate was very less ≥ 3.2%.

DISCUSSION:

A case-control study reported that the short term use of phenytoin increases the risk of SJS and TEN for a period of less than 8 weeks. In such case, the offending drug causesdevelopment of SJS/TEN in 1-4 weeks in majority of the cases. In a clinical report, it was shown that onset of exposure to occurrence of SJS was after 10 days of Phenytoin consumption in a patient.[7]In our case, it was also developed after 10 days of administration of phenytoin.

The study by Sanmarkan *et al*. showed that SJS is more common in males.[7] correlating with our study. Other studies reported patients are in mean age group of 10-40 years.[7,8,9] In our case, he is a 30-year-old patient.

Patient was administered hydrocortisone for the treatment of SJS/TEN overlap. Gradually, rashes started decreasing and he was shifted to male general ward. All medications were discontinued along with tapering of steroids was planned, which was found to be beneficial in this patient. Our experience was similar to that reported by Michaels b and Cheriyan *et al.*[10,11]Patient's condition was normalized, no lesions were observed. Hence, the patient was planned for discharge.

KEY MESSSAGE : From this case we have seen Phenytoin to be a cause of a life threatening condition. It has become necessary for a Clinician to identify the adverse effects following a drug use and report it at the earliest. This can prevent fatal outcomes from such a hypersensitivity reaction. Early diagnosis helps the clinician to elude secondary infection and subsequent complications. The offending drug should be discontinued.

REFERENCES:

1. Rzany B, Correia O, Kelly JP, Naldi L, Auquier A, Stern R. Risk of Stevens-Johnson syndrome and toxic epidermal necrolysis during first weeks of antiepileptic therapy: A case-control study. Study Group of the International Case Control Study on Severe Cutaneous Adverse Reactions. Lancet. 1999;353:21904.
2. Kandil AO, Dvorak T, Mignano J, Wu JK, Zhu JJ. Multifocal Stevens-Johnson syndrome after concurrent phenytoin and cranial and thoracic radiation treatment, a case report. Radiat Oncol. 2010;5:49.
3. Gau SS, Chao PF, Lin YJ, Chang CJ, Gau CS. The association between carbamazepine and valproate and adverse cutaneous drug reactions in patients with bipolar disorder: A nested matched case-control study. J Clin Psychopharmacol. 2008;28:50917.
4. Chia FL, Leong KP. Severe cutaneous adverse reactions to drugs. Curr Opin Allergy Clin Immunol. 2007;7:3049.
5. Bastuji-Garin S, Rzany B, Stern RS, et al. Clinical classifi cation of cases of toxic epidermal necrolysis, Stevens-Johnson syndrome, and erythema multiforme. Arch Dermatol 1993;129(1):92-6.
6. Kardaun SH, Jonkman MF. Dexamethasone pulse therapy for Stevens-Johnson syndrome/toxic epidermal necrolysis. Acta Derm Venereol. 2007;87:1448.
7. Sanmarkan AD, Sori T, Thappa DM, Jaisankar TJ. Retrospective analysis of stevens-johnson syndrome and toxic epidermal necrolysis over a period of 10 years. Indian J Dermatol. 2011;56:259.
8. Devi K, George S, Criton S, Suja V, Sridevi PK. Carbamazepine: The commonest cause of toxic epidermal necrolysis and Stevens-Johnson syndrome: A study of 7 years. Indian J Dermatol Venereol Leprol. 2005;71:3258.
9. Sharma VK, Sethuraman G, Minz A. Stevens Johnson syndrome, toxic epidermal necrolysis and SJS-TEN overlap: A retrospective study of causative drugs and clinical outcome. Indian J Dermatol Venereol Leprol. 2008;74:23840.
10. Michaels B. The role of systemic corticosteroid therapy in erythema multiforme major and stevens-johnson syndrome: A review of past and current opinions. J Clin Aesthet Dermatol. 2009;2:515.
11. Cheriyan S, Patterson R, Greenberger PA, Grammer LC, Latall J. The outcome of Stevens-Johnson syndrome treated with corticosteroids. Allergy Proc. 1995;16:1515.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00118.1

A Case Report

Amniotic Fluid Embolism - A Rare Case Report

1. **Ashwini Kumar,** Associate Professor, Department of Forensic Medicine & Toxicology*
2. **Vrinda Chopra,** MBBS student*
3. **Deepak Nayak M,** Associate Professor, Department of Pathology*
4. **Shankar M Bakkannavar,** Associate Professor, Department of Forensic Medicine & Toxicology*
5. **Sowmya Shashidhara,** Assistant Professor, Department of Paediatrics*

*Kasturba Medical College, Manipal, Manipal Academy of Higher Education, Manipal

ABSTRACT:

Amniotic fluid embolism (AFE) is one of the most catastrophic complications of pregnancy in which it is postulated that amniotic fluid, fetal cells, hair, or other debris enters the maternal pulmonary circulation, causing cardiovascular collapse and other complications which are a cause of high case fatality. It was first reported by Meyer in 1926. The incidence of Amniotic fluid embolism is rare, and the exact pathophysiology is still unknown. The process is similar to anaphylaxis than to embolism, so also termed as anaphylactoid syndrome of pregnancy because foetal tissue or amniotic fluid components are not universally found in women who present with signs and symptoms attributable to AFE.

This is a case of a 27-year old female who developed severe bleeding after delivery of a male child and died 3 hours later to it. The post mortem report showed 50 ml of straw-coloured fluid in both the right and left pleura. Section from lung shows dilated and preserved alveolar air spaces with luminal secretions; surrounded by congested and inflamed interstitium, with congested blood vessels as per the histopathological report. Vessels showed luminal lamellated keratin flakes and squamous cells. The cause of death on examination was found to be amniotic fluid embolism.

Since there was no indication of any sort of abdominal trauma therefore in such cases it becomes important to figure out the possible reasons behind the development of amniotic fluid embolism in an apparently normal individual. Though it is a rare condition, an early diagnosis of amniotic fluid embolism is necessary to prevent fatality.

Corresponding Author :
Dr. Ashwini Kumar
Associate Professor,
Department of Forensic Medicine & Toxicology, Kasturba Medical College, Manipal, Manipal Academy of Higher Education, Manipal
Contact : +91 99641-39848
Email:kumar.ashwini@manipal.edu

Article History:
Received: 26 May 2020
Received in revised form: 12 August 2020
Accepted on: 12 August 2020
Available online: 30 April 2021

KEYWORDS : Hemopericardium, Ventricular rupture, sudden death

INTRODUCTION :

Amniotic fluid embolism (AFE) is a type of syndrome comprising of sudden onset hypoxia, seizures, hypotension, or disseminated intravascular coagulopathy (DIC), which occur during the process of labour, delivery, or immediately in the postpartum period, resulting from inflow of amniotic components into the maternal circulation. The entry of foetal cells into the maternal blood circulation initiate a anaphylactic reaction in the mother resulting in complications which eventually lead to fatality. The incidence of Amniotic fluid embolism is approximately 1 in 40,000 deliveries and the mortality rate ranges between 20% to 60%. A few modifiable risk factors were found to be associated with the development of Amniotic fluid embolism which include medical induction, caesarean delivery, instrumental vaginal delivery, and uterine or cervical trauma.

The patient usually presents with acute hypoxia, sudden fall in blood pressure, severe haemorrhage or coagulopathy which usually develop in presence of the above mentioned risk factors.

CASE DETAILS :

This is a case of a 27-year old female who developed severe bleeding after delivery of a male child and died 3 hours after the delivery.

The most remarkable finding found at the **external examination** was a sutured wound (episiotomy suture) measuring 5 cm in length was present over the posterior aspect of vagina, posterior commissure and perianal raphe. This particular finding is very critical since this will later help us to reach a point where we will be in a situation to determine the sequence of events which lead to the death of the woman.**(Figure 1)**

On internal examination, the post mortem report showed 50 ml of straw-coloured fluid in both the right and left pleura.

Both the lungs were soft congested oedematous and blood-stained fluid oozed put on cut section. Brain weighed 1,280 g and showed signs of cerebral oedema. Tracheal and oesophageal mucosa was pale. Uterus with adnexae weighed 965g. Endometrial mucosa was spongy in consistency and showed hemorrhagic areas at several places.

The histopathology report is very important in this regard and mentioned below are some of the very critical findings.

Section from lung at 50x shows dilated and preserved alveolar air spaces with luminal secretions; surrounded by congested and inflamed interstitium, with congested blood vessels as per the histopathological report. Vessels showed luminal lamellated keratin flakes and squamous cells. The fluid in the lung interstitium was later found to be amniotic fluid and therefore the histopathological report revealed amniotic fluid embolism.(**Figure 2-3)**

Figure 1:

Uterus on post mortem

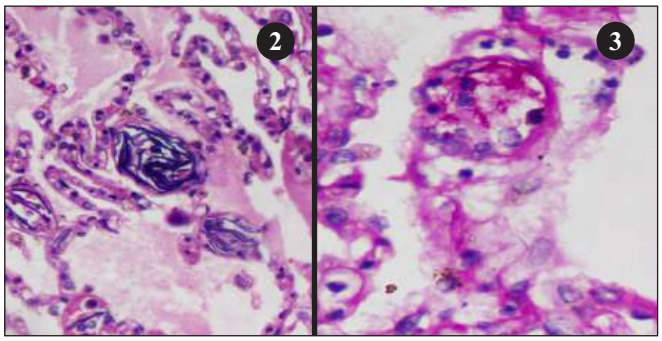


Figure 2: Section from lung showing vascular occlusion by lamellated keratin flakes (H&E; x400)

Figure 3: Vascular occlusion by lamellated keratin flakes (PAS stain; x400)

DISCUSSION :

Amniotic fluid embolism is one of the most dreaded complication of pregnancy which results from entry of amniotic fluid, fetal cells ,fetal hair and other debris into the maternal circulation which lead to cardiovascular collapse[1]. Epidemiological studies show that the incidence of AFE ranges from 1 in 8000 to 1 in 80,000 deliveries[2]. Several theories have been proposed for the development of AFE. Physical obstruction in the pulmonary circulation due to entry of amniotic fluid in the maternal circulation which occurs due to breach of the barrier between maternal blood and amniotic fluid is the first hypothesis[3,4] .The other one suggests an immunological basis for the development of AFE .The entry of amniotic fluid into the maternal circulation leads to the release of inflammatory mediators which leads to the activation of immune response.[5,6]

The important risk factors which were found to be associated with AFE are abdominal trauma., cesarean section, older maternal age, eclampsia, tears in uterus and cervix, early separation of placenta, foetal distress , foetal death and male sex of the child[7-9]

The signs and symptoms of AFV include acute dyspnea, sudden chills, shivering, sweating, coughing , anxiety, hypotension, encephalopathy, uterine atony and severe haemorrhage due to coagulopathy. AFE is usually a diagnosis of exclusion[9,10].The management is primarily supportive involves a multicentric approach.[11]

In the above case ,the post mortem findings like keratin flakes and squamous cells in the pulmonary vessels along with amniotic fluid in the lung interstitium are suggestive of Amniotic fluid embolism. Also, the pale oesophageal and tracheal mucosa points towards anaemia resulting from excessive blood loss due to Disseminated intravascular coagulation which is a major complication of amniotic fluid embolism.

The occurrence of a rare event like AFE in an apparently normal pregnancy without any history of abdominal trauma makes this case extraordinary .Though there was no history of abdominal trauma but there are a few evidences in the external examination which indicate towards the fact that initially normal delivery was intended but eventually a caesarean section was done which would have lead to a tumultuous labor and resulted in the development of AFE .Also the deceased delivered a male child and the male sex of the child has been correlated to the development of amniotic fluid embolism The reasons for the above association are still unknown.

In India it has been noted that late diagnosis of the development of amniotic fluid embolism is a major reason for the high case fatality.

CONCLUSION :

The development of tumultuous labour, caesarean section are the major factors which probably led to the development of amniotic fluid embolism in an apparently normal pregnancy.[11]

Elimination of predisposing factors which contribute to the development of amniotic fluid embolism and early diagnosis of the same is necessary to reduce the incidence of maternal mortality due to amniotic fluid embolism. Management is

primarily supportive and rescucitative.[12-14]

REFERENCES:

1. Kaur K, Bhardwaj M, Kumar P, Singhal S, Singh T, Hooda S. Amniotic fluid embolism. J Anaesthesiol Clin Pharmacol. 2016;32(2):153–9.
2. Rudra A, Chatterjee S, Sengupta S, Nandi B, Mitra J. Amniotic fluid embolism. Indian J Crit Care Med. 2009;13(3):129–35.
3. Dean LS, Rogers RP 3rd, Harley RA, Hood DD. Case scenario: amniotic fluid embolism. Anesthesiology. 2012 Jan;116(1):186–92.
4. Conde-Agudelo A, Romero R. Amniotic fluid embolism: an evidence-based review. Am J Obstet Gynecol. 2009 Nov;201(5):445.e1-13.
5. Clark SL. Amniotic fluid embolism. Clin Obstet Gynecol. 2010 Jun;53(2):322–8.
6. Gist RS, Stafford IP, Leibowitz AB, Beilin Y. Amniotic fluid embolism. Anesth Analg. 2009 May;108(5):1599–602.
7. Moore J, Baldisseri MR. Amniotic fluid embolism. Crit Care Med. 2005 Oct;33(10 Suppl):S279-285.
8. Benson MD. Current concepts of immunology and diagnosis in amniotic fluid embolism. Clin Dev Immunol. 2012;2012:946576.
9. Dobbenga-Rhodes YA. Responding to amniotic fluid embolism. AORN J. 2009 Jun;89(6):1079–88; quiz 1089–92.
10. O'Shea A, Eappen S. Amniotic fluid embolism. Int Anesthesiol Clin. 2007 Winter;45(1):17–28.
11. Thongrong C, Kasemsiri P, Hofmann JP, Bergese SD, Papadimos TJ, Gracias VH, et al. Amniotic fluid embolism. Int J Crit Illn Inj Sci. 2013 Jan;3(1):51–57.
12. Tamura N, Farhana M, Oda T, Itoh H, Kanayama N. Amniotic fluid embolism: Pathophysiology from the perspective of pathology. Journal of Obstetrics and Gynaecology Research. 2017 Apr 1;43(4):627–32.
13. Shamshirsaz AA, Clark SL. Amniotic Fluid Embolism. Obstetrics and Gynecology Clinics of North America. 2016 Dec 1;43(4):779–90.
14. Bussen S., Schwarzmann G., Steek T. Clinical aspects and therapy of amniotic fluid embolism. Illustration based on a case report. *Z. Geburtshilfe. Neonatol*. — 1997.-Vol.88.-P.523.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00119.3

A Case Report

Sudden Death due To Pulmonary Embolism in Software Professionals: Two Case Reports

1. **Rashid Nehal Khan,** Associate Professor*
2. **K V Radhakrishna,** Professor*
3. **Ravi Rautji,** Professor & HOD*
4. **Abhishek Rathee,** PG Resident*

*Department of Forensic Medicine & Toxicology, Armed Forces Medical college, Pune (Mahahrashtra) India

ABSTRACT:

Two successive cases of young software professionals where cause of death was attributed to Pulmonary Embolism are reported here. Both cases had similar presentation and profile and hence are presented as a series of two case reports. In the first case 24 year old software professional had reported to the casualty with a history of pain in the chest for the last 4-5 days which had increased in evening and had hence requested his colleagues to get him medical help. He collapsed in the vehicle as he was being transported to hospital. On arrival apart from CPR an urgent echocardiography was done which revealed a pulmonary embolism. Before a thought for thrombolyses could be given, the patient had a cardiac arrest which could not be revived and the patient was declared dead. An autopsy was conducted to find out the cause of death. Left ventricle wall was hypertrophied and an embolus was found in the Rt ventricle and the pulmonary artery. The heart weight was increased. Second case in this series was of a 30 year old software professional who had dyspnoea on exertion for last 3 days and in the morning developed giddiness and collapsed at his house. He was rushed to the hospital . CPR was started and an echocardiography revealed a massive pulmonary embolism. Before a plan for thrombolyses could be put in place, the patient had a cardiac arrest and died. The autopsy was conducted at Armed Forces Medical college Pune and it revealed a pulmonary embolus at the bifurcation of pulmonary artery and the weight of heart was increased.The above two cases brings into light a case of death due pulmonary embolism in software professionals who were young, doing their routine work and had no complaints of any illness in the past. Though the parents denied of any history of risk factors or similar history of sudden death due to cardiac pathology in family or symptoms of cardiac disease in deceased , the paper brings forward the factors that can cause Pulmonary Embolism at an young age.

Corresponding Author :
Dr. Rashid Nehal Khan,
Associate Professor,
Department of Forensic Medicine & Toxicolgy, Pune (Mahahrashtra) India
Contact : +91 98238-73507
Email: krashidnehal@hotmail.com

Article History:
Received: 12 June 2020
Received in revised form: 25 June 2020
Accepted on: 25 June 2020
Available online: 30 April 2021

KEYWORDS : Pulmonary Embolism, Sudden Death, Software Professionals

CASE REPORT 1 :

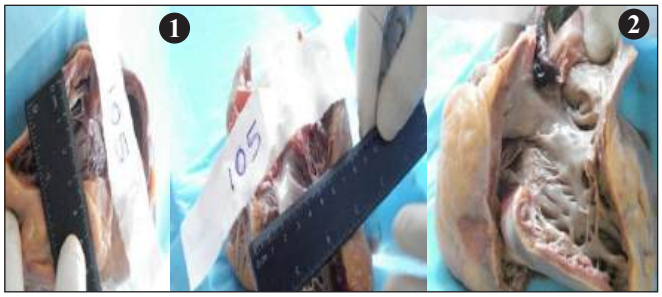
24yr old male was brought for autopsy at the mortuary of Armed Forces Medical College, Pune with history of pain in the chest for the last 4-5 days which had increased in the evening and had hence requested his colleagues to get him medical help. He collapsed in the vehicle as he was being transported to hospital. On arrival apart from CPR an urgent echocardiography was done which revealed a Pulmonary Embolism. Before a thought for thrombolysis could be given the patient had a cardiac arrest which could not be revived and the patient was declared dead.

On history there was h/o complaint of chest pain for last 4-5 days. No h/o breathlessness on exertion, syncopal attack, pain in the calf muscles or any history of prolonged travel or surgery in recent past.

On external examination the deceased was 176 cm in height and 73 kg in weight. He was well built with a musculature body. Rigor mortis was present all over the body and postmortem lividity was present over the back with areas of contact pallor. External examination revealed no injuries on the body.

On internal examination the heart was 450g in weight with pericardial sac intact. On dissection the coronaries were patent. The left ventricle and right ventricle were hypertrophied and showed thickness of 2.1 cm and 0.8 cm respectively **(Figure 1).** Both the mitral and tricuspid valves and the aortic and pulmonary valves showed no abnormal findings. There was an embolus of size 4cm x 1.5 cm ,branched in appearance , cylindrical in shape with tapering ends found occluding the pulmonary artery (**Figure 2).** The surface of the embolus is

striped having faint and dark red appearance. The lungs on gross examination were heavy and oedmatous. The weight of right lung was 600gm and that of left lung was 550gm. On dissection, exudation of froth was seen. Multiple emboli were present in the branches and sub branches of Pulmonary artery. The stomach showed 200 gm of partially digested food and the internal mucosa was healthy. The liver was enlarged and heavy and weighed 2.2kg. On cut section it revealed congestion. Spleen weighed 220 gm and on cut section showed congestion. The right kidney and left kidney weighed 120 gm each and on dissection showed congestion. The brain was oedematous and obliteration of sulci and gyri were seen. The weight of brain was 1500 gm. On dissection nothing abnormal was detected.



CASE REPORT 2 : was of a 30 yr old male, a software professional by profession, who was brought for Autopsy at the mortuary of Armed Forces Medical College, Pune with history of dyspnoea on exertion for last 03 days and had developed giddiness with sudden collapse. He was rushed to the hospital. On arrival apart from CPR an urgent echocardiography was done which revealed a massive pulmonary embolism. Thrombolyses was being planned but before it could be started the patient had a cardiac arrest which could not be revived and the patient was declared dead.

On history there was h/o complaint of dyspnoea on exertion for last 03 days No h/o chest pain , syncopal attack, pain in the calf muscles or any history of prolonged travel or surgery in recent past.

On external examination the deceased was 173 cm in height and 85 kg in weight. He was well built with a musculature body. Rigor mortis was present all over the body and postmortem lividity was present over the back with areas of contact pallor. External examination revealed no injuries on the body.

On internal examination the heart was 350g in weight with pericardial sac intact. On dissection the coronaries were patent . The right ventricle was hypertrophied and showed thickness of 0.8 cm. The thickness of left ventricle was 1.2 cm. Both the mitral and tricuspid valves and the aortic and pulmonary valves showed no abnormal findings. There was an embolus of size 3cm x 1 cm, branched in appearance, cylindrical in shape with tapering ends at the bifurcation of pulmonary trunk **(Figure 3 & 4).** The lungs on gross examination were heavy and oedmatous. The weight of right lung was 450 gm and that of left lung was 400 gm. On dissection exudation of froth demonstrated. The stomach showed 50 ml of brown coloured fluid and the internal mucosa was healthy. The liver weighed 1.4 kg. On cut section it revealed congestion. Spleen weighed 300 gm and on cut section showed congestion. The right kidney and left kidney weighed 150 gm 160 gm respectively and on dissection showed congestion. The brain was oedematous and obliteration of sulci and gyri were seen. The weight of brain was1500 gm. On dissection nothing abnormal was detected.

DISCUSSION :

Three primary influences predispose a patient to thrombus formation; these form the so-called Virchow triad, which consists of the following [1-3]

Endothelial injury

Stasis or turbulence of blood flow

Blood hypercoagulability

Thrombosis usually originates as a platelet nidus on valves in the veins of the lower extremities. Further growth occurs by accretion of platelets and fibrin and progression to red fibrin thrombus, which may either break off and embolize or result in total occlusion of the vein. The endogenous thrombolytic system leads to partial dissolution; then, the thrombus becomes organized and is incorporated into the venous wall.

Pulmonary emboli usually arise from thrombi originating in the deep venous system of the lower extremities; however, they may rarely originate in the pelvic, renal, or upper extremity veins or the right heart chambers. After traveling to the lung, large thrombi can lodge at the bifurcation of the main pulmonary artery or the lobar branches and cause hemodynamic compromise. Smaller thrombi typically travel more distally, occluding smaller vessels in the lung periphery. These are more likely to produce pleuritic chest pain by initiating an inflammatory response adjacent to the parietal pleura. Most pulmonary emboli are multiple, and the lower lobes are involved more commonly than the upper lobes

The causes for pulmonary embolism are multifactorial and are not readily apparent in many cases. The causes described in the literature include the following:

a) Venous stasis

b) Hypercoagulable states

c) Immobilization

d) Surgery and trauma

e) Pregnancy

f) Oral contraceptives and estrogen replacement

g) Malignancy

h) Hereditary factors

i) Acute medical illness

A study by Malek et al confirmed the hypothesis that individuals with HIV infection are more likely to have clinically detected thromboembolic disease. 4The risk of developing a pulmonary embolism or DVT is increased 40% in these individuals.

In the PIOPED II study, 94% of patients with pulmonary embolism had 1 or more of the following risk factors[5]

a) Immobilization

b) Travel of 4 hours or more in the past month

c) Surgery within the last 3 months

d) Malignancy, especially lung cancer

e) Current or past history of thrombophlebitis

f) Trauma to the lower extremities and pelvis during the past 3 months

g) Smoking

h) Central venous instrumentation within the past 3 months

i) Stroke, paresis, or paralysis

j) Prior pulmonary embolism

k) Heart failure

l) Chronic obstructive pulmonary disease

Venous stasis leads to accumulation of platelets and thrombin in veins. Increased viscosity may occur due to polycythemia and dehydration, immobility, raised venous pressure in cardiac failure, or compression of a vein by a tumor.The complex and delicate balance between coagulation and anticoagulation is altered by many diseases, by obesity, or by trauma. It can also occur after surgery. Concomitant hypercoagulability may be present in disease states where prolonged venous stasis or injury to veins occurs.Hypercoagulable states may be acquired or congenital. Factor V Leiden mutation causing resistance to activated protein C is the most common risk factor. Factor V Leiden mutation is present in up to 5% of the normal population and is the most common cause of familial thromboembolism.Primary or acquired deficiencies in protein C, protein S, and antithrombin III are other risk factors. The deficiency of these natural anticoagulants is responsible for 10% of venous thrombosis in younger people.

The term e-thrombosis was coined by Beasley et al. in 2003 , who described the case of a 32-year-old man who developed an extensive bilateral proximal pulmonary embolism. In a paper published by Lippi et al[6] it has reported 21 cases of death related to pulmonary embolism or venous thromboembolism in which the triggering factor was related to sitting for long hours on computer games related activities.

In a prospective study by Geertset al[7] it indicated that major trauma was associated with a 58% incidence of DVT in the lower extremities and an 18% incidence in proximal veins.Surgical and accidental traumas predispose patients to venous thromboembolism by activating clotting factors and causing immobility. Pulmonary embolism may account for 15% of all postoperative deaths. Leg amputations and hip, pelvic, and spinal surgery are associated with the highest risk.Fractures of the femur and tibia are associated with the highest risk of fracture-related pulmonary embolism, followed by pelvic, spinal, and other fractures. Severe burns also carry a high risk of DVT or pulmonary embolism.

In a study conducted by Van den HeuvelEibrink et al [8] it has been shown that malignancy has been identified in 17% of patients with venous thromboembolism. Pulmonary emboli have been reported to occur in association with solid tumors, leukemias, and lymphomas. The neoplasms most commonly associated with pulmonary embolism, in descending order of frequency, are pancreatic carcinoma; bronchogenic carcinoma; and carcinomas of the genitourinary tract, colon, stomach, and breast. In a study conducted by Artz M et al[9] Sleep-disordered breathing has been identified as additional risk factor for Pulmonary thromboembolism.

In contrast to adults, most children (98%) diagnosed with pulmonary emboli have an identifiable risk factor or a serious underlying disorder .In 1993, David et al [10] reported that 21% of children with DVT and/or pulmonary emboli had an indwelling central venous catheter.Additional series have reported the presence of central lines in as many as 36% of patients.[11]A clot may form as a fibrin sleeve that encases the catheter. When the catheter is removed, the fibrin sleeve is often dislodged, releasing a nidus for embolus formation. In another scenario, a thrombus may adhere to the vessel wall adjacent to the catheter.

As regarding the pathophysiology of pulmonary embolism, pulmonary embolism can arise from anywhere in the body, most commonly it arises from the calf veins. The venous

thrombi predominately originate in venous valve pockets (inset) and at other sites of presumed venous stasis. To reach the lungs, thromboemboli travel through the right side of the heart, right atrium; right ventricle; left atrium and left ventricle.Pulmonary thromboembolism is not a disease in and of itself. Rather, it is a complication of underlying venous thrombosis. Under normal conditions, microthrombi (tiny aggregates of red cells, platelets, and fibrin) are formed and lysed continually within the venous circulatory system. This dynamic equilibrium ensures local hemostasis in response to injury without permitting uncontrolled propagation of clot. On the basis of pathologic diagnosis, an embolus can be acute or chronic. If it is situated centrally within the vascular lumen or if it occludes a vessel (vessel cutoff sign) it is called acute . Acute pulmonary embolism commonly causes distention of the involved vessel. An embolus is chronic if it is eccentric and contiguous with the vessel wall, it reduces the arterial diameter by more than 50%, evidence of recanalization within the thrombus is present, and an arterial web is present.

As regarding diagnosis of Pulmonary Embolism is concerned in article published by Kluetz et al [12] it has been shown that despite high prevalence acute pulmonary embolism is difficult to diagnose. It was reported that 62% to 83 % of autopsy proven pulmonary embolism were not diagnosed clinically. History and physical examination findings for pulmonary embolism and DVT are neither sensitive not specific. One study revealed that as few as 19 %of those who had autopsy proven pulmonary embolism had symptomatic DVT. Currently the diagnostic work up of pulmonry embolism uses a combination of clinical scoring alogrithms, serum tests, ECG, chest radiographs, and further diagnostic imaging studies which include nuclear ventillation perfusion scanning, lower extremity ultrasound, CT pulmonary angiography and less frequently , echocardiography, magnetic resonance and conventional pulmonary angiography.

In an article published by Wood K E[13] it has been highlighted that major pulmonary embolism results wherever the combination of embolism size and underlying cardiopulmonary status interact to produce hemodynamic instability. Physical findings and standard data crudely estimate the severity of the embolic event in patients without prior cardiopulmonary disease but are unreliable indicators in patients with prior cardiopulmonary disease. In either case, the presence of shock defines threefold to sevenfold increase in mortality, with a majority of deaths occurring within 01 hr of presentation. A rapid integration of historical information and physical findings with readily available laboratory data and structured physiologic approach to diagnosis and resuscitation are necessary for are necessary for optimal therapeutics in this "Golden Hour" Echocardiography is ideal because it is transportable, and is capable of differentiating shock states and recognizing the characteristics features of Pulmonary Embolism. Spiral CT scanning is evolving to replace angiography as a confirmatory study in this population. Thrombolytic therapy is acknowledged as the treatment of choice, with embolectomy reserved for those in which thrombolysis is contraindicated.

Although e-thrombosis is still be regarded as a relatively rare disorder (i.e., with a cumulative frequency <1:2,000) , the use of personal computers has consistently grown during the past 20 years, with worldwide sales having nearly doubled from the year 2000 to present time, reaching a peak around the years 2009–2012, and slightly declining afterwards due to a growing market and increasing usage of smartphones and tablet computers . Notably, the cumulative shipment of desktop, laptop and tablet computers is predicted to increase to nearly 400 million units in the year 2020, and it is hence predictable that the burden of e-thrombosis will increase further, since approximately 80% of users are expected to spend a large part of their life working, playing or internet surfing with these devices in the next decade .[6,14]

CONCLUSION:

The cause of death in two young software professionals could be attributed to their sedentary life style which could have resulted in the immobilization for a longer duration. They did not have any of the risk factors as mentioned in the Prospective Investigation of Pulmonary Embolism Diagnosis (PIOPED) study II other than sedentary work habits which may have led to prolonged immobilization. Identification of the causative factor, quick diagnosis and following the principle of "Golden Hour" can significantly reduce the mortality due to Pulmonary Embolism.

REFERENCES:

1. Boyden EA. Segmental Anatomy of the Lungs: Study of the Patterns of the Segmental Bronchi and Related Pulmonary Vessels. New York, NY: McGraw-Hill; 1955:23-32.
2. Mitchell RN, Kumar V. Hemodynamic disorders, thrombosis, and shock. In: Kumar V, Cotran RS, Robbins SL, eds. Basic Pathology. 6th ed. Philadelphia, Pa: WB Saunders; 1997:60-80.
3. Wharton LR, Pierson JW. JAMA. Minor forms of pulmonary embolism after abdominal operations.
4. Malek J, Rogers R, Kufera J, Hirshon JM. Venous thromboembolic disease in the HIV-infected patient. Am J Emerg Med. Mar 2011;29(3):278-82.
5. Stein PD, Beemath A, Matta F, Weg JG, Yusen RD, Hales

CA, et al. Clinical characteristics of patients with acute pulmonary embolism: data from PIOPED II. Am J Med. Oct 2007;120(10):871-9.

6. LippiG, Mattiuzzi C, Favaloro EJ. E-thrombosis: epidemiology, physiopathology and rationale for preventing computer-related thrombosis. Ann Transl Med 2018;6(17):344
7. Geerts WH, Code KI, Jay RM, Chen E, Szalai JP. A prospective study of venous thromboembolism after major trauma. N Engl J Med. Dec 15 1994;331(24):1601-6.
8. Van den Heuvel-Eibrink MM, Lankhorst B, Egeler RM, Corel LJ, Kollen WJ. Sudden death due to pulmonary embolism as presenting symptom of renal tumors. Pediatr Blood Cancer. May 2008;50(5):1062-4.
9. Arzt M, Luigart R, Schum C, Lüthje L, Stein A, Koper I, et al. Sleep-disordered breathing in deep vein thrombosis and acute pulmonary embolism. EurRespir J. Oct 2012;40(4):919-24.
10. David M, Andrew M. Venous thromboembolic complications in children. J Pediatr. Sep. 1993;123(3):337-46.
11. Biss TT, Brandão LR, Kahr WH, Chan AK, Williams S. Clinical features and outcome of pulmonary embolism in children. Br J Haematol. Sep 2008;142(5):808-18.
12. Kluetz PG, White CS. Acute pulmonary embolism: imaging in the emergency department. RadiolClin North Am. Mar 2006;44(2):259-71.
13. Wood KE. Major pulmonary embolism: review of a pathophysiologic approach to the golden hour of hemodynamically significant pulmonary embolism. Chest. Mar 2002;121(3):877-905.
14. Danese E, Lippi G. Rare diseases: the paradox of an emerging challenge. Ann Transl Med 2018;6:329

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00120.X

A Case Report

Rupture of Berry Aneurysm – A Preventable Fatality

1. **Ashwini Kumar,** Associate Professor, Department of Forensic Medicine & Toxicology*
2. **Swetha Sritharan,** MBBS student*
3. **Ajay Hedge,** Assistant Professor, Department of Neurosurgery*
4. **Vikram Palimar,** Professor, Department of Forensic Medicine & Toxicology*
5. **Sowmya Shashidhara,** Assistant Professor, Department of Paediatrics*

*Kasturba Medical College, Manipal, Manipal Academy of Higher Education, Manipal

ABSTRACT:

Berry aneurysm is one of the commonest cause of subarachnoid haemorrhage commonly seen in bifurcation sites of circle of Willis. Unruptured aneurysms are asymptomatic and are usually missed unless suspected, even with radiological methods. Common risk factors include Autosomal Dominant Polycystic Kidney Disease (AD-PKD), smoking, hypertension, connective tissue disorders etc.

Hereby we present a 37-year old hypertensive male who was taken to a primary health care centre due to unresponsiveness. He was suspected to be having intracranial haemorrhage and referred to a tertiary hospital wherein he was declared brought dead. Dissection of cranial cavity revealed rupture of berry aneurysm in the left posterior communicating artery of circle of Willis. Intracerebral haemorrhage was noted in the left internal capsule. Pontine haemorrhage was noted. Cause of death was determined to be intracranial haemorrhage secondary to rupture of berry aneurysm.

Ruptured berry aneurysms are associated with high mortality and morbidity rates. Screening and early diagnosis can prevent complications associated with rupture. Screening is recommended for high risk groups. Cessation of smoking and control of hypertension can prevent rupture and prevent this fatality.

Corresponding Author :
Dr. Ashwini Kumar
Associate Professor,
Department of Forensic Medicine & Toxicology, Kasturba Medical College, Manipal, Manipal Academy of Higher Education, Manipal
Contact : +91 99641-39848
Email:kumar.ashwini@manipal.edu

Article History:
Received: 26 May 2020
Received in revised form: 12 August 2020
Accepted on: 12 August 2020
Available online: 30 April 2021

KEYWORDS : Berry aneurysm, hypertension, intracranial haemorrhage, preventable

INTRODUCTION

Dilatation of a localized segment of the arterial system is called an aneurysm. Deficiency in the tunica media leads to weakness of the vessel wall resulting in its local dilatation[1]. Morphologically, aneurysms can be saccular (known as Berry aneurysm), fusiform or dissecting[2]. Berry aneurysms are most commonly seen at bifurcation sites of circle of Willis.

Unruptured aneurysms are asymptomatic and are usually missed unless suspected, even with routine radiological investigations. However, rupture of these aneurysms is catastrophic and remains the commonest cause of non-traumatic subarachnoid haemorrhage (SAH)[3]. The worldwide incidence of SAH is estimated to be 9/100,000 persons per year albeit with regional variation[4]. Common risk factors for aneurysm growth and rupture include smoking, hypertension and female sex[5-7]. We describe the case of a young male who succumbed to a catastrophic aneurysm rupture.

CASE PRESENTATION :

A 37- year old hypertensive male was taken to a local primary health centre with sudden loss of consciousness. He was suspected to be having intracranial haemorrhage and referred to our hospital wherein he was declared brought dead. An autopsy was performed which revealed the following details:

External examination revealed blood stain in the left nostril.

On dissecting the brain, the brain weighed 1900 grams. Bilateral coning of orbital cortex, uncus of the temporal lobe and tonsils were observed, indicating cerebral oedema. Subarachnoid haemorrhage was noted over cerebrum and cerebellum at several places. Intracerebral haemorrhage was observed over internal capsule. A centrally placed pontine haemorrhage was noted. Clots weighing 126 grams were noted in lateral ventricles. A ruptured berry aneurysm in left posterior communicating artery was noted. Other organs showed no significant findings. The cause of death was determined to be Intracranial haemorrhage secondary to ruptured berry

aneurysm in left posterior communicating artery.**(Figure 1-3)**

Figure 1 : shows the brain with bilateral coning, subarachnoid haemorrhage at places, a centrally placed pontine haemorrhage.

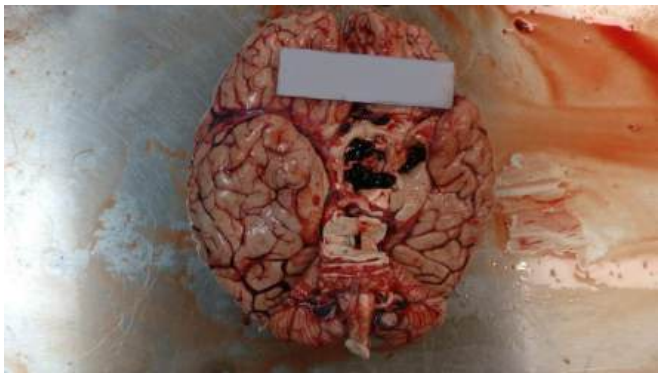
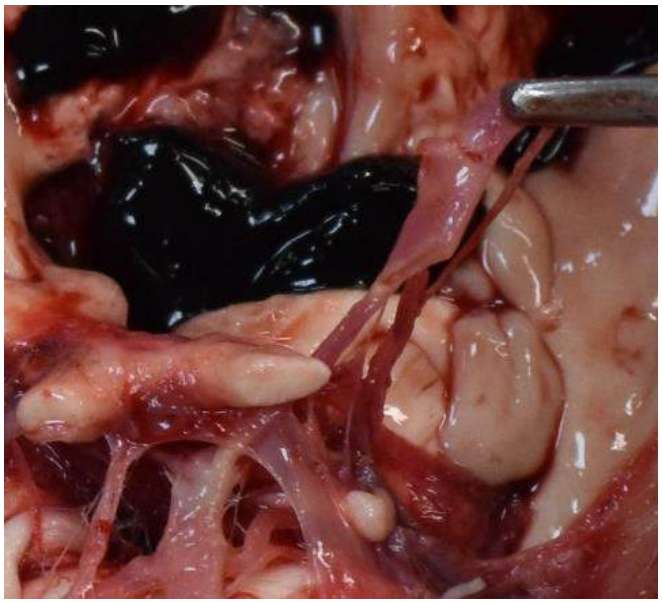


Figure 2 : Massive Intraventricular haemorrhage-126 grams of clots found in lateral ventricles of brain.

Figure 3 : shows the ruptured berry aneurysm in left posterior communicating artery



DISCUSSION :

Berry Aneurysm shows a prevalence of 3.2% in general population with no comorbidities[8], more commonly in females [5,6]. 0.25% of these aneurysms rupture[8].

Saccular berry aneurysms account for 90% of the total aneurysms and is the most common cause of Sub-arachnoid haemorrhage (SAH). Fusiform aneurysms account for the remaining 10% and are most commonly located in the posterior circulation[9].

The important risk factors for the development of cerebral aneurysms are hypertension, smoking, chronic alcohol use [7,10,11] and family history of intracranial aneurysms in two or more first-degree relatives[5,6,12,13]. Autosomal dominant polycystic kidney disease (AD-PKD) is an inherited disorder with a prevalence rate of intracranial aneurysm that is 2 to 4 times higher than the general population[5,14-17]. Aneurysmal rupture associated with AD-PKD is 64%[16]. Connective tissue disorders like Marfan syndrome and Ehlers-Danlos syndrome type IV are weakly associated with intracranial aneurysms.

Only 10–15% of unruptured intracranial aneurysms (UIA) are symptomatic[18,19], with the majority being identified incidentally during evaluation for other conditions. When present, the symptoms are primarily due to the mass effect of a large aneurysm, or possibly from minimal leakage called sentinel bleeds which irritate the meninges, though not enough to be classified as a haemorrhage. Symptoms include headache, bilateral temporal hemianopsia and bilateral lower extremity weakness, unilateral third nerve palsy[20]. These symptoms may be a warning sign of an impending rupture, as 10% to 43% of patients with SAH report experiencing a sentinel headache in the 2 months preceding the rupture [21].

Diagnostic modalities for aneurysms include DSA, MRA and CT Angiography. DSA remains the gold standard technique for diagnosis due to its high sensitivity. Since most of the aneurysms are asymptomatic, they are diagnosed incidentally on non-invasive imaging for other presenting complaints. Clinicians may prefer non-invasive imaging in patients with renal insufficiency or Ehlers-Danlos syndrome, in whom the risk of catheter angiography is higher[6].

Main treatment involves surgical clipping and endovascular coiling. Endovascular treatment of UIA provides a safe and effective alternative to surgical treatment. The risks associated with endovascular repair are lower and incur shorter hospital stays[22] for appropriately selected patients. The method of endovascular treatment should be considered based on factors such as aneurysm size, location, patient medical history, and clinician experience. Increased clinician experience with endovascular coiling shows decreased risk of complications [23].

Currently both surgical clipping and endovascular coiling are considered complimentary to each other.

Ruptured Intracranial aneurysms lead to SAH. The symptoms of SAH result from blood spilling into the cerebrospinal fluid (CSF) and the subsequent increased intracranial pressure and breakdown of blood products. The most common presenting as a sudden transient loss of consciousness[3]. In 10% of the patients, the loss of consciousness lasts for 10 days[3]. Upon regaining consciousness, 45% of the patients complain of sudden onset severe headache[3]. It may be associated with nausea, vomiting, neck rigidity, and photophobia[6]. Focal neurological deficits are uncommon but are seen in 10% of patients[3].

Non-contrast head computed tomography (CT) is the initial imaging modality of choice[24,25]. The presence of SAH requires further evaluation with CT angiography (CTA) or cerebral angiography[25]. Non-contrast CT followed by CTA provides diagnosis in aSAH in 99% of the cases[26,27]. Lumbar puncture is important in checking for false negative results to avoid potential misdiagnosis[25,28,29]. The Fisher scale is used to classify the appearance of SAH on a cranial CT scan based on the amount of blood in the subarachnoid space and is a predictor of cerebral vasospasm, DCI, and possibly the overall patient outcome [30-32].

Patients with SAH are graded on Hunt-Hess Scale or World Federation of Neurosurgeons Scale (WFNS). Higher grades on both scales are associated with the worst outcomes. However, Neurological status should also be assessed using the Glasgow Coma Scale, which has a prognostic value and less observer variability[33].

SAH is treated as a medical emergency with the priority being maintenance of airway, breathing and circulation. Decrease in cerebral perfusion due to raised intracranial pressure must be prevented. Delayed cerebral ischemia caused by vasospasm due to haemorrhagic clots is the commonest cause of mortality in SAH[3] and must be prevented.

45% of patients presenting with aneurysmal SAH at the hospital die within a month[3]. Of the survivors, more than half suffer with major neurologic deficits due to initial haemorrhage, cerebral vasospasm with infarction, or hydrocephalus[3]. If the aneurysm is not obliterated, the rate of re-bleeding is about 20% in the first 2 weeks, 30% in the first month, and about 3% per year afterward[3]. These rates indicate the importance of prevention of rupture.

Screening is recommended every 7 years from the age of 20 to the age of 80 for a positive family history and AD-PKD and can be offered to patients with coarctation of the aorta and patients with microcephalic osteodysplastic primordial dwarfism[8]. Controlling modifiable risk factors plays a vital role in reducing incidence of rupture in such patients.

MRI and CT scans are expensive in India with need for highly trained personnel to conduct the tests and interpret the results. Patients are usually not compliant for screening as they bear most of the financial burden (62.64% of total expenditure in 2014[34]). Though total health expenditure has increased in India from 1998 to 2000, most of it is due to increase in private health expenditures[35]. In fact, the government health expenditure has been on the decline, with no significant increase in percentage of GDP directed towards healthcare[35]. This has resulted in poor healthcare infrastructure and increased burden on the patient. An increased focus towards healthcare sector is imperative to reverse these trends.

The patient discussed here is a known hypertensive who has not been taking medications regularly. Though he does not have other risk factors that recommend screening, this highlights the ignorance of the general population about the complications of common chronic diseases like Hypertension and Diabetes Mellitus. It is therefore important to create awareness among people through awareness campaigns and advertisements on social media sites and other simple measures like adding a chapter about chronic diseases in school textbooks.

CONCLUSION

Berry aneurysm is the one of the common causes of intracranial haemorrhage. They are usually asymptomatic and hence, mostly detected incidentally. Mortality associated with rupture is very high. Therefore, screening of high risk groups is recommended. Control of hypertension, cessation of smoking plays a pivotal role in preventing aneurysmal growth and rupture. These can be effectively achieved by increased focus towards the healthcare sector and public awareness.

REFERENCES:

1. Snell RS, Snell RSC neuroanatomy for medical students. Clinical neuroanatomy [Internet]. 6th ed. Philadelphia: Lippincott Williams & Wilkins; 2006. Available from: http://lib.ugent.be/catalog/rug01:001310200
2. Vernooij MW, Ikram MA, Tanghe HL, Vincent AJPE, Hofman A, Krestin GP, et al. Incidental Findings on Brain MRI in the General Population. N Engl J Med. 2007 Nov 1;357(18):1821–8.
3. Hemphill I J Claude, Smith WS, Gress DR. Subarachnoid Hemorrhage. In: Jameson JL, Fauci AS, Kasper DL, Hauser SL, Longo DL, Loscalzo J, editors. Harrison's Principles of Internal Medicine, 20e [Internet]. New York, NY: McGraw-Hill Education; 2018 [cited 2018 Nov 15]. Available from:

accessmedicine.mhmedical.com/content.aspx?aid=1156563332

4. de Rooij NK, Linn FHH, van der Plas JA, Algra A, Rinkel GJE. Incidence of subarachnoid haemorrhage: a systematic review with emphasis on region, age, gender and time trends. J Neurol Neurosurg Psychiatry. 2007 Dec 1;78(12):1365.
5. Vlak MH, Algra A, Brandenburg R, Rinkel GJ. Prevalence of unruptured intracranial aneurysms, with emphasis on sex, age, comorbidity, country, and time period: a systematic review and meta-analysis. The Lancet Neurology. 2011 Jul 1;10(7):626–36.
6. Suarez JI, Tarr RW, Selman WR. Aneurysmal Subarachnoid Hemorrhage. N Engl J Med. 2006 Jan 26;354(4):387–96.
7. Feigin Valery L., Rinkel Gabriel J.E., Lawes Carlene M.M., Algra Ale, Bennett Derrick A., van Gijn Jan, et al. Risk Factors for Subarachnoid Hemorrhage. Stroke. 2005 Dec 1;36(12):2773–80.
8. Thompson B. Gregory, Brown Robert D., Amin-Hanjani Sepideh, Broderick Joseph P., Cockroft Kevin M., Connolly E. Sander, et al. Guidelines for the Management of Patients With Unruptured Intracranial Aneurysms. Stroke. 2015 Aug 1;46(8):2368–400.
9. Charles G. Drake, Sydney J. Peerless. Giant fusiform intracranial aneurysms: review of 120 patients treated surgically from 1965 to 1992. Journal of Neurosurgery. 1997;87(2):141–62.
10. Ellamushi HE, Grieve JP, Jäger HR, Kitchen ND. Risk factors for the formation of multiple intracranial aneurysms. Journal of Neurosurgery [Internet]. 2001;94(5). Available from: https://thejns.org/view/journals/j-neurosurg/94/5/article-p728.xml
11. Unruptured Intracranial Aneurysms — Risk of Rupture and Risks of Surgical Intervention. New England Journal of Medicine. 1998;339(24):1725–33.
12. Ronkainen A, Hernesniemi J, Puranen M, Niemitukia L, Vanninen R, Ryynänen M, et al. Familial intracranial aneurysms. The Lancet. 1997 Feb 8;349(9049):380–4.
13. Bor ASE, Rinkel GJE, Adami J, Koffijberg H, Ekbom A, Buskens E, et al. Risk of subarachnoid haemorrhage according to number of affected relatives: a population based case–control study. Brain. 2008 Oct 1;131(10):2662–5.
14. Brisman JL, Song JK, Newell DW. Cerebral Aneurysms. N Engl J Med. 2006 Aug 31;355(9):928–39.
15. Rinkel Gabriel J. E., Djibuti Mamuka, Algra Ale, van Gijn J. Prevalence and Risk of Rupture of Intracranial Aneurysms. Stroke. 1998 Jan 1;29(1):251–6.
16. Schievink WI, Torres VE, Piepgras DG, Wiebers DO. Saccular intracranial aneurysms in autosomal dominant polycystic kidney disease. J Am Soc Nephrol. 1992 Jul 1;3(1):88.
17. Rinkel GJE. Natural history, epidemiology and screening of unruptured intracranial aneurysms. Journal of Neuroradiology. 2008 May 1;35(2):99–103.
18. Friedman JA, Piepgras DG, Pichelmann MA, Hansen KK, Brown RD, Wiebers DO. Small cerebral aneurysms presenting with symptoms other than rupture. Neurology. 2001 Oct 9;57(7):1212.
19. Wiebers DO. Unruptured intracranial aneurysms: natural history, clinical outcome, and risks of surgical and endovascular treatment. The Lancet. 2003 Jul 12;362(9378):103–10.
20. Keedy A. An overview of intracranial aneurysms. McGill journal of medicine : MJM : an international forum for the advancement of medical sciences by students. 2006 Jul;9(2):141–6.
21. Polmear A. Sentinel Headaches in Aneurysmal Subarachnoid Haemorrhage: What is the True Incidence? A Systematic Review. Cephalalgia. 2003 Dec 1;23(10):935–41.
22. Alshekhlee Amer, Mehta Sonal, Edgell Randall C., Vora Nirav, Feen Eli, Mohammadi Afshin, et al. Hospital Mortality and Complications of Electively Clipped or Coiled Unruptured Intracranial Aneurysm. Stroke. 2010 Jul 1;41(7):1471–6.
23. Singh V, Gress DR, Higashida RT, Dowd CF, Halbach VV, Johnston SC. The learning curve for coil embolization of unruptured intracranial aneurysms. AJNR American journal of neuroradiology. 2002 May;23(5):768—771.
24. Edlow JA, Caplan LR. Avoiding Pitfalls in the Diagnosis of Subarachnoid Hemorrhage. N Engl J Med. 2000 Jan 6;342(1):29–36.
25. Manno EM. Subarachnoid hemorrhage. Neurologic Clinics. 2004 May 1;22(2):347–66.
26. McCormack RF, Hutson A. Can Computed Tomography Angiography of the Brain Replace Lumbar Puncture in the Evaluation of Acute-onset Headache After a Negative Noncontrast Cranial Computed Tomography Scan? Academic Emergency Medicine. 2010 Apr 2;17(4):444–51.

27. Westerlaan HE, van Dijk JMC, Jansen-van der Weide MC, de Groot JC, Groen RJM, Mooij JJA, et al. Intracranial Aneurysms in Patients with Subarachnoid Hemorrhage: CT Angiography as a Primary Examination Tool for Diagnosis—Systematic Review and Meta-Analysis. Radiology. 2011 Jan 1;258(1):134–45.
28. Bederson Joshua B., Connolly E. Sander, Batjer H. Hunt, Dacey Ralph G., Dion Jacques E., Diringer Michael N., et al. Guidelines for the Management of Aneurysmal Subarachnoid Hemorrhage. Stroke. 2009 Mar 1;40(3):994–1025.
29. Sidman R, Connolly E, Lemke T. Subarachnoid Hemorrhage Diagnosis: Lumbar Puncture Is Still Needed When the Computed Tomography Scan Is Normal. Academic Emergency Medicine. 1996 Sep;3(9):827–31
30. Fisher CM, Kistler JP, Davis JM. Relation of Cerebral Vasospasm to Subarachnoid Hemorrhage Visualized by Computerized Tomographic Scanning. Neurosurgery. 1980 Jan 1;6(1):1–9.
31. Frontera JA, Claassen J, Schmidt JM, Wartenberg KE, Temes R, Connolly ES, et al. Prediction of symptomatic vasospasm after subarachnoid hemorrhage: the modified fisher scale. Neurosurgery. 2006 Jul 1;59(1):21–7.
32. Nomura Y, Kawaguchi M, Yoshitani K, Kurita N, Hayashi H, Tamura K, et al. Retrospective analysis of predictors of cerebral vasospasm after ruptured cerebral aneurysm surgery: influence of the location of subarachnoid blood. Journal of Anesthesia. 2010 Feb 1;24(1):1–6.
33. Rosen DS, MacDonald RL. Subarachnoid hemorrhage grading scales. Neurocritical Care. 2005 Apr 1;2(2):110–8.
34. World Health Organisation. Out-of-pocket Health Expenses.

    apps.who.int/gho/data/view.main.GSWCAH41v
35. Spinaci S, Currat L, Shetty P, Crowell V, Kehler J. Tough Choices: Investing in health for development: Experiences from national follow-up to commission on macroeconomics and health. WHO Report; 2006.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00121.1

A Case Report

Death due to Fungal Endocarditis – A Case Report

1. **Ashwini Kumar,** Associate Professor, Department of Forensic Medicine & Toxicology*
2. **Saumya Saxena,** MBBS student*
3. **Deepak Nayak M,** Associate Professor, Department of Pathology*
4. **Anitha Shivajirao,** Associate Professor, Department of Forensic Medicine & Toxicology*
5. **Sowmya Shashidhara,** Assistant Professor, Department of Paediatrics*

*Kasturba Medical College, Manipal, Manipal Academy of Higher Education, Manipal

ABSTRACT:

Sudden deaths of cardiac origin are usually caused by unexpected loss of heart function. One of the causes may be Infective endocarditis (IE) which refers to the microbial infection of the heart valves or mural endocardium that leads to the formation of thrombotic vegetations that cause calcification and destruction of underlying cardiac tissue. The vegetations are typically friable and embolize easily causing abscesses (Ring abscess), septic infarcts and mycotic aneurysms. Left untreated, IE may lead to congestive heart failure (CHF). Hence, it is important to discuss cases where IE was the main cause for death.

Case suggested of a 67-year-old female who developed breathlessness, was taken to a local hospital and later brought to a multi-speciality hospital on the advice of doctors where she was declared brought dead.

Internal Examination revealed the brain to be soft, congested and oedematous. There was coning of the orbital part of the frontal lobe, uncal part of the hippocampal gyrus of the temporal lobe and the cerebellar tonsil bilaterally. Tracheal lumen contained blood stained mucoid fluid. White patch was present on the anterior surface of the right ventricle 4 cm above apex. Right coronary artery showed 50% occlusion in its entire course. Left anterior descending artery showed 75% occlusion for 4cm from its origin. Multiple atheromatous streaks and plaques were present over the aortic intima at several places. Histopathology suggested chronic myocardial infarct with left coronary artery atherosclerosis. Pseudo hyphae were noticed in the vegetation's on the heart valve which were confirmed to be belonging to the genus *Candida*. Final opinion as to the cause of death after hospital records, autopsy findings, histopathology report and RFSL reports-due to sequelae of fungal infective endocarditis.

Corresponding Author :
Dr. Ashwini Kumar, Associate Professor,
Department of Forensic Medicine & Toxicology, Kasturba Medical College, Manipal, Manipal Academy of Higher Education, Manipal
Contact : +91 99641-39848, 86609-50453
Email:kumar.ashwini@manipal.edu,
ashwini.kumar.dr@gmail.com

Article History:
Received: 26 May 2020
Received in revised form: 12 August 2020
Accepted on: 12 August 2020
Available online: 30 April 2021

KEYWORDS : Infective endocarditis, sudden death, cardiac, histopathology

INTRODUCTION :

Infective endocarditis (IE) is an acute or subacute endocardial infection caused by bacterial, viral or fungal micro-organisms. The most commonly involved pathogens are *Streptococcus viridans*, which generally leads to subacute endocarditis and *Staphylococcus aureus* which causes acute endocarditis[1]. The high rates of mortality and morbidity are related to complications like valvular regurgitation, heart failure, development of abscess and embolic complications.[2] Fungal endocarditis (FE) is considered as the most serious form of infective endocarditis, which has a high mortality rate of about 50%[3,4]. It is fatal, and is usually diagnosed after post mortem examination and laboratory results[5]. It is highly challenging to identify the source of the disease, and to establish a diagnosis in time to carry out the specific treatment[6].

Hereby, we present a case on fungal endocarditis where the patient presented with atypical features of the disease. The diagnosis could not be made in time and due to the lack of proper treatment, she succumbed to it. The report highlights on the importance of maintaining high index of suspicion as this rare disease proves to be really fatal and is one of the causes of sudden death.

CASE PRESENTATION

A 67 year old female was apparently healthy before developing breathlessness for which she was brought to a secondary care hospital. She was referred from there to a tertiary care hospital where she was declared brought dead.

On external examination : conjunctivae of both eyes were congested. All the external orifices were intact and unremarkable. No fresh external injury was noted over the

body.

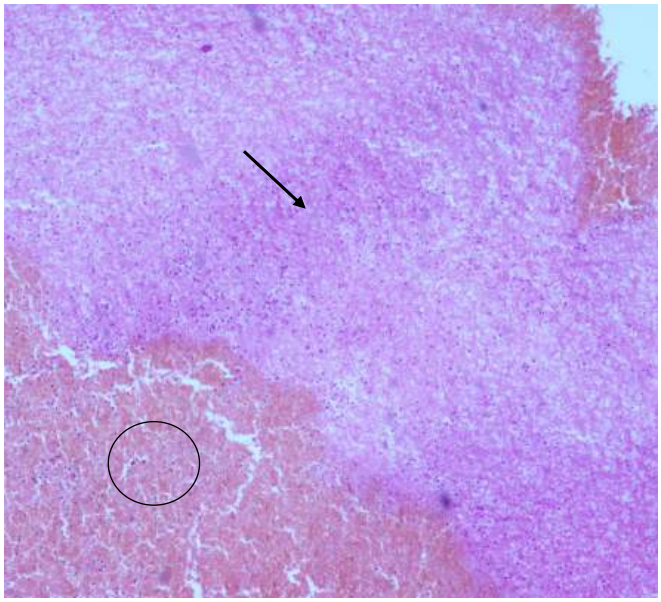
On internal examination: Tracheal mucosa was found to be congested and lumen contained blood-stained mucoid fluid. A white patch measuring 3X2cmwas noted over the anterior surface of the right ventricle, 4cms from the apex. Right coronary artery showed 50% occlusion along its entire course. Left anterior descending artery showed 75% occlusion for a distance of 4cm from origin. Large vessels like Aorta showed presence of multiple atheromatous streaks and plaques over the intima at several places.

Histopathological report : Heart revealed the presence of thrombotic vegetations in the tricuspid valve. On 100x magnification, alternating bands of fibrin with enmeshed RBCs and leukocytes (represented by the circle) and fungal colonies infiltrating the vegetation (represented by arrow) were seen. **(Figure 1-3)**

Other findings were chronic myocardial infarct with left coronary atherosclerosis, steatosis in Liver, pulmonary edema with bronchiectasis in Lungs and Acute pyelonephritis in Kidneys.

The final opinion into the cause of death was made to be Fungal Endocarditis.

Figure 1: Vegetation with alternate layers of blood components and colony of fungal species (H&E; x100)



DISCUSSION

Infective Endocarditis refers to the microbial infection of the valves of the heart. This results in the formation of thrombotic vegetations in the heart which may further lead to calcification of the underlying cardiac tissue. The vegetations are friable,

Figure 2: Vegetation with enmeshed fungal and bacterial organisms (H&E; x400).

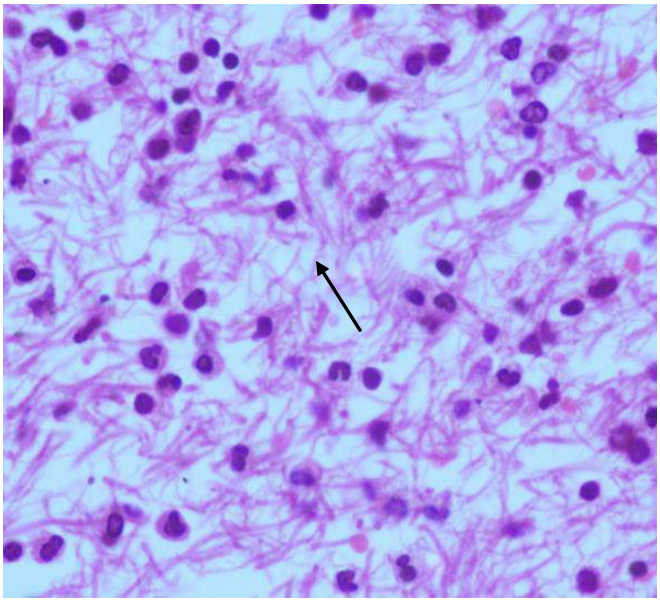
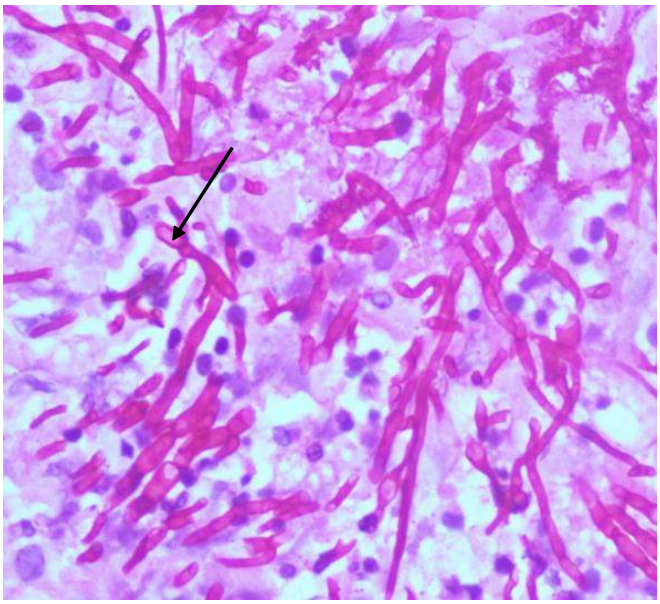


Figure 3: Fungal vegetation with colony composed of acute-angled branching septate hyphae (PAS ; x400).



may get dislodged easily and result in complications like septic infarcts,ring abscesses and mycotic aneurysms.[7] Cardiac failure may occur leading to conditions like pulmonary edema and glomerulonephritis. Systemic embolus is the most common complication of endocarditis involving major arteries and exerting a primary effect on the central nervous system.[8,9]

The main causative agents are bacteria- *Staphylococcus aureus* and *Streptococcus viridans.* Other agents like HACEK group(Hemophilus,Actinobacter,Cardiobacterium,Eikenella, Kingella), gram negative bacteria and fungi.[2] The etiologic

fungi more commonly involved are the *Candida* and *Aspergillus* species. They can be isolated from surgically removed emboli, resected valves, or infected foreign bodies[6]. *Candida albicans* is responsible for 24-46% of all the cases of FE and for 3.4% of all the cases of prosthetic valve endocarditis, with a mortality rate of 46.6-50%[6] .Candida forms biofilms on the native as well as prosthetic valves due to which treatment becomes difficult as it results in poor antifungal activity.[10,11]

The common symptoms of the disease are fever (present in 80% patients), chills,joint pain.excessive fatigue,chest pain and night sweats. Patients may also present with Roth spots, Osler nodes, Janeway lesions, subungual and subconjunctival hemorrhages.[3]

The clinical diagnosis is done based on the Duke's modified criteria where if there is a presence of either two major symptoms or one major and three minor ones or atleast five minor symptoms, it is confirmed as Infective Endocarditis. Major symptoms include presence of positive blood culture, evidence of endocardial involvement(echocardiographic identification). Minor symptoms include presence of any predisposing heart lesion or risk factors, fever, vascular or immunological phenomenon, micobiologic or consistent echocardiographic evidence.[3]

However, some patients might not present with common manifestations. And in some, the blood cultures test negative.[12] Therefore, the diagnosis and treatment become challenging. The overall mortality for IE remains high, ranging between 20% and 25%.[9]

Previous dental surgery and intravenous drug abuse were once reported to be the most frequent risk factors for development of FE. Other factors are immunosuppression, underlying cardiac abnormalities, prosthetic heart valves, indwelling central venous catheters, prolonged use of broad-spectrum antibiotics or steroids and cardiovascular surgery. Evolving myelodysplastic syndrome, use of cytotoxic drugs, and bone marrow transplantation with a high dose of immunosuppressive therapy are the major predisposing risk factors.[1,3]

CONCLUSION

The symptoms are highly variable and they develop gradually over time. As in this case the patient developed an atypical feature like breathlessness and could not be diagnosed in time. Sometimes the blood cultures also test negative due to which proper treatment is not provided to the patients in time. And as the complications are usually fatal, the mortality becomes substantial.

Therefore, high index of suspicion should be maintained in such conditions. Antimicrobial prophylaxis should be given to patients undergoing high risk procedures. Proper monitoring is also required.

REFERENCES:

1. Türkkan D, Yüksel F, Şamdancı E, Ak S. Enfektif Endokardite Bağlı Santral Sinir Sitemi Septik Embolisi: Otopsi Olgu Sunumu. Turgut Özal Tıp Merkezi Dergisi. 2010 Nov 23;17(4):387-9.
2. Baig W, Sandoe J. Infective endocarditis. Clinical Medicine. 2010 Apr 1;10(2):188–91.
3. Badiee P, Amirghofran AA, Ghazi Nour M, Shafa M, Nemati MH. Incidence and outcome of documented fungal endocarditis. Int Cardiovasc Res J. 2014 Dec;8(4):152–5.
4. Pierrotti LC, Baddour LM. Fungal Endocarditis, 1995–2000. CHEST. 2002 Jul 1;122(1):302–10.
5. Seo GW, Seol SH, No TH, Jeong HJ, Kim TJ, Kim JK, Song PS, Kim DK, Kim KH, Kim DI. Acute myocardial infarction caused by coronary embolism from Aspergillus endocarditis. Internal Medicine. 2014;53(7):713-6.
6. Rubinstein E, Lang R. Fungal endocarditis. European heart journal. 1995 Apr 1;16(suppl_B):84-9.
7. Vinay Kumar,Abdul Abbas,Jon Aster.Robbins and Cotran Pathologic Basis of Disease:South Aia 9th Edition.Elsevier India;2014.
8. Ulu-Kiliç A, Tütüncü E, Sari S, Sayar MS, Gürbüz Y, Çiçek-Sentürk G, Sencan I. Infektif Endokarditin Embolik Komplikasyonlari: Iki Olgu Sunumu ve Ulusal Literatürün Irdelenmesi/Embolic Complications of Infective Endocarditis: Report of Two Cases and Review of National Literature. Klimik dergisi. 2011 Dec 1;24(3):179.
9. Yuan S-M. Fungal Endocarditis. Braz J Cardiovasc Surg. 2016;31(3):252–5.
10. Hemphill I J Claude, Smith WS, Gress DR. Subarachnoid Hemorrhage. In: Jameson JL, Fauci AS, Kasper DL, Hauser SL, Longo DL, Loscalzo J, editors. Harrison's Principles of Internal Medicine, 20e [Internet]. New York, NY: McGraw-Hill Education; 2018 [cited 2018 Nov 15].
11. Demir T, Ergenoglu MU, Ekinci A, Tanrikulu N, Sahin M, Demirsoy E. Aspergillus flavus endocarditis of the native mitral valve in a bone marrow transplant patient. The American journal of case reports. 2015;16:25.
12. Castelli JB, Almeida G, Siciliano RF. Sudden death in infective endocarditis. Autops Case Rep. 2016 Sep 30;6(3):17–22.
13. Guler S, Sokmen A, Mese B, Bozoglan O. Infective endocarditis developing serious multiple complications. BMJ Case Reports. 2013 Jan 28;2013:bcr2012008097.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00122.3

A Case Report

Fatal Intussusception in a 2-month-old Infant: A Post Mortem Experience

1. **Zunaizah Hilmi**, Forensic Medical Officer, National Institute of Forensic Medicine (IPFN), Hospital Kuala Lumpur, Malaysia
2. **Effat Omar,** Professor, Institute of Pathology, Laboratory and Forensic Medicine (I-PPerForM), Faculty of Medicine, Universiti Teknologi MARA Sungai Buloh, Selangor, Malaysia.
3. **Mohd Shah Mahmood,** Head of Department and Forensic Pathologist, National Institute of Forensic Medicine (IPFN), Hospital Kuala Lumpur, Malaysia
4. **Ahmad Hafizam Hasmi,** Forensic Pathologist, National Institute of Forensic Medicine (IPFN), Hospital Kuala Lumpur, Malaysia
5. **Mansharan Kaur Chainchel Singh,** Associate Professor, Institute of Pathology, Laboratory and Forensic Medicine (I-PPerForM), Faculty of Medicine, Universiti Teknologi MARA Sungai Buloh, Selangor, Malaysia.

ABSTRACT:

Introduction: Intussusception, the invagination or telescoping of a proximal segment of bowel into an adjacent distal segment of bowel is the second commonest cause of abdominal emergency in children after appendicitis. It is important to note that intussusception though a relatively benign condition, can cause unexpected death due to misdiagnosis or delayed referral resulting in intestinal perforation.

Case Report: We report a case of a two- month old baby boy who presented to a general practioner with fever for two days, one episode of bilious vomiting and being less active for one day. He was examined and discharged with symptomatic treatment, however was found dead at 5am the next day.

Conclusion: This case highlights the importance of identifying the level of intussusception, bowel ischaemia and evidence of local or systemic diseases if possible, during autopsy to confirm the diagnosis.

Corresponding Author :
Dr. Mansharan Kaur Chainchel Singh,
Associate Professor,
: Institute for Pathology, Laboratory and Forensic Medicine (I-PPerForM),Universiti Teknologi MARA, Sungai Buloh, Jalan Hospital ,47000 Selangor, Malaysia.
Contact : +603-6126 7466
Email: mansharan@uitm.edu.my, mansharan70@gmail.com

Article History:
Received: 22 June 2020
Received in revised form: 1 November 2020
Accepted on: 1 November 2020
Available online: 30 April 2021V

KEYWORDS : Fatal; Intussusception; Systematic Approach; Autopsy

INTRODUCTION :

Intussusception, the invagination or telescoping of a proximal segment of bowel into an adjacent distal segment of bowel, is most common in children aged 3 months to 3 years with a male preponderance of 3:2. It is the second commonest cause of abdominal emergency in children after appendicitis with the most common type being ileocolic in 90% of cases, followed by ileo-ileal, jejunojejunal and colo-colic [1-2]. In children, 90% of intussusception are idiopathic in nature while other causes include enlarged Peyer patches, polyps, Meckel diverticula, cystic fibrosis, lymphoma, viral due to adenovirus and rotavirus vaccine.

Intussusception though relatively benign, can cause unexpected death due to misdiagnosis especially when symptoms are subtle or absent causing delayed referral resulting in intestinal perforation [3-4].

CASE PRESENTATION :

A two-month old Indonesian baby boy was brought to a private clinic with complaints of fever for two days, one episode of bilious vomiting and being less active for one day. He was examined and discharged with symptomatic treatment, however was found dead at 5am the next day one hour after his last bottle feed. The child was then brought by the investigating police officer to the National Institute of Forensic Medicine, Hospital Kuala Lumpur with a request for an autopsy to determine the cause of death.

Mother claimed that the infant had been well with an uneventful antenatal history and delivered full term via spontaneous vaginal delivery. He had completed immunization up to his age with no history of rotavirus vaccination or recent surgery.

A post-mortem computed tomography (PMCT) done prior to the autopsy showed an intestinal soft tissue mass lesion due to intestinal mural thickening of the bowel wall at the region of

the descending and sigmoid colon with dilatation of bowel loops proximal to it. There was no radiological evidence of pneumoperitoneum or free fluid and a presumptive diagnosis of intussusception of the descending colon was made which needed to be confirmed on autopsy **(Figure 1 a, b and c).**

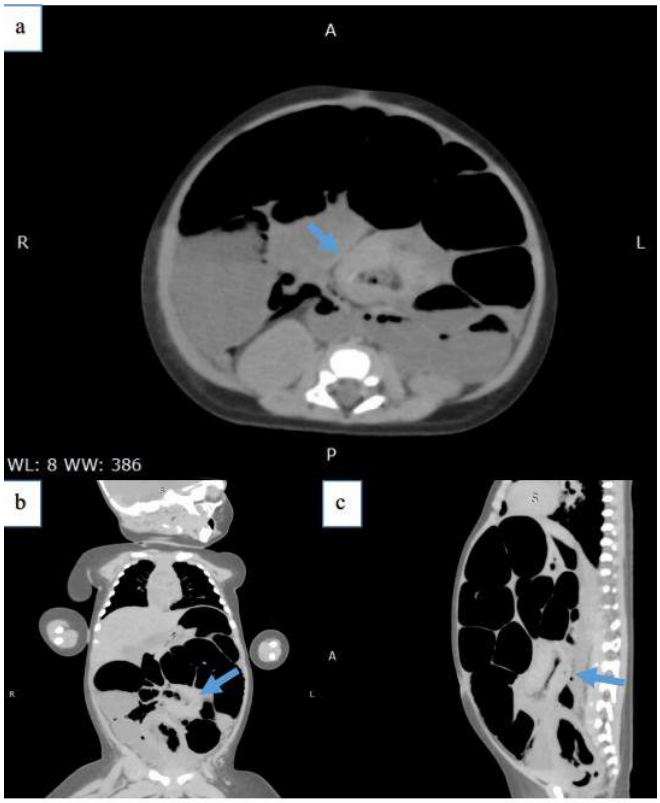


Figure 1. a) Axial PMCT demonstrating intussusception at the level of the sigmoid colon (blue arrow) with proximal bowel loop dilatation. **(b)** Coronal PMCT demonstrating intussusception at the level of the sigmoid colon (blue arrow) with proximal bowel loop dilatation. **(c)** Sagittal PMCT demonstrating intestinal mural thickening of the distal end of the descending colon (blue arrow).

External examination revealed a baby boy weighing 6.5kg which was less than the 2nd percentile for his age with a crown heel length of 68 cm. His abdomen was significantly distended with a firm mass at the supra-pubic region with feculent fluid inside the oral cavity and drooling of feculent fluid from both nostrils. Per rectal examination revealed a smooth, firm, palpable mass in the rectum with no evidence of red currant jelly stools. There were also no obvious syndromic features or significant marks of injury present.

Internal examination revealed 20 cc of straw-coloured fluid in the abdominal cavity with distended small bowel and adhesions between the bowel loops. The small and large intestine were also dusky in appearance with reddish to greenish discoloration of its walls. Further exploration was carefully done for evidence of herniation, adhesion, volvulus and intussusception. A colo-colic intussusception of the descending colon (intussusceptum) into the sigmoid colon (intussuscepient) measuring 4 cm in length was seen as a solid mass, with a twisted, collapsed, string of bowel as the lead point **(Figure 2)**.

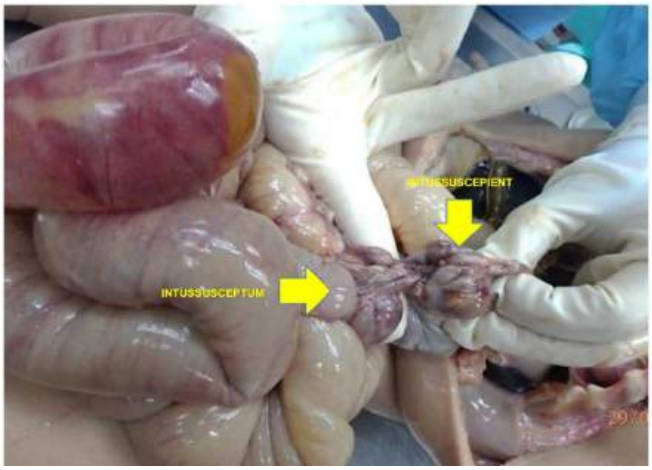


Figure 2 : Dilated bowel loops with colo-colic intussusception of the descending colon (intussusceptum) into the sigmoid colon (intussuscepient).

The crucial part of the examination was palpation of the bowel before and after the lead point leading to the diagnosis of intussusception based on its sausage-like consistency. Demonstration of intussusception was further confirmed by cutting the outer wall of the sigmoid colon to display the invagination of the descending colon into the sigmoid colon which explained the sausage-like consistency contributed by the gangrened bowel telescoping into the sigmoid colon.

Histological examination of the intestine showed superficial mucosal infarction with transmural hemorrhagic necrosis at the worst affected area. There was no evidence of tumour or polyps seen **(Figure 3 a and b)**.

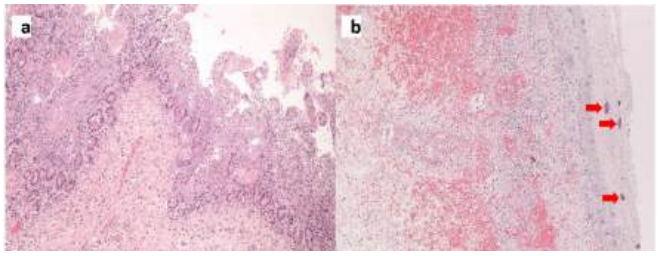


Figure 3 : (a) Sections from the more viable area of the bowel showing superficial mucosal infarction and viable deeper portion of the organ. **Figure 3 (b)** The worst affected area with total gangrene of the entire bowel wall. Bacteria colonies are seen at the serosa (arrow). No evidence of tumour, polyps or any other mass lesion seen.

DISCUSSION :

Intussusception the invagination or telescoping of a proximal segment of bowel into an adjacent distal segment of bowel is the second commonest cause of abdominal emergency in children after appendicitis with a mortality of 9.4% [5]. Imaging which include plain x- rays, ultrasound, computed tomography and magnetic resonance imaging play an important role in the diagnosis of intussusception as in this case. This is because in addition to helping diagnose intussusception, imaging also helps identify pathological lead points [1].

Autopsy in possible deaths due to intussusception should include a clear description of the level of the lesion, with demonstration of vascular compromise, ischaemic damage to the intestinal wall and a careful examination to identify local causes of intussusception. Blood cultures may be useful in demonstrating disseminated sepsis while vitreous humour electrolyte measurements may indicate dehydration [2,4]. We recommend evaluation of the intussusception be made in situ by first palpating the mass before and after the lead point to differentiate a volvulus and intussusception during autopsy and cutting the outer layer of the intussusception, in this case, formed by the sigmoid wall to reveal the underlying intussusceptum.

At autopsy, it is also important to distinguish agonal intussusception from one which can cause ante mortem functional disturbance as agonal intussusceptions are believed to occur terminally, possibly related to intestinal dysmotility and peristaltic incoordination, and are an incidental finding, not a cause of death [2,6]. Agonal intussusception can be differentiated from ante mortem intussusception during autopsy as it is easily reducible and bowel loops will be viable. In this case however the bowel loops were dusky with reddish to greenish discoloration of its walls.

Lastly a review of the presenting history, clinical examination and a high suspicion of a possible intussusception is very important in order to avoid deaths due to misdiagnosis and delayed referrals as not all cases present with the typical symptoms of abdominal pain, vomiting and bloody stools [2,3].

CONCLUSION :

Intussusception is the invagination or telescoping of a proximal segment of bowel into an adjacent distal segment of bowel. Autopsy assessment of death due to intussusception should include a clear description of the level of the lesion demonstrated in this case by cutting the outer wall of the sigmoid colon, with demonstration of vascular compromise and resultant ischaemic damage to the wall of the intestine on histology to differentiate it from agonal intussusception.

Though intussusception is a relatively benign and treatable condition, potential and unexpected death can occur at any age with intussusception at any level as a result of misdiagnosis or delayed referral resulting in intestinal perforation.

Acknowledgement :

The authors would like to thank the Director of Health, Malaysia for permission to publish this paper. We would also like to express our appreciation to the Director of Hospital Kuala Lumpur and Director of the National Institute of Forensic Medicine, Malaysia, for allowing the use of resources throughout the study as well as staff of the Forensic Department involved in this case.

Declaration of Interest : Authors declare that there is no conflict of interest and no financial interest or benefit that has arisen from the direct applications of this case report.

REFERENCES :

1. Katherine Mandeville, Ming Chien, F. Anthony Willyerd, Gerald Mandell, Mark A. Hostetler and Blake Bulloch. Intussusception: Clinical Presentations and Imaging Characteristics. Pediatric Emergency Care 2012; 28 (9): 842-844.
2. R W Byard and A. Simpson. Sudden Death and Intussusception in Infancy and Childhood - Autopsy Considerations. Med. Sci. Law 2001; 41(1):41-45. Sudden Death and Intussusception in Infancy and Childhood - Autopsy Considerations. https://doi.org/10.1177/002580240104100108
3. Paul M. Ng'walali, Kosei Yonemitsu, Shigeyuki Tsunenari. Fatal intussusception in infancy: an experience in forensic autopsy. Legal Medicine 2003; 5: 181–184. https://doi.org/10.1016/S1344-6223(03)00056-7
4. Yap Shiyi, Eileen, Ganapathy, Sashikumar. Intussusception in Children Presenting to the Emergency Department: An Asian Perspective. Pediatric Emergency Care– 2017; 33(6):409413.
5. Edino ST, Ochicha O, Mohammed AZ, Anumah M. Intussusception in Kano: a 5-year analysis of pattern, morbidity and mortality. Nigerian journal of medicine: Journal of the National Association of Resident Doctors of Nigeria 2003;12(4):221-4.
6. Hirotaro Iwase, Hisako Motani, Daisuke Yajima, Mutsumi Hayakawa, Kazuhiro Kobayashi, Kaoru Sato, et al. Two Infant Deaths Linked to Intussusception without Peritonitis. Legal Medicine 2010; 12:151–153. https://doi.org/10.1016/j.legalmed.2010.02.002

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00123.5

A Case Report

Deaths Due To Illegal Electrification of Barbed Wire – A Case Report

1. **Pavanchand Shetty,** Associate Professor, Department of Forensic Medicine and Toxicology, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal, Karnataka, India
2. **Haneil Larson Dsouza,** Associate Professor, Department of Forensic Medicine and Toxicology, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal, Karnataka, India
3. **Anita S,** Associate Professor, Department of Forensic Medicine and Toxicology, Kasturba Medical College, Manipal, Manipal Academy of Higher Education, Manipal, Karnataka, India
4. **Francis NP Monteiro,** Professor and HOD, Department of Forensic Medicine and Toxicology, AJ Institute of Medical Sciences and Research Centre, Mangalore

ABSTRACT:

From running small gadgets to powering the omnipresent cell phone, use of electricity and electrical gadgets cannot be escaped. Unfortunately, this ubiquity has also led to various ways to get injured or even die from electricity. Though all electrical instruments carry with them some inherent risk in their use, a peculiar problem met in India is the use of electricity in unintended and dangerous ways. This can vary from modified electric fishing poles to electrified barbed wires used for hunting. In this case, portable electrified barbed wires were erected in a forested area to kill and obtain wild boar. Two men who had gone hunting in the same forest were found dead there. On one body, characteristic patterned burn injuries resembling the pattern of barbed wires were present. The cause of death was found to be due to electrical injuries. Finding bodies with burn injuries due to electricity in a forested area will usually raise suspicion of lightning injuries. Nevertheless, an unusual pattern of injuries should be investigated further. In this case, an examination of the crime scene led to the possible scenario of electrification injuries which was confirmed by autopsy and police investigations.

Corresponding Author :
Dr. Haneil Larson Dsouza,
Associate Professor,
Department of Forensic Medicine and Toxicology, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal, Karnataka, India
Contact : +91 9845175456
Email: hanihere@gmail.com

Article History:
Received: 16 November 2020
Received in revised form: 10 December 2020
Accepted on: 10 December 2020
Available online: 30 April 2021

KEYWORDS : Barbed Wire, illegal electrification, electrical burn injuries, electric fences

INTRODUCTION :

From running small gadgets to powering the omnipresent cell phone, use of electricity and electrical gadgets cannot be escaped. Unfortunately, this ubiquity has also led to various ways to get injured or even die from electricity. Though all electrical instruments carry with them some inherent risk in their use, a peculiar problem met in India is the use of electricity in unintended and dangerous ways. This can vary from modified electric fishing poles to electrified barbed wires used for hunting. Recklessness, improper use or improper upkeep of wiring and equipment have been stated as the most common causes of electrocution[1]. As per one media report, in one area of Kerala, along with 553 animals, 2439 people were killed in electric fence related incidents over ten years[2]. Other regions all over India have reported accidental deaths due to illegal electric fences as well. In the unfortunate incident in the case reported here, multiple factors played a role in the deaths.

CASE DESCRIPTION :

In this case, portable electrified barbed wires were erected in a forested area to kill and obtain wild boar. Two men who had gone hunting in the same forest were found dead there. At the time of discovery of the bodies, both bodies showed signs of putrefaction such as gas stiffening and purging of fluids. On one body, no characteristic injuries could be found. On the other body, however, characteristic patterned burn injuries resembling the pattern of barbed wires were present **[Figure 1 and 2]**.

These consisted of a deep burn injury resulting in the splitting of the skin, measuring 33 x 1.5 cm x muscle deep at its centre (subcutaneous deep at the edges) with charring of the margins present over the back of the chest, 7 cm below the base of the neck.

Another full-thickness burn injury resulting in the splitting of the skin, measuring 25 x 5 x dermis deep with charring of the margins was present over the back of the abdomen, 25 cm below the first injury.

A third injury consisted of a deep burn injury resulting in the splitting of the skin, measuring 8 x 4 cm x subcutaneous deep at its centre (dermal deep at the edges) with charring of the margins was present over the back of the right forearm, below the elbow joint.

Histopathology features also confirmed the injuries to be due to electrocution. These included the skin showing ulceration, spongiosis and vertical elongation of superficial keratinocytes of the epidermis. The dermis showed homogenized eosinophilic collagen oriented perpendicular to the epidermis. Subepidermis clefting was also seen. Thus, the cause of death was found to be due to electrical injuries.

DISCUSSION :

Electric fences are used for both as a conservation modality for wild animals by limiting their interaction with humans, and also as a means of protecting animals raids on crops [3]. In the Indian context, electric fences using a voltage of 5 kV were shown to generate adequate electric shock to thwart elephants from breaking fences[4]. Electric fences may also serve as a way of minimizing human fatalities by wild animals by preventing their entry into human habitats. This does not consider the illegal use of electric fences for hunting, a common practice in some parts of India. These illegal electric fences do not use an electric fence energizer, thereby causing all of the electricity to be directly transferred to any animal or person coming into contact with the fence[2].

The comparative impacts of damage due to a pure electric component and a thermal component depend on multiple factors such as the alignment of the cells in the current path, their position, the period of electric current movement, among others. With a brief contact time, non-thermal processes of cell damage will be the most important factor, with the damage being relatively confined to the cell membrane. With a longer contact time, damage due to the thermal component dominates, and the entire cell is affected directly[5]. In this case, another factor that needs to be considered is the fact that the barbed wire may have trapped the individuals or at the very least made it very difficult to escape as one of the applications of a barbed wire is also to trap trespassers. Mechanism of electric deaths is primarily physiological, and, consequently, the autopsy findings are usually not overtly apparent and mostly non-specific [6]. A significant exception, however, is the presence of entry and exit wounds. In this case, not only were the histopathological features characteristic of electrical injuries, but the external appearance was a perfect match to the source of electricity, in this case, the electrified barbed wires. The charring too of the injuries was characteristic. It has been stated that " the primary factors contributing to charring are possibly electric current and duration, and the dryness or dampness of the skin, which greatly affects its resistance"[6].

CONCLUSION AND IMPLICATIONS FOR CLINICAL PRACTICE :

Finding bodies with burn injuries due to electricity in a forested area will usually raise suspicion of lightning injuries. Nevertheless, an unusual pattern of injuries should be investigated further. In this case, an examination of the crime scene led to the possible scenario of electrification injuries which was confirmed by autopsy and police investigations.

REFERENCES :

1. Shaha KK, Joe AE. Electrocution-related mortality: A retrospective review of 118 deaths in Coimbatore, India, between January 2002 and December 2006. Med Sci Law. 2010;50(2):72–4.
2. Kumar PL. 553 animals killed by electrocution during last 10 years [Internet]. [cited 2020 Nov 10]. Available from: https://english.mathrubhumi.com/news/kerala/553-animals-killed-by-electrocution-during-last-10-years-1.4421023
3. Kioko J, Muruthi P, Omondi P, Chiyo PI. The performance of electric fences as elephant barriers in Amboseli, Kenya. African J Wildl Res. 2008;38(1):52–8.
4. Sukumar R. Wildlife-Human Conflict in India: An ecological and social perspective. In: R. Guha, editor. Social ecology Oxford University Press … [Internet]. Oxford University Press Delhi, India; 1994. p. 303–17.
5. Lee Raphael C. Injury by electrical forces: Pathophysiology, manifestations and the rapy. Curr Probl Surg [Internet]. 1997 [cited 2020 Nov 10];34(9):684–764.
6. Michiue T, Ishikawa T, Zhao D, Kamikodai Y, Zhu BL, Maeda H. Pathological and biochemical analysis of the pathophysiology of fatal electrocution in five autopsy cases. Leg Med [Internet]. 2009;11(SUPPL. 1):S549–52.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00124.7

A Case Report

Acute Mesenteric Ischemia Due to Amphetamine Use - A Case Report

1. **Anitha Shivaji,** Associate Professor*
2. **Ashwini Kumar,** Associate Professor*
3. **Vinod C Nayak**, Professor*
4. **Vikram Palimar,** Professor*
5. **Shankar M Bakkannavar,** Associate Professor*
6. **Nirmal Krishnan,** Assistant Professor*
7. **Arpita Pradhan,** II year MBBS student, Kasturba Medical College, Manipal, Manipal Academy of Higher Education.

*Department of Forensic Medicine and Toxicology, Kasturba Medical College, Manipal, Manipal Academy of Higher Education.

ABSTRACT:

Introduction: Mesenteric ischemia is the cause leading to gangrene of the small intestine. The cause being atherosclerosis and is commonly seen in old individuals. However, in young patients, it is a rare phenomenon and the cause can be attributed to drugs of abuse such as cocaine, methamphetamine which makes our case distinct.

Case details: A 19 year old female was suffering from vague symptoms like pain abdomen and burning micturition since two months which increased 2 days prior to her death. She consulted a doctor but refused admission. The diagnosis was not made and she was prescribed medications for the pain. She was found unresponsive and when taken to hospital, the doctor declared as brought dead. The salient autopsy feature were small intestine gangrene and bronchiolitis which were confirmed by histopathology. The toxicology analysis of postmortem blood tested positive for amphetamine.

Discussion: Amphetamine addiction is common among today's youth by virtue of its stimulant effects. Even though used in treatment of conditions such as ADHD, it is prone to cause addiction. It has various side effects and causes complications related to central nervous system. However, the gastrointestinal effects are rare with mesenteric ischemia being the prominent cause.

Corresponding Author :
Dr. Anitha Shivaji,
Associate Professor
Department of Forensic Medicine and Toxicology, Kasturba Medical College, Manipal, Manipal Academy of Higher Education.
Contact : +91
Email:

Article History:
Received:
Received in revised form:
Accepted on:
Available online: 30 April 2021

KEYWORDS : Small intestine gangrene, amphetamine, mesenteric ischemia

INTRODUCTION:

Mesenteric ischemia is a common cause of intestinal gangrene in elderly age group. It is classified as acute and chronic with the causes of former being atrial fibrillation, heart failure, chronic kidney failure, conditions prone to forming blood clots. The causes in chronic ischemia are atherosclerosis commonly seen in old patients. The symptoms in acute condition is mostly severe abdominal pain whereas in chronic, there is abdominal pain after eating, unintentional weight loss, vomiting. The acute or chronic types are seen in individuals above 40 years. The other cause of mesenteric ischemia is due to use of recreational drugs like cocaine and amphetamine group of drugs.[1,2] The effects of amphetamine can be beneficial for preexisting psychological conditions like ADHD, its misuse or overuse can lead to addiction and acute psychosis along with established cardiovascular and cerebrovascular pathologies.[3] The amphetamine and methamphetamine use is a rare cause of gastrointestinal pathology causing non occlusive intestinal is chemia and can be challenging clinically. It causes splanchnic vasoconstriction which results in mesenteric is chemia and can cause bowel necrosis.[4] Only a few case reports have confirmed this due to its high morbidity and mortality. The following case is hereby presented as the mesenteric is chemia with positive test for amphetamine at autopsy of a young woman as an isolated cause was noted.

CASE PRESENTATION:

A 19 year old woman had succumbed in her sleep and postmortem examination was carried out. As per the history furnished, it was alleged that she was unwell, on and off, since last 2 months and had quit her job and was staying at home. There was burning micturition and pain abdomen, three days

prior to her death for which she had consulted a doctor nearby and was prescribed medications for the same (antibiotics). The next evening she had her menstrual bleeding. The same night at 12 am she complained of severe pain abdomen for which she was taken to a hospital where doctors advised to get admitted. However she refused admission and left. The next day at 7 pm, she went to sleep and having dinner. When her parents came to check on her at around 8 pm, she did not respond to them and was again taken to the same hospital where the doctor examined and told she had passed away.

Her body was stored in cold chamber till request for autopsy was made. The findings at the autopsy were that she was underweight (BMI was 16), pale postmortem lividity with no other remarkable external findings. On internal examination, there was pulmonary edema, cerebral edema and no signs of pulmonary thromboembolism. There was 200 ml of blood stained fluid in peritoneal cavity. The ileum showed black discolouration at a site 60 cm from the ilio-caecal junction measuring 15 cm in length. The surrounding portion of ileum showed reddish black dicolouration measuring 10 cm on either sides. On dissection, the layers at the black discoloured site was thinned out with black discolouration extending till the mucosa. The content was pasty black fecal matter. A few lymph nodes were also noted at the mesentry adjoining the ilieum. These findings were suggestive of gangrene of small intestine. **(photograph 1 & 2)** The heart, liver, stomach, spleen and uterus were intact and unremarkable. The histopathology of lung and intestine revealed acute (fungal) bronchiolitis and gangrenous necrosis of small intestine with no occlusion noted in mesenteric vessels. The toxicology analysis of urine was done for detection of poison and was positive for Amphetamine. The cause of death was opined to be due to intestinal gangrene due to non-occlusive mesenteric ischemia possibly due to amphetamine. The history regarding amphetamine use or abuse could not be ascertained by her relatives. However, they gave history about her solitude behavior, loss of appetite and few incidents where she had borrowed money from her friends.

DISCUSSION :

Amphetamine and its substitute such as methamphetamine, ephedrine, MDMA (ecstasy) have a wide range of use as drug of treatment and for abuse. Amphetamine is a CNS stimulant used as a therapeutic drug in conditions like ADHD, acts by increasing the dopamine levels, but it has a high addiction potential and can be abused by certain proportion of the population, though not by everyone. There can be variations in the basal dopamine and people with higher D2 receptors as measured by [^{11}C]-raclopride positron emission tomography (PET) may find the effects aversive[5]. Amphetamine and its derivatives is also a component of weight loss supplements which are adulterated with multiple pharmaceutical agents such as potent anorectics, benzodiazepines, beta-blockers, and other medications to suppress the anorectic adverse effects. These are marketed as bright colored pills with varying colours and the term "rainbow diet pill" is used.[6] The people who consume the tablets lose weight due to the suppression of appetite but also suffer from other ill effects such as hypertension, tachycardia, arrhythmias, and in certain instances acute myocardial infarction.[7] Methamphetamine is known to cause splanchnic vasoconstriction which can be followed by gastrointestinal effects including bowel ischemia and there are few case reports that confirm the same.[3,8,9,10] It is well established that cocaine and amphetamine poisoning have similar presentation with hyperexcitement and heart palpitations. Amphetamine however causes 100-200 times increase in tolerance from the usual dose. Cocaine and amphetamine rarely cause death and is usually due respiratory depression as a result of true overdose in relation to the usual intake. The other causes of death are due to myocardial complications.[11] Cases of cocaine abuse leading to ischemic bowel and ischemic colitis have been reported where patient presented with weight loss, recurrent abdominal pain and bloody diarrhea.[12] Methamphetamine and its associated drugs is known to have sympathomimetic effect causing vasoconstriction in splanchnic circulation. They also cause catecholamine release and its uptake at presynaptic axon terminals is reduced which leads to excess catecholamines producing sympathomimetic vasoconstriction by acting on

alpha-1adrenergic in the arteriolar smooth muscle. The other known cardiovascular and cerebrovascular complications include hypertensive crises, myocardial infarction, and cerebrovascular accidents.[2]

In our case, the most probable cause of small bowel ischemia is amphetamine-induced vasoconstriction. The gangrene was localized at ileum, supplied by superior mesenteric artery which is most commonly affected.[13] Colonic ischemia is usually more transient and resistant to gangrene formation and tends to resolve without surgery or further complications.[14] Non-occlusive intestinal ischemia has a mortality rate of 70–90%.[15] These group of drugs also causes changes in the adaptive immune response, permitting the unrestrained development of opportunistic diseases which could be the reason of the histopathology finding of fungal bronchiolitis in our case.[16] The history of unwillingness for treatment, changes in appetite and money seeking behavior and the findings at autopsy certainly strongly points towards amphetamine overdose. As many reports are being published in the news regarding amphetamine replacing cocaine as a cheap substitute, the doctors and authorities need to work together in identifying, treating and curbing the menace of drug abuse.[17]

REFERENCES:

1. Endress C, Gray DG, Wollschlaeger G. Bowel ischemia and perforation after cocaine use. American journal of Roentgenology. 1992; 159(1):73-5.
2. Kihoon Choi, Andrew Imrie. Intestinal ischemia due to methamphetamine use: A case report. International Journal of Surgery Case Reports. 2019; 58: 11–13.
3. H. Attaran, Fatal small intestinal ischemia due to methamphetamine intoxication: report of a case with autopsy results. Acta Medica Iranica. 2017; 55: 344–347.
4. J.E. Anderson, I.E. Brown, K.A. Olson, K. Iverson, C.S. Cocanour, J.M. Galante. Nonocclusive mesenteric ischemia in patients with methamphetamine use. Journal of Trauma and Acute Care Surgery. 2018; 84: 885–892.
5. David J Heal, Sharon L Smith, Jane Gosden and David J Nutt. Amphetamine, past and present – a pharmacological and clinical perspective. Journal of Psychopharmacology. 2013; 27(6): 479–496.
6. Pieter A. Cohen, Alberto Goday, John P. Swann. The Return of Rainbow Diet Pills. American Journal of Public Health. 2012; 102(9): 1676–1686.
7. Perez-Downes, J., Hritani, A., Baldeo, C., & Antoun, P. Amphetamine Containing Dietary Supplements and Acute Myocardial Infarction. Case reports in cardiology. 2016. 6404856. doi:10.1155/2016/6404856
8. Brannan TA, Soundararajan S, Houghton BL. Methamphetamine associated shock with intestinal infarction. Medscape General Medicine. 2004; 6: 6.
9. Parsa C, Orlando R, Felman I, Duarte DA, Jacoby B. Multiple-organ failure due to abuse of methamphetamine-A case of Methamphetamine-associated intestinal infarction presenting with altered mental status, abdominal pain, and laboratory findings reminiscent of diabetic ketoacidosis. Journal of Southern California Clinicians. 2012;6:25-28.
10. Holubar SD, Hassinger JP, Dozois EJ, Masuoka HC. Methamphetamine colitis: a rare case of ischemic colitis in a young patient. Archives of Surgery. 2009;144(8):780-2.
11. Cesare George Tedeschi, Luke G. Tedeschi, William G. Ecker. Forensic Medicine Vol II-Physical trauma. Injury caused by chemical agents-Drug abuse. Michigan: WB Saunders company; 1977: 826-829.
12. Khaldoon Shaheen et al. Illicit Drug, Ischemic Bowel. The American Journal of Medicine. 2011; 124(8): 708 - 710
13. J. Osorio, N. Farreras, L. Ortiz De Zárate, E. Bachs, Cocaine-induced mesenteric ischaemia, Digestive Surgery. 2000;17(6):648-651.
14. I.H. Hundscheid, J. Grootjans, K. Lenaerts, D.H. Schellekens, J.P. Derikx, B.T. Boonen, et al., The human colon is more resistant to ischemia-reperfusion-induced tissue damage than the small intestine: an observational study, Annals of Surgery. 2015; 262(2):304-11.
15. A. Mitsuyoshi, K. Obama, N. Shinkura, T. Ito, M. Zaima, Survival in nonocclusive mesenteric ischemia: early diagnosis by multidetector row computed tomography and early treatment with continuous intravenous high-dose prostaglandin E(1), Annals of Surgery. 2007; 246 (2): 229–235.
16. Salamanca Sergio, Sorrentino Edra, Nosanchuk Joshua, Martinez Luis. Impact of methamphetamine on infection and immunity. Frontiers in neuroscience. 2014; 8: 445.
17. Mail Today 2015, 'Amphetamine becomes cheap substitute of cocaine for Delhi youth', India Today, 1 June, assessed May 2019.

    (https://www.indiatoday.in/mail-today/story/amphetamine-cocaine-delhi-youth-party-drug-issue-rave-291753-2015-05-31)

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00125.9

Review Article

Comparative Analysis of Security Features of Passports of Different Countries

1. **Kiran,** Assistant Professor, Department of Forensic Science, Lovely Professional University, Phagwara, Punjab, India
2. **Baibhaba Satpathy,** B.Sc. Forensic Science, Department of Forensic Science, Lovely Professional University, Phagwara, Punjab, India
3. **Ananya Tiwari,** Assistant Professor, Department of Forensic Science, Lovely Professional University, Phagwara, Punjab, India

ABSTRACT :

Passport is considered as the first line of security in any country from external affairs. It marks out a person citizenship and also plays an important role in economic as well as security advancement of a country. However, these days many terrorist activities are taking place with the help of forged passport by manipulating one's identity due to which it is not only pointing out flaws in one's country security capabilities but also creating antisocial relationships with other countries. In this review security feature of passports of different countries were compared with the security features of Indian passport and examined how strong or weak it is from them. As we know in today's world producing a forged passport is easier than before so study of the security features plays an important role among the forensic document experts. Passports of countries such as Sri Lanka, Maldives and Tanzania were taken and their security features were studied.

Corresponding Author:
Kiran,
Assistant Professor,
Department of Forensic Science, Lovely Professional University, Phagwara, Punjab, India
Contact : +91 8700500226
Email : kiranyadav128@gmail.com

Article History :
Received : 27 November 2019
Received in revised from : 12 April 2020
Accepted on : 12 April 2020
Available online : 30 April 2021

Key words : Visa, Security Feature, Machine Readable Zone

INTRODUCTION :

In recent day to day world,National security is becoming the most concerned topic for country's governmental agencies. Moreover, in recent changing scenario of modern civilisation criminals are much more organised than the investigators. Day by day it is becoming difficult to approach some of the criminal because of their knowledge, they are becoming more high-tech which is a great threat to any country's National security. As the topic comes to passport security features nowadays criminals are able to produce unlawful counterfeit travel documents very easily. In every country passport is important travel document issued by government, Ministry of External affairs of the specific country.so learning its security features and knowing the criminals mind in duplication of passport is becoming the eye-catching topic for Forensic Investigator because passport forgery is directly related with the diplomatic as well as internal security of the country.In the upcoming era technologically is developing drastically along with the scientific techniques. Hence the probability of forging a passport is increasing drastically. As passport proves a person citizenship it can also be forged and used for illegal purposes so each and every country has included certain safety features into their passport.

Security features present in Passport of Sri Lanka:

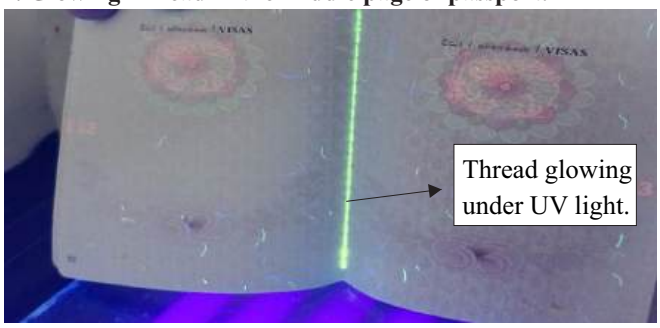
Sri Lanka is an island nation south of Indian Ocean. The people living in Sri Lanka were issued Sri Lanka passports for the purpose of International travel. The responsibilities of issuing passports to Sri Lanka citizens are taken by the Department of Immigration and Emigration. It is considered as one amongst strongest passport. It has taken 94th rank out of 100 countries according to Passport Power Rank Index.

In Sri Lanka passports are divided into five categories:

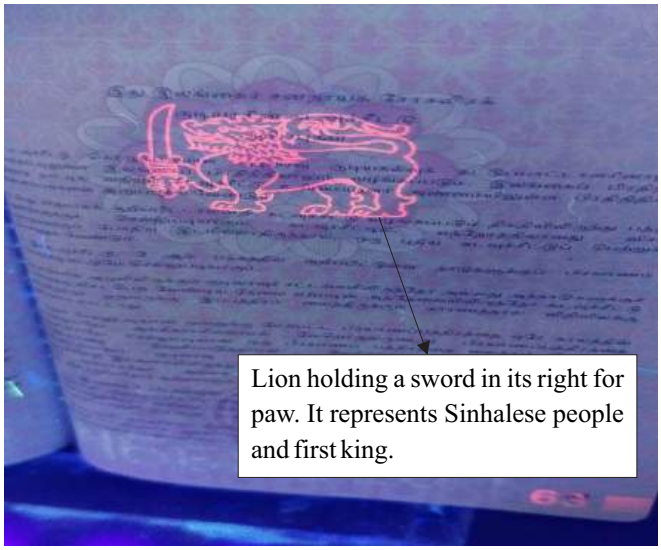
1. **Diplomatic Passport:** It is in Light Red colour, issued to Sri Lanka diplomats i.e. top government officials and Diplomatic couriers.
2. **Official Passport:** It is in Red colour, issued to Sri Lankan government official for state or business purposes.
3. **Ordinary Passport:** It is in Maroon colour, issued fornormal travelling such as vacations, tripsetc.It is valid for all countries.
4. **Non-Machine-Readable Passports:** It is in Brown colour, issued by Sri Lanka Mission under Special Circumstances.
5. **Emergency certificate:** It is in silver colour, valid For India and Nepal in case of Medical treatment purpose.

Some of the security features present in Sri Lankan Passport are:

1. Glowing Thread in the middle page of passport.

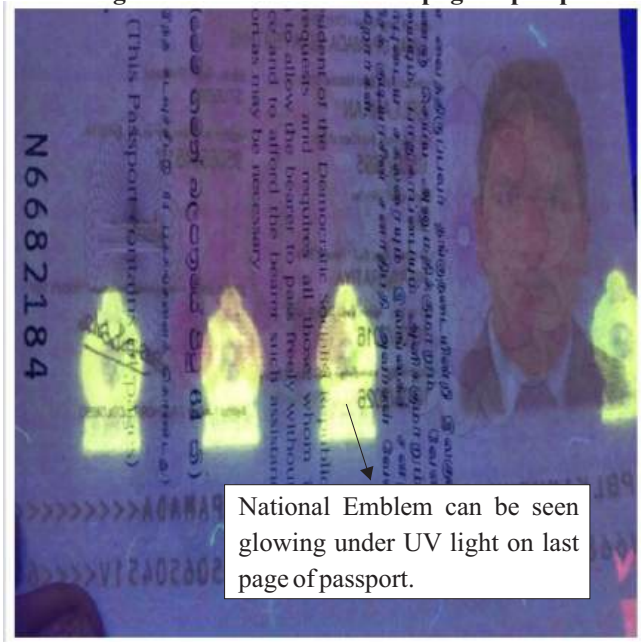


2. Glowing Lion present on every passport page.

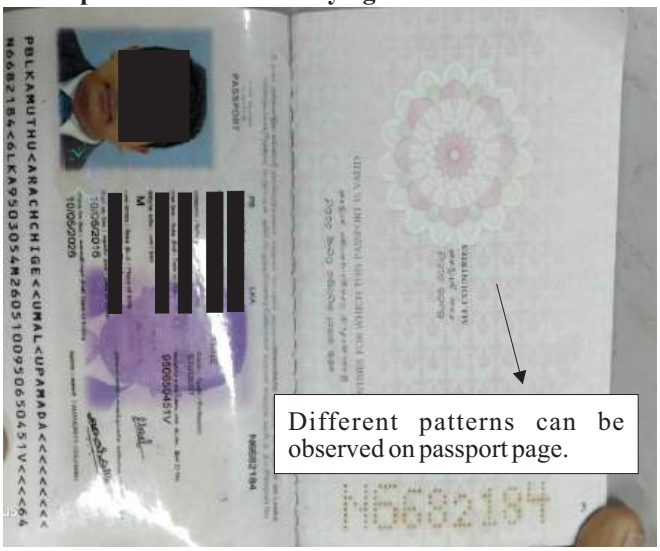


3. Glowing National Emblem on first page of passport

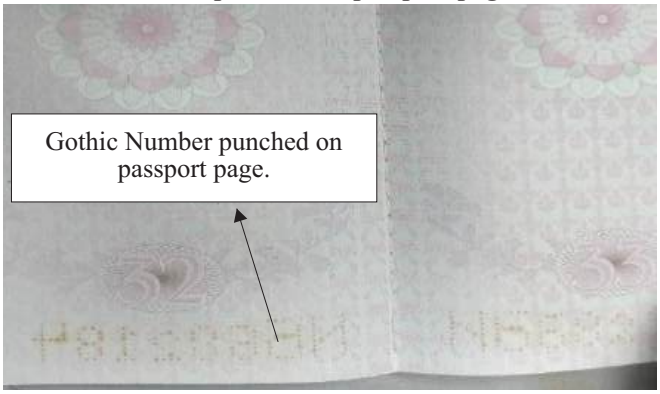
4. Glowing National Emblem on last page of passport



5. Passport under normal day light.



6. Gothic Number punched on passport page.



Security features present in Passport of Maldives:

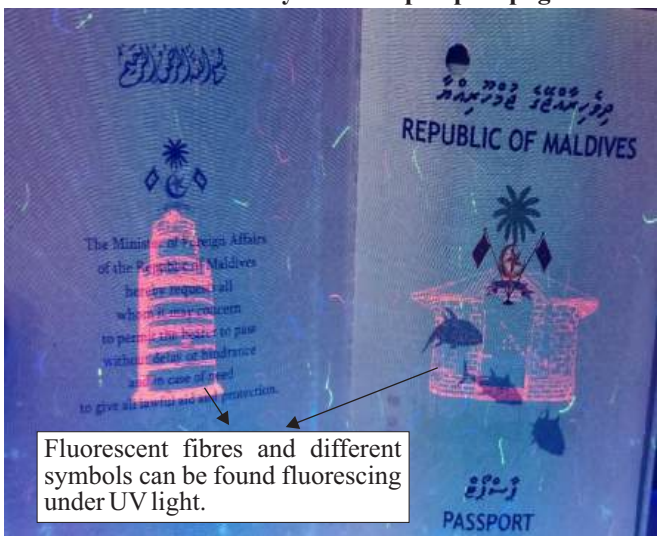
Maldives passport card claim to be the world first bankcard made up of polycarbonate material with a dual interface chip for contactless card reading certified by bank of Maldives.The card contains biometric data of card holder,this bio-metric passport released in late 2007.Maldives passport will expire after 5 year from the date it has been issued. As well as it is used as passport card. It is useful as national ID used for payment method, driving license, health card and also insurance card. Therefore, Maldives people do not want to carry so much cards with them. This passport introduced as a novel multiapplication card this idea was developed by Maldives immigration in Conjunction with Hum burg - Dream log.The card contains biometric data of the card holder such as fingerprints and this feature allows the Maldives passport card to be use like a regular passport at all boundaries of Maldives. The passport card confirms to International Civil Aviation Organisation (ICAO) international passport standard and has PCMDV as the first five characters in its Machine-Readable Zone (MRZ).

Design of Maldives Passport:

A normal passport is issued with 32pages for about MRF1000but the Maldives passport are issued with 64pages for about MRF1500.The passport will expire after 5years from the date it has been issued. Maldives show their culture in the passport with a sketch in colour on the top-right of each page in the passport and it is very colourful with a pinkish tinge on the page inside and in every page, there will be written numbers.We can see emblem of Maldives in their passports.

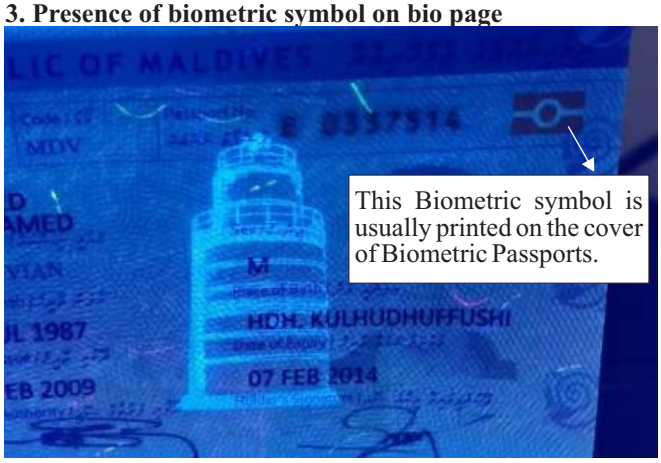
Some of the security features present in Maldives Passport are:

1. Presence of different symbols on passport pages.

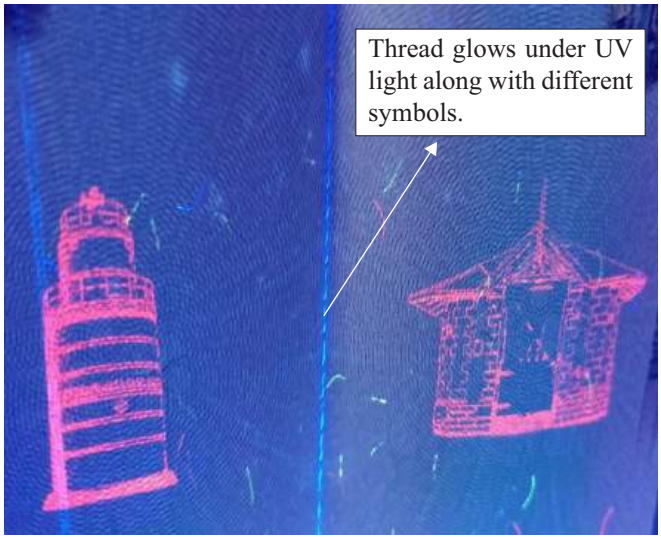


2. National Emblem on first page of passport

3. Presence of biometric symbol on bio page



4. Thread used for stitching glows under UV light

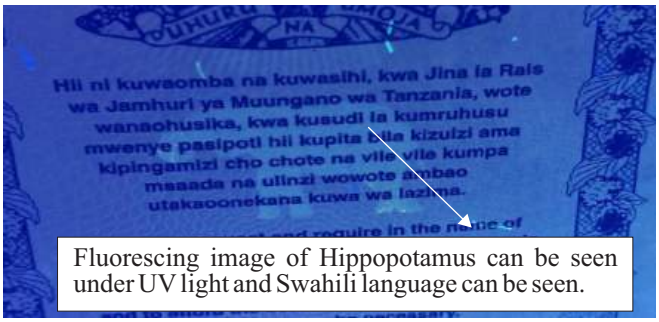


Security features present in Passport of Tanzania:

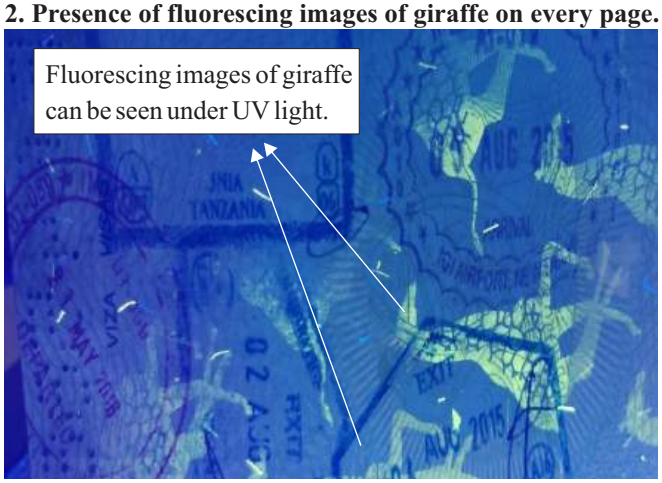
For international travel, the Tanzanian passport is issued to the citizens of United Republic of Tanzania. As for the security concern there are mainly three types of passports- ordinary, service and diplomatic. The ordinary passport is in (navy blue) colour and are for ordinary citizens, service passport in (red) colour which is issued to government employees for work related travel and diplomatic passport which is in (green) colour is issued to diplomats of country and their accompanying dependants. It is usually valid for 10 years from the issued date.

Some of the security features present in Tanzanian Passport:

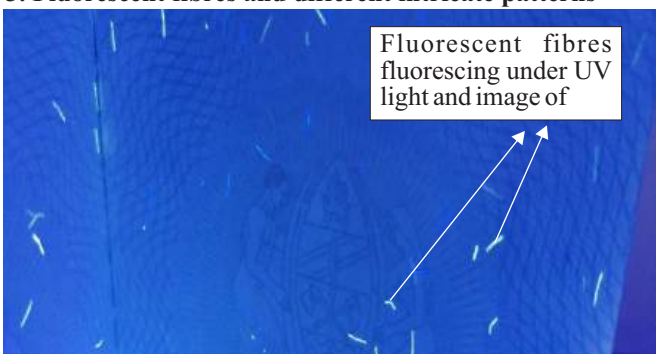
1. Presence of fluorescent fibres



2. Presence of fluorescing images of giraffe on every page.

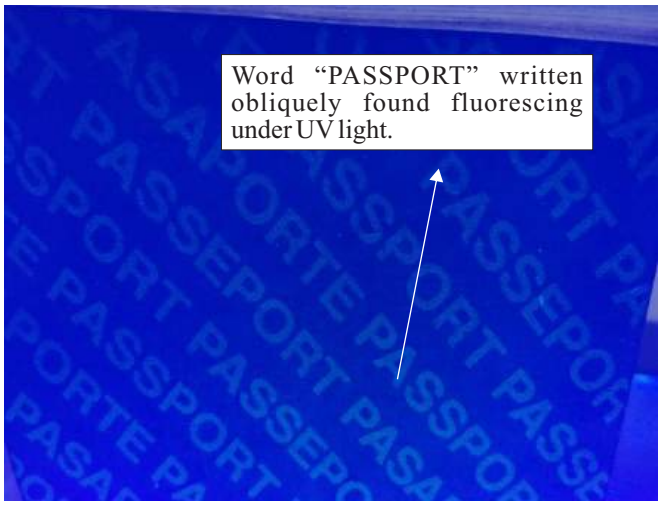


3. Fluorescent fibres and different intricate patterns

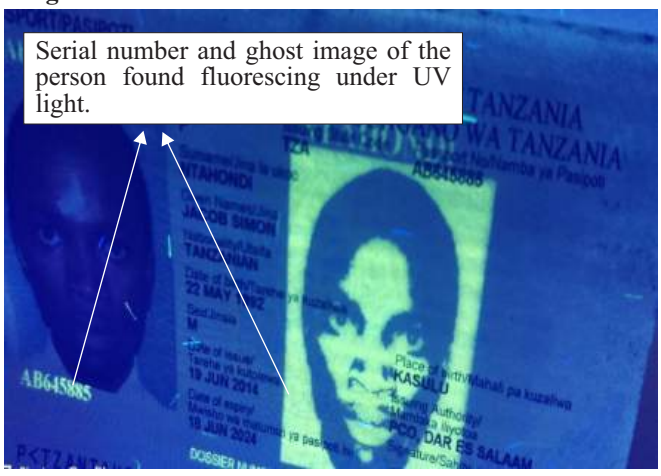


4. Passport under normal day light.

5. Word "PASSPORT" on back cover, visible only under UV light.



6. Ghost Imaging of the passport holder is visible under UV light.

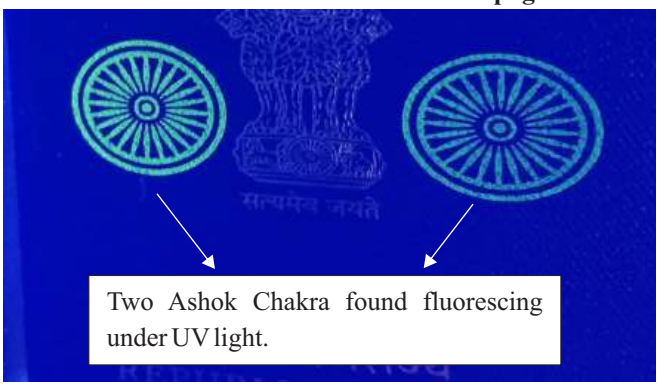


Security features present in Passport of India:

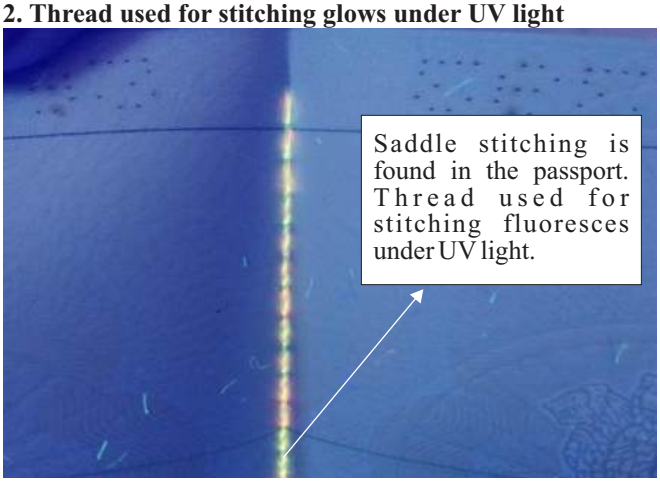
From the recent studies it is considered that Indian passport is one among the others, is the most secure passport known in today's world. However, when the concern comes to passport it is also most significant security threats in today's scenario. Nevertheless, for security concern Indian passport is divided into three types i.e. White passport, issued to Government officers on temporarydeputation to other country, Blue passport, is issued to Common Indian citizen and Maroon passport is issued to Indian diplomats or top ranked officials of government.

Some of the security features present in Indian Passport:

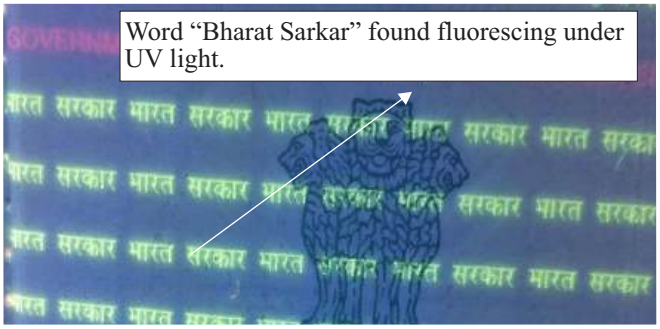
1. Hidden "ASHOKA CHAKRA" on front page.



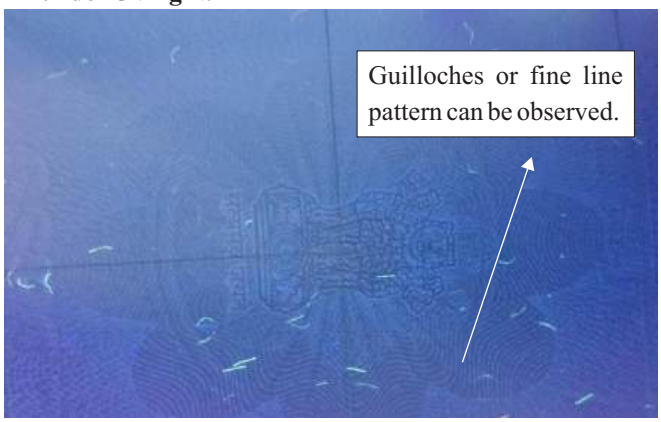
2. Thread used for stitching glows under UV light



3. Bharat Sarkar is written in Hindi and Government of India in English language.



4. Different intricate patterns were found fluorescing under UV light.



5. Information page is "HAUV" laminated which makes it wear and tear proof.

Passport consists of all these security features still it is not safe from fraud. The major challenges faced in these areas are Alteration, Counterfeiting, Stealing, Recycling and passport misuse by a similar-looking person.

Counterfeiting, defined as reproduction of the complete document such as imitating the original documents using substitute materials e.g. polycarbonate and paper, scanning it for modification using software or recreating the whole document, using alternate printing technologies for the fake reproduction of logos and background.

It can be restrained by designing the passport with high security features that are not easy to copy or to reproduce. To prevent the counterfeiting different sophisticated technologies should be used with inks or material not available to general public.

Alteration is changing the data in original document includes alteration of images, biographical and personal data, or their deletion, deleting the entries using chemicals or mechanical processes.

To prevent the alteration of data, it should be embedded inside the document. It will cause difficulty to reach the data and so altering it. All the data should be combined with security features and data should be duplicated using different techniques.

Recycling is the other challenge faced in this area. In recycling the fake passport is made using material from the original document or removing the entire pages or interchanging it between fake and original. Recycled material used from the original to make the falsify passports and visas. It is difficult to regulate can be achieved by interlocking all the element present in the document to protect its integrity.

Stealing is theft of the genuine and original document. It takes place at any time or place while manufacturing the document, feeding the data or while storing or transiting it. To maintain the security chain of blank document accounting is very mandatory for its tracking.

Mostly, the genuine document is misused by similar looking person by the personation of that person to whom the passport belongs. It can be suppressed with the use of sophisticated personalization techniques to add repeated numbers of portraits at different places.

CONCLUSION :

we can say that passport of each country is unique and security features are being added to reduce the risk of forgery. The review work conducted in this article signifies different security features that make a passport unique and safe from copying.

REFERENCES:

1. Anil Jain, Ruud Bolle and Sharath Pankanti. Introduction to Biometrics. In Biometrics: Personal Identification in Networked Society. Kluwer Academic Publishers, Forth Printing 2002, ISBN 0-7923-8345-1
2. P. J. Phillips, A. Martin, C. L. Wilson, and M. Przybocki. An Introduction to Evaluating Biometric Systems. In IEEE Computer. February 2000, pp. 56-63
3. G. Doddington, W. Liggett, A. Martin, M. Przybocki, and D. Reynolds, Sheeps, goats, lambs and wolves: a statistical analysis of speaker performance in the NIST 1998 speaker recognition evaluation. In Proc. of ICSLD '98, Sydney, Australia, November 1998
4. Ross Beveridge, David Bolme, Marcio Teixeira and Bruce Draper. The CSU Face Identification Evaluation System User's Guide: Version 5.0. Computer Science Department Colorado State University, May 1, 2003.
5. Patrick Grother, Ross J. Micheals, and P. Jonathon Philips. Face Recognition Vendor Test 2002 Performance Metrics. In Proceedings of the Fourth International Conference on Audio-Visual Based Person Authentication. Guildford, UK, June 2003
6. S. Pankanti, S. Prabhakar, and A. K. Jain. On the Individuality of Fingerprints. IEEE Transactions on Pattern Analysis and Machine Intelligence. Vol. 24, No. 8, pp. 1010-1025, August 2002
7. T. Matsumoto, H. Matsumoto, K. Yamada, S. Hoshino. Impact of Artificial Gummy Fingers on Fingerprint Systems. In Proceedings of SPIE. Vol. 4677. Optical Security and Counterfeit Deterrence Techniques IV
8. K. Messer, J. Matas, J. Kittler, J. Luettin, and G. Maitre. XM2VTSDB: The Extended M2VTS Database. In Second International Conference on Audio and Video-based Biometric Person Authentication. March 1999
9. R.Brunelli and Daniele Falavigna. Person Identification Using Multiple Cues. In IEEE Transactions on Pattern Analysis and Machine Intelligence. Vol. 17, No. 10, pp. 955-966, 1995
10. Anil K. Jain and Arun Ross. Multibiometric Systems. In Communications of the ACM. Vol. 47, No. 1, January 2004
11. Y. Wang, T. Tan and A. K. Jain, Combining Face and Iris Biometrics for Identity Verification, Proc. of 4th Int'l Conf. on Audio- and Video-Based Biometric Person Authentication (AVBPA), pp. 805-813, Guildford, UK, June 9-11, 2003
12. A. K. Jain, A. Ross and S. Prabhakar, An Introduction to Biometric Recognition, IEEE Transactions on Circuits and Systems for Video Technology, Special Issue on Image- and Video-Based Biometrics, Vol. 14, No. 1, pp. 4-20, January 2004
13. Edward G. Carmines and Richard A. Zeller. Reliability and validity assessment. Sage University Paper Series on Quantitative Applications in the Social Sciences, 07-017. Newbury Park, CA: Sage, 1979

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00126.0

Review Article

Drugs and their Effects on Development Rate of Decomposers: An Entomotoxicological Approach

1. **Muskan,** Research Scholar, Department of Forensic Science*
2. **Shubham Saini ,** Research Scholar, Department of Forensic Science*
3. **Jaskaran Singh ,** Assistant Professor, Department of Forensic Science, School of Allied Health Sciences, Sharda University, Greater Noida
4. **Harish Dasari,** Professor & Head, Department of Forensic Medicine& Toxicology, Govt. Medical College & Hospital, Chandigarh
5. **Neeta Raj Sharma ,** Head of School, School of Bio-Engineering and Bio-Sciences, Lovely Professional University, Jalandhar

*School of Bio-Engineering and Bio-Sciences, Lovely Professional University, Jalandhar

ABSTRACT :

Forensic Entomotoxicology is an advanced branch of Forensic Entomology which studies the drugs ingested by insects that are feeding on cadaver. It is helpful in those cases where the time since death and cause of death is unknown. Many cases have been reported in which the cadaver is completely skeletonized and the toxicological studies can't be done due to absence of body tissues and fluids; entomotoxicology plays a vital role in such cases. The time of death can be estimated from the life cycle of insects that are feeding on the cadaver. But in cases where the body was intoxicated, it can be difficult, as the drugs cause various effects on the development rate of insects and false results can be observed. Various studies have been done to check the effect of drugs on the development rate of insects or decomposers. However, entomotoxicology helps the justice system in a number of ways like estimating the time since death, identifying the place of death, analyzing the quality and quantity of drug, etc. Present review is a review of what various scientists studied about the effect of drugs on the rate of development of insects feeding on cadaver so that the better results can be calculated.

Corresponding Author :
Muskan,
Research Scholar, Department of Forensic Science
School of Bio-Engineering and Bio-Sciences, Lovely Professional University, Jalandhar
Contact : +91 9050572119
Email : 19071996ms@gmail.com

Article History:
Received: 4 July 2020
Received in revised form: 14 July 2020
Accepted on: 14 July 2020
Available online: 30 April 2021

KEYWORDS : Entomotoxicology, Intoxicated, Forensic Entomology, Development rate, Decomposers

INTRODUCTION :

Legal Medicine is concernedwith determining the cause of death, time of death and mannerof death, in criminal and civil cases, and consequently, the application of entomological evidencehascome up as an essential job in these discoveries.[1] Drugs present in the corpse can be identified by using maggots of insects feeding on it. Entomotoxicology is emerging as an important division in the field of entomology which can be utilized for examination in drugs and poisons relevant cases. Investigation includes the examination of poisons in decomposers that feed on remains. Entomotoxicology is a modern order as well as developing control of scientific entomology. It investigates and explores the poison or drug in peripatus or arthropods, mainly beetles and flies. Forensic Entomotoxicology additionally helps with examining the cadaver feeding beetles so as to perceive toxic substances existing in any tissue which is intoxicated. But the concentration of drugs effects the development of insects feeding on the cadaver.[2]Drugs cause different effects on different stages of insect growth, even the different types of drugs act differently. This review shows the developmental effects of drug on insects that particularly feed on cadavers. Maggots are used for toxicological analysis in cases where tissues or other body fluids like blood, urine or viscera were not analysed or the body is completely skeletonized.Maggots are used to calculate time since death, quantity of drug etc. but the effect of drug on development of insect can cause problem in estimating the time since death because it is calculated from the life stage ofinsect.

Detection of drug in insects was first reported in 1980 by Beyer and colleagues. It is used in the cases where body is decomposed and no tissues are left for toxicological analysis.[3]The significant interest of entomotoxicology is to check the drug taken before death and to evaluate the post mortem interval. Insects are important as they are present in large amount and are present for long period of time, even

when toxicological matrices are of no use. Necrophagous species like coleopteran and diptera are recommended for entomotoxicological analysis as they are the first to colonize the corpses.[4] Analysis and extraction of drugs from larvae is the same as of human tissues. The most commonly found species on corpses are the calliphora (bluebottles)[3] Moreover, in insects the concentration of drug observed to be more stable as compared to many post-mortem tissues. First drug to be identified in larvae of fly on skeletonized corpse was phenobarbital in 1980.[5] Analysis of insects can be easily done with toxicological techniques including immunoassay, gas chromatography, gas-mass chromatography, high pressure liquid chromatography.[6]

The analysis can help in detection of drug but when it comes to calculate the time since death, the drugs can cause some uncertain results. More and more researches have been done and number of drugs are found in maggots like ethanol[7], trazodone[8], phenobarbital[9], Sodium barbitone[10], diazepam[11], oxazepam[12], morphine[13], methadone[14], triazolam[12], cyamezanine[12], thiorodazine[15], antimony[16], cadmium[17], levomepromazine[15], malathion[18], parathion[1]. The effects of drug should also be studied in future.

Types of decomposers that comes first are from orders: Diptera, Coleoptera, Hymenoptera etc. They are the foremost to colonize and feed on cadaver. Blowfly (*Calliphoridae*) are most common to be found on crime scenes.

Effects studied in field :

The effect of ketamine drug on the development of *Luciliasericata*, in their study ten New Zealand rabbits were injected with ketamine hydrochloride with different concentrations the dead tissues of different concentration and controlled samples placed in an open environment for decomposition insect *Luciliasericata* come for feeding the dead tissue then it is seen for development of larvae different stages found that ketamine delayed the early development of larvae reared on tissues with high concentration of the drug, the larvae collected from tissue treated with lethal and high dose of ketamine after 12 hour stayed in the 1 instar stage and other larvae goes to second instar stage, significant difference were found chi- square test in between different concentrated treated samples and controlled samples, larvae body length and weight was also analysed between control and treated samples and found significant difference between them.[19] Similar kind of study was done to analyze the effect of morphine on the growth rate of *Calliphorastygia*, in their study pet mince was used which contains kangaroo mince, lamb fry and heart was used for four treatment group for larvae nourishing with various concentration of morphine, high performance liquid chromatography was used for qualitative analysis of morphine in four different samples and found that no presence of morphine in the control samples and present in the other two samples, and also there was no significant change in length and width of larvae in four different groups, statistical analysis was done and significant changes between treatments in length or width of pupae were found.[2]

The drug level and effect of diazepam on the growth of necrophagous flies, in their study they used male rabbits as test animals and lethal dose of diazepam, twice lethal dose and without drug injected in rabbits and killed mechanically five replicates were prepared and exposed to flies for feeding after this at different time periods weight of larvae was measured and growth of larvae was observed and it is found that presence of drug was significant for larvae development, control sample of larvae developed slower than the larvae exposed to drug, generally it was observed in different time hours that controlled larvae grows slower than the larvae exposed to the drug.[20] The Malathion levels and its effect on the development of *Chrysomyamegacephala*, in their experiment they used three rabbits for injecting different concentrations of malathion drug and exposed to the flies to reared on the different tissues and liver of the rabbits and examined for the development of larvae on different time period and presence of drug in different concentrations exposed larvae and found positive presence of drug in larvae and negative in controlled sample, the development was observed by total length measurement of larvae the presence of malathion drug decreased the growth rate of larvae and the development rate of larvae was significant for different concentrations of the drugs and no significant difference in growth rate of control sample larvae.[21]

A case of chronic heroine abuse was studied wherein it was shown that the heroine can be extracted from the maggots feeding on corpse. In this case a manwho was a chronic heroine abuser was found dead in kitchen and the time of death was unknown and body was partially skeletonized. Calliphoridae family flies were sampled. Other samples were femoral blood and bile. The concentration of drug was best found in bile and followed by femoral blood and larvae. The analysis was done with LCMS. The time of death and amount of drug in the body was estimated.[25] In this study the sample was taken of leg muscles which are self-poisoning cases of amitriptyline, temazepam and combination of both. Leg muscles were cut in 25 mm cubes. *Calliphoravicina*samples were collected which were feeding from 12-24 hours and the different stages were noticed. The analysis was done on days 4-11 with GCMS.[26] In this setup, 4 pigs were taken as sample and the alcohol was administered through oral tract and intravenously in 2 pigs. Rest 2 were used as non-alcoholic samples. Ante-mortem and post-mortem blood was collected and 1 kg of meat was

extracted from both alcoholic and non-alcoholic samples. Favorable conditions were provided to meat for decomposition and the analysis was done at different time intervals. The concentration of alcohol in maggots and both ante-mortem and post-mortem blood was found in alcoholic samples and in non-alcoholic samples, the concentration of alcohol was found only in post mortem blood.[8] And the level of amphetamine and alcohol can be estimated from maggots. In this study, a dead body was found and decomposition was started. Maggots from skin and inside the body were collected. Blood, liver, kidney were also collected and stored at 4ºC. The extraction from maggots was done through solid phase extraction using Amberlite XAD2, poly-aromatic adsorbent resin. The analysis was done on GCMS with head space and flame ionization detector. The presence of amphetamine was tested and results were positive in maggots and quantification can't be found but in liver, kidney and blood quantification was also done.[27]

The effect and extraction of flunitrazepamfroms maggots was observed. In this study beef heart was spiked with flunitrazepam and larvae of known colony of *Calliphoramegacephala* were transferred on it. Proper humidity and light was provided. The larvae were collected from tissue at different time intervals and rinsed with deionized water. Before analysis they were stored at -20ºC. The analysis was done Near Infrared Spectroscopy. The NIR analysis is a non-destructive technique and can be used in detection of drug from maggots.[23]

CONCLUSION :

In field of entomotoxicology, more research has been conducted in latest years. These researches were conducted to find a relationship between drug concentration in the substrate and insects raised on that substrate and to increase the knowledge of insect development. Entomotoxicology is used where human is skeletonized or mummified and no tissues or other essential body parts are available to find toxicological results about drug consumption before death. Qualitative results can be estimated with accuracy but still the quantity of drug can't be estimated. Forensic toxicologists can estimate the post-mortem interval through the development of insects which were raised on body. As the drug effects the development rate of insects feeding on it, the post mortem interval will not be estimated correctly. There is further scope of research in this particular area.

In near future, research should be focused on physiological process during the feeding stage, metabolism of drugs, accumulation and excretion mechanism in insects, and also on drugs redistribution and post mortem drugs stability. When these parameters will be studied it will be easy to apply on insects feeding on human body.

REFERENCES :

1. Wolff M, Builes A, Zapata G, Morales G, Benecke M. Detection of parathion (O,Odiethyl O-(4-nitrophenyl) phosphorothioate) by HPLC in insects of forensic importance in Medellin, Colombia. Anil Aggrawal's Internet, Journal of Forensic Medicine Toxicology 2004;5:6-11.
2. George K, Archer M, Green L, Conlan X, ToopT.Effect of morphine on the growth rate of Calliphorastygia (Fabricius) (Diptera: Calliphoridae) and possible implications for forensic entomology. Forensic Science International 2009;193:21-5.
3. Pounder D. Forensic entomo-toxicology. Journal of the Forensic Science Society 1991;31:469-72.
4. Gosselin M, Wille S, Fernandez M, Fazio M, Samyn N, Boeck G, Bourel B. Entomotoxicology, experimental set-up and interpretation for forensic toxicologists. Forensic Science International 2011;208:1-9.
5. Karampela S, Pistos C, Moraitis K, Stoukas V, Papoutsis I, Zorba E, Koupparis M, Spiliopoulou C, Athanaselis S. Development and validation of a LC/MS method for the determination of Δ9-tetrahydrocannabinol and 11-carboxy-Δ9-tetrahydrocannabinol in the larvae of the blowfly Luciliasericata: Forensic applications. Science and Justice 2015;55:472-80.
6. Introna F, Campobasso C, Goff M. Entomotoxicology. Forensic Science International 2011;120:42-7.
7. Gojanovic M, Sutlovic D, Britvic D. Boze, Drug analysis in necrophageous flies and human tissues. Arh. Hig. Rada Toksikol 2007; 313-6.
8. Sadler D, Fuke C, Court F, Pounder D. Drug accumulation and elimination in Calliphoravicina larvae. Forensic Science International 1995;71:191-7.
9. Beyer J, Enos W, Stajic M, Drug identification through analysis of maggots. Journal of Forensic Science 1980;25:411-2.
10. Sadler D, Robertson L, Brown G, Fuke C, Pounder D. Barbiturates and analgesics in Calliphoravicina larvae. Journal of Forensic Science 1997;42:481-5.
11. Wood M, Laloup M, Pien K, Samyn N, Morris M, Maes R, Bruijn E, Maes V, Boeck G. Development of a rapid and sensitive method for the quantification of benzodiazepines in Calliphoravicina larvae and puparia by LC–MS-MS. Journal of Analytical Toxicology 2003;27:505-12.
12. Tracqui A, Tracqui C, Kintz P, Ludes B.

Entomotoxicology for the forensic toxicologist: much ado about nothing? International Journal of Legal Med 2004;118:194-6.

13. Bourel B, Tournel G, Hedouin V, Goff M, Gosset D. Determination of drug levels in two species of NecrophageousColeoptera reared on substrates containing morphine. Journal of Forensic Science 2001;46:600-3.
14. Gosselin M, Fernandez M, Wille S, Samyn N, Boeck G, Bourel B. Quantification of Methadone and its Metabolite 2-Ethylidene-1, 5-dimethyl- 3,3-diphenylpyrrolidine in Third Instar Larvae of Luciliasericata (Diptera: Calliphoridae) Using Liquid Chromatography–Tandem Mass Spectrometry. Journal of Analytical Toxicology 2010;34:1-7.
15. Campobasso C, Gherardi M, Caligara M, Sironi L, Introna F. Drug analysis in blowfly larvae and in human tissues: a comparative study. International Journal of Legal Medicine 2004;118:210-4.
16. Roeterdink E, Dadour I, Watling J. Extraction of gunshot residues from the larvae of the forensically important blowfly Calliphoradubia (Macquart) (Diptera: Calliphoridae). International Journal of Legal Medicine 2004;118:63–70.
17. Simkiss K, Daniels S, Smith R. Effects of population density and cadmiumtoxicity on growth and survival of blowflies. Environmental Pollution 1993;81:41-5.
18. Rashid R, Osman K, Ismail M, Zuha R, Hassan R. Determination of malathion levels and the effect of malathion on the growth of Chrysomyamegacephala (Fabricius) in malathion-exposed rat carcass. Tropical Biomedicine 2008;25:184-90.
19. Zou Y, Huang M, Huang R, Wud X, You Z, Lin J, Huang X, Qiu X, Zhang S. Effect of ketamine on the development of Luciliasericata (Meigen) (Diptera: Calliphoridae) and preliminary pathological observation of larvae. Forensic Science International 2013;226:273-81.
20. Carvalho L, Linhares A, Trigo J. Determination of drug levels and effect of diazepam on the growth of necrophagous flies of forensic importance in South-eastern Brazil. Forensic Science International 2001;120:140-4.
21. Liu X, Shi Y, Wang H, Zhang R. Determination of Malathion levels and its effect on the development of Chrysomyamegacephala (Fabricius) in South China. Forensic Science International 2009;192:14-18.
22. Tabor K, Fell R, Brewster C, Pelzer K, Behonick G. Effects of Antemortem Ingestion of Ethanol on Insect Successional Patterns and Development of Phormiaregina(Diptera: Calliphoridae)Journal of Medical Entomology 2005;42:481-9.
23. Oliveira J, Taina C, Renata A, Kássio M. Development of a novel non-destructive method based on spectral fingerprint for determination of abused drug in insects: An alternative entomotoxicology approach. Microchemical Journal 2014;115:39-46.
24. Magni P, Pazzi M, Vincenti M, Alladio E, Brandimarte M, Dadour I. Development and validation of a GC–MS method for nicotine detection in Calliphoravomitoria(L.) (Diptera: Calliphoridae). Forensic Science International 2016;261:53-60.
25. Kintz P, Tracqui A, Mangin P. Analysis of opiates in fly larvae sampled on a putrefied cadaver. Journal of the Forensic Science Society 1994;34:95-7.
26. Sadler D, Fukeb C, Court F, Pounder D. Drug accumulation and elimination in Calliphoravicina larvae Forensic Science International 1995; 71: 191-197.
27. Gojanovic M, Sutlovic D, Britvic D, Kokan B. Drug analysis in necrophagous flies and human tissuesArhivzahigijenuradaitoksikologiju 2007; 58: 313-316.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00127.2

Review Article

POCSO Act At A Glance

1. **Mukesh Kumar Goyal**, Professor and Head*
2. **Nowsheen Goni,** PG Student (MD Forensic Medicine)*
*Department of Forensic Medicine and Toxicology, NIMS Medical College, NIMS University, Jaipur.

ABSTRACT :

Child sexual abuse is a menace worldwide with portentous life-long consequences. It is estimated that 20% females and 8% males become victim to this plunder globally. Census of India reported 41% of total population comes under 18 years of age, thus putting the nation under huge burden of child sexual abuse. The actual prevalence of such carnal abuse is under reported due to social, cultural and law ignorant rationalities. To curb this heinous crime Government of India took a great initiative in June 2012 by implementing the Protection of Children against Sexual Offences (POCSO) Act. It protects children from all types of sexual abuse, there by safe guarding the interest of a child at every stage of judicial process and defines a child as any person below the age of 18 years. POCSO Act has the provision for child friendly reporting, recording of evidences, investigation and offers speedy trial of offences under special courts. It defines different forms of sexual offences, including penetrative and non-penetrative sexual assault, along with sexual harassment and pornography, and constitutes a sexual assault to be "aggravated" under specific circumstances. This Act underwent amendments in 2019, making it stronger in virtue of punishment standards as per the magnitude of offence thus introducing Capital Punishment. In this article we will review the Principal POCSO Act, reshaping it went through, and finally discussing its merits and limitations.

The present article is based on significant step taken by Government of India towards child sexual abuse. To compile the points, authors have collected literature from library and internet. Many articles have been searched through NIMS University library, and through normal Google search, and Google scholar. The main key words used were POCSO Act, child sexual abuse and sexual offences. All the relevant articles were identified and studied for inference. Authors have reported all the major points that have come up in the authenticated data on POCSO Act.

Corresponding Author :
Dr. Nowsheen Goni,
PG Student (MD Forensic Medicine),
Department of Forensic Medicine and Toxicology, NIMS Medical College, NIMS University, Jaipur.
Contact : +91 70068-17116
Email : gnowsheen@gmail.com

Article History:
Received: 2 July 2020
Received in revised form: 10 July 2020
Accepted on: 10 July 2020
Available online: 30 April 2021

KEYWORDS : Protection of children, child sexual abuse, POCSO (protection of children against sexual offence) Act, sexual offences/ assault.

INTRODUCTION :

THE PRINCIPAL POCSO ACT, 2012

It was enforced on 14 November 2012 by Government of India[1-3]. POCSO Act is an act to protect children from various types of sexual assault, harassment and pornography and provide for establishment of Special Courts for trial of such offences and for matters connected there with or incidental thereto[4]. The implementation of POCSO Act is monitored by National Commission for Protection of Child Rights[5]. The procedure for reporting of such cases and recording statement of the child is also prescribed by POCSO Act.

TYPES OF SEXUAL OFFENCES UNDER POCSO ACT

Sexual Harassment: Whoever passes sexuality related remark, sexual gesture/noise, repeatedly following, flashing, or makes the child exhibit any part of his body so as it is seen by such person or any other person.

Sexual Assault: When a person with sexual intent touches the vagina, penis, anus or breast of the child or makes the child touch the same for that person or someone else.

Penetrative Sexual Assault: Whoever causes Insertion of penis/ object/ another body part in child's vagina /urethra/ anus/ mouth, or asking the child to do so with them or some other person.

Aggravated Penetrative Sexual Assault/ Aggravated Sexual Assault:

With the above two late mentioned definitions, if any of the following criteria is matched the said assault becomes aggravated:

• When committed by a person in a position of trust for example relative of child by blood or adoption, police officer, armed force staff/ officer, public servant, management/ staff of hospital or jail, management/ staff of an educational or religious institution[6].

• When committed by gang.

• When committed leads to grievous hurt.

• When committed on mentally or physically challenged child.

• When committed more than once or repeatedly.

• When committed incapacitates the child or cause mental illness.

• When committed inflicts child with Human Immunodeficiency Virus or any life threatening disease or infection.

• When committed on female child makes her pregnant (only applicable to penetrative sexual assault).

• When committed on a child below 12 years of age.

• When committed attempts to murder the child.

• When committed on a pregnant child.

• When committed in the course of communal or sectarian violence.

• When committed makes the child to strip or parade naked in public.

Using child for Pornographic purpose: Whoever uses child in any form of media for the purpose of sexual gratification.

PUNISHMENTS FOR SEXUAL OFFENCES:

The Act prescribes stringent punishment graded as per the gravity of the offence, these are briefly described in **table 1**.

AMENDMENT IN POCSO ACT :

Amendment bill[7] was passed in August 2019 by Parliament of India to strengthen the POCSO Act by including death penalty for aggravated sexual assault on children, besides providing stringent punishments for other crimes against minors[8]. Various new clause are added with change in many punishment scales of different offences that comes under POCSO Act which are summarized the as follows[9]:

Penetrative sexual assault: The punishment for such offence was imprisonment minimum of seven years to maximum life-time imprisonment, and a fine. The Amendment Bill has increased the minimum punishment from seven years to ten years. It further states that if a person commits penetrative sexual assault on a child less than 16 years of age, the accused will be punished with imprisonment of minimum 20 years which can extend to imprisonment for life, which means

Table 1: Punishments of Sexual Offences

OFFENCE	PUNISHMENT		
	MINIMUM	MAXIMUM	FINE
Sexual Harassment	<3 years	3 years	yes
Sexual Assault	3 years	5 years	yes
Aggravated Sexual Assault	5 years	7 years	yes
Penetrative Sexual Assault	7 years	Life imprisonment	yes
Aggravated Penetrative Sexual Assault	10 years	Life imprisonment	yes
Use of Child for Pornographic Purpose	<5 years	5 years	yes
Sexual Assault for Pornographic Purpose	6 years	8 years	yes
Aggravated Sexual Assault for Pornographic Purpose	8 years	10 years	yes
Penetrative Sexual Assault for Pornographic Purpose	10 years	Life imprisonment	yes
Aggravated Penetrative Sexual Assault for Pornographic Purpose	Life imprisonment		yes
Storage of pornographic material	<3years	3years or fine or both	yes
Abetment of any of above offences	If abetment offence is committed, punishment for abetment shall be same as that of offence.		
Attempt to commit an offence	Punishment will be half of the punishment prescribed for that offence or fine or both.		

remainder of his natural life, with a fine.

Aggravated penetrative sexual assault: The Bill adds two more grounds to the definition of aggravated penetrative sexual assault. These include:

(i) assault resulting in death of child

(ii) assault committed during a natural calamity, or in any similar situations of violence.

The punishment for aggravated penetrative sexual assault was imprisonment between 10 years to life, and a fine. The Bill increased the minimum punishment from ten years to 20 years, and the maximum punishment imprisonment for life or even death sentence.

Aggravated sexual assault: In this sub-section two more offences are added to the definition of aggravated sexual assault. These are: (i) assault committed during a natural calamity, and (ii) administrating or help in administering any hormone or any chemical substance, to a child for the purpose of attaining early sexual maturity.

Pornographic purposes: The amended POCSO Act defines child pornography as any visual depiction of sexually explicit conduct involving a child including photograph, video, digital or computer generated image indistinguishable from an actual child. Penalty for using a child for pornographic purpose which results in any form of sexual assault is in addition to minimum five years imprisonment for using a child for pornographic purpose. Moreover, amendment have taken place in the punishments for various offences as under which are described in **table 2**.

MERITS:

•Empowerment to the State: The POCSO act empowers each state of India to make special provisions for children in case of sexual offences.

• No Ambiguity: It recognizes almost every known form of sexual abuse against children as punishable offences which were previously not considered as sexual offence, for example child pornography thus leaving no room for ambiguity in its interpretation.

• Unbiased Support and Care: The POCSO Act practices no discrimination in the provision of care towards abused child, irrespective of sex, race, ethnicity, religion, sexual orientation, and socioeconomic status which is in accordance with WHO guidelines[10].

• Gender Neutral: The POCSO Act is gender neural for both the victim and accused. Every gender is treated equal on standards of law.

• Mandatory Reporting: Under POCSO Act, a person who has knowledge of offences or apprehensions committed against children should report the same to police. The media,

Table 2: The Offences And Their Respective Punishments For Using Child For Pornographic Purposes

OFFENCE	PUNISHMENT
Use of child for pornographic purposes	Minimum: 5 years
Use of child for pornographic purposes resulting in penetrative sexual assault	Minimum: 10 years (in case of child below 16 yrs: 20 yrs) Maximum: life-time imprisonment
Use of child for pornographic purposes resulting in aggravated penetrative sexual assault	Minimum: 20 years Maximum: life-time imprisonment, or death.
Use of child for pornographic purposes resulting in sexual assault	Minimum: Three years Maximum: Five years
Use of child for pornographic purposes resulting in aggravated sexual assault	Minimum: Five years Maximum: Seven years
Storage of child pornographic material: 1. Failure to destroy pornographic material	Fine
2. Propagation and distribution of pornographic material	Imprisonment for ≤3 years, or with fine or with both.
3. Use of pornographic material for commercial purpose	Minimum: Three years, or with fine or with both. Maximum: Five years, or with fine or with both.

studio and photographic authorities are directed to report a case if they came across any material or object which is sexually exploitative of the child. Failure to report same is punishable offence[11]. Under POCSO Act 2012, crime reported areas are as high as 34.4% of total crime against children[12].

• **Child Amiable Special Courts:** The POCSO Act has designated special courts in different states which provide speedy trial to cases[13]. No aggressive questioning of child is permitted. Child friendly atmosphere is created by allowing family members, guardians or relatives to be present in the court along with child.

• **Ensuring Healthy State of the Child:** The POCSO Act makes it crucial that the law operates in a manner so that the interest and regard of the child are valued at every stage in order to ensure healthy physical, emotional, intellectual and social development of the child[14].

• **Penalty for False Complaint:** Any person who makes false complaint against any other person in respect of an offence committed as per POCSO Act will be punished.

• **Protection of Privacy and Confidentially of the Child:** The right of privacy and confidentially of a child is to be protected and respected by every person in all the means and through all the stages of legal proceedings. No reports in any media shall disclose identity of child, address, family details, school or any other particulars which may lead to disclosure of identity of child unless directed by special courts in the interest of the child[15].

• **Providing Safety and Security to Child:** The police is liable to inform about every case that comes under POCSO Act to Child Welfare Committee (CWC) within 24 hours of receiving the report, so that CWC can proceed further with arrangements for the safety and security of the child.

• **Compensation to Victim:** The Special Court can determine the amount of compensation to be paid to a child who has been sexually abused for the child's medical treatment and rehabilitation.

• **Abetment of Child Sexual Abuse is an Offence:** If a person instigates any other person to do any offences which comes under POCSO Act or engages in any conspiracy or illegal omission takes place in pursuance of that conspiracy or intentionally aids, shall be punished. People who are involved in children trafficking for sexual purposes are also punishable under the provisions relating to abetment in the Act[4].

• **Provision for time bound clearance of the Case:** Under POCSO Act ideally trial should complete within one year from the date of taking cognizance of the offence.

SHORTCOMINGS

• **Definition of Age:** The POCSO Act defines a child as any person under the age of 18 years. However, this definition is a purely biological, and does not consider any intellectual and psycho-social deficit[16].

• **No sexual autonomy:** All sexual activities done under 18 years of age are punishable under POCSO Act, even if consensual. Thus prohibiting the sexual autonomy of adolescent children.

• **Consensual Sex between two Minor:** In cases of consensual sex between two children of age less than 18 years, the concept of victim and offender becomes challengeable.

• **Consensual Sex between a Major and a Minor:** In case of consensual sex between two people one below age of 18 years and other above age of 18 years, will label prior as innocent and later being criminal for the same act[17].

• **Obstacle in propagating Sex Education:** The POCSO Act criminalizes sexual activities below 18 years, thus hurdling the school counsellors and health care professionals to provide sex education. As later may cause sensitization of children to carnal knowledge.

• **Contention with Medical Termination of Pregnancy Act, 1971:** Under POCSO Act, if any girl under 18 years is seeking abortion, the health care professional is compelled to report a complaint of sexual assault with the police. However, under the MTP Act[18], it is not mandatory to report the identity of the person seeking an abortion. Thus creating a state of chaos for health care professionals.

• **Mandatory Reporting of Crime:** There may be many survivors who do not want to go through the judicial trial, but POCSO Act provision takes away choice from children. Moreover mandatory reporting may also hinder easy access to medical aid, and psycho-social intervention.

• **Indiscreet Position Creeps in when a Female Doctor is not available:** As per POSCO Act female victim is to be examined by female Medical Practitioner only making it difficult in the situation where there is unavailability of female doctor.

• **No proper Trained Professionals in POCSO:** There is lack of training and experience in all the medical undergraduates and health care professionals during identification and intervention of cases which come under POCSO Act[19], due to the fear of litigation, and concern about offending patient or embarrassment about bringing up the topic. Thus research, information monitoring and sensitizing the public are the biggest challenge[20].

• **Gender Bias with respect to Quantum of Punishment:** There is clear gender bias when it comes to quantum of

punishment between a male and a female offender. For example a teenage girl below 18 years of age who had consensual sexual intercourse with a boy above 18 years, may later allege him of sexual abuse. The boy will be punished under Penetrative Sexual Assault Section of POCSO Act but vice-versa won't be true, as the boy below 18 years of age and the alleged girl above 18 years, she will only be booked under Sexual Assault Section of POCSO Act. The measure of punishment between the two sections has huge difference as per the POCSO Act, punishment is sterner for Penetrative Sexual Assault as compared to Sexual Assault.

Funding: Nil

Conflict of interest: None

REFERENCES :

1. Pereda N, Guilera G, Forn M, Gomez-Benito J. The prevalence of child sexual abuse in community and student samples: A meta-analysis. Clinical Psychology Review. 2009;29(4):328–338.
2. Census Data 2001-Age Structure and Marital Status. Available from: http://censusindia.gov.in/Census_And_You/age_structure_and_marital_status.aspx#:~:text=India%20has%20one%20of%20the,than%2018%20years%20of%20age Accessed 25th December 2019.
3. India Code- Digital Repository of all Central and State Acts. Available from: https://indiacode.nic.in/show-data? actid = AC_CEN_13_14_00005_201232_1517807323686&orderno=1 Accessed on 25th December 2019.
4. The Gazette of India- The Protection of Children from Sexual Offences,2012 Available from: https://wcd.nic.in/sites/default/files/POCSO%20Act%2C%202012.pdf Accessed 26th December 2019.
5. National Commission of Protection of Child Rights-Government if India. Available from: https://ncpcr.gov.in/index1.php?lang=1&level=1&&sublinkid=14&lid=607Accessed on 26th December 2019.
6. Sunny KV, Sudhir ND. Study on Incidence of POCSO Cases in Mumbai Region. IJHRMLP. 2018;4(1):74-77.
7. Ministry of Women and Child Development -The Protection of Children from Sexual Offences (Amendment) Bill, 2019. Available from: http://164.100.47.4/BillsTexts/RSBillTexts/asintroduced/POSCO-intro-E-18719.pdf Accessed on 1st January 2020.
8. The Economic Times- Government approves changes in POCSO Act, includes death penalty for sexual offences against children. Available from: https://economictimes.indiatimes.com/news/politics-and-nation/government-approves-changes-in-pocso-act-includes-death-penalty-for-sexual-offences-against-children/articleshow/70159690.cms?from=mdr Accessed on 04 Jan 2020.
9. The Gazette of India- The Protection of Children from Sexual Offences (Amendment) Act, 2019. Available from: https://wcd.nic.in/sites/default/files/Protection%20of%20Children%20From%20Sexual%20Offences%20%28Amendment%29%20Act%2C%202019.pdf Accessed on 5th January 2020.
10. Responding to children and adolescents who have been sexually abused WHO clinical guidelines.Available from: https://www.who.int/reproductivehealth/publications/violence/clinical-response-csa/en/Accessed on 5th January 2020.
11. Children Right and You (CRY) - Understanding the POCSO Act. Available from: https://www.cry.org/cry-resources/reports-publications/understanding-the-pocso-act Accessed on 01 Jan 2020
12. Ministry of Statistics and Programme Implementation-Children in India 2018, A Statistical Appraisal. Available from: http:// www.mospi.gov.in / sites / default / files / publication_reports/Children%20in%20India%202018%20%E2%80%93%20A%20Statistical%20Appraisal_26oct18.pdf Accessed on 7th January 2020.
13. Ministry of Women and Child Development, Government of India- Special Court´s for Juvenile Justice. Available from: https://pib.gov.in / Pressreleaseshare.aspx ? PRID=1579557 Accessed on 8th January 2020.
14. Press Information Bureau, Government of India- Cabinet approves Amendment in the Protection of Children from Sexual Offences (POCSO) Act, 2012 Available from: https://pib.gov.in/newsite/PrintRelease.aspx?relid=186879 Accessed on 8th January 2020.
15. Nag A, Sharma S. Protection of Children from Sexual Offences and its Management: An Appraisal. IJAR&D; 2018:4(2):62-68.
16. The Hindu- Does age encompass mental age? Available from: https://www.thehindu.com/opinion/op-ed/does-age-encompass-mental-age/article17436626.ece Accessed on 10th January 2020.

17. In Plainspeak- Sexuality and Law.Available from: http://www.tarshi.net/inplainspeak/voices-love-and-sex-in-the-time-of-the-pocso-act-2012/Accessed on 10th January 2020.

18. The Medical Termination of Pregnancy Act, 1971.

Available from: http://tcw.nic.in/Acts/MTP-Act-1971.pdf

Accessed on 11 Jan 2020.

19. Khandare VS, Sudhir ND, Study on Incidence of POCSO Cases in Mumbai Region. International Journal of Health Research and Medico Legal Practice; 2018:4(1):74-77.

20. Kulkarni UK, Kulkarni KV, Kokre RN, Dhaundkar BB. Forensic study on child sexual abuse under pocso act. ejbps. 2016; 3(7):1-5.

J Punjab Acad Forensic Med Toxicol 2020;20(2) ISSN : 0972-5687 DOI:10.5958/0974-083X.2020.00128.4

Scientific Correspondence

The protective effects of turbans against cranial trauma: A call for systematic epidemiological studies in the Punjab

1. **Dirk HR Spennemann,** Institute for Land, Water and Society; Charles Sturt University; PO Box 789; Albury NSW 2640

Corresponding Author :
Dr. Dirk HR Spennemann,
Institute for Land, Water and Society; Charles Sturt University;
PO Box 789; Albury NSW 2640
Contact : +91
Email : dspennemann@csu.edu.au

Article History:
Received: 15 May 2020
Received in revised form: 20 May 2020
Accepted on: 1 June 2020
Available online: 30 April 2021

KEYWORDS :

INTRODUCTION :

Throughout India, the use of helmets is mandatory while riding two-wheelers.[1] Specific exemptions for religious reasons have been granted for Sikhs, both the rider and pillion passenger.[2–3] While the medical profession has been vociferous in the call for uniform helmet laws without any exemptions, the Sikh community is equally vociferous in its defence of the freedom of religious expression.

There is a global interest in the topic as Sikhs in many countries have lobbied to be made exempt from the respective mandatory helmet rules while riding bicycles or motorbikes and also while being engaged in construction activities. In some countries such exemptions have been granted, and in others not.[4] In many countries Sikhs are still agitating strongly to have their spiritual requirements with regard to hear wear accommodated.

METHODS :

This paper draws on data derived from a review of over 200 journal articles discussing cranial trauma following two-wheeler accidents on the Indian subcontinent.[5]

RESULTS AND DISCUSSION :

Most studies on head injuries pass comment on the presence or absence of helmets worn by the riders and pillion passengers of two-wheelers.[5] In many instances the extent of protection provided by a turban is either simply assumed or noted as a possible mitigating factor of unknown benefit, but has not been formally assessed.[6–12] It would have been expected that studies conducted in the wider Punjab area (Chandigarh and Punjab State) would be more likely to comment on the wearing of turbans as an influencing fact but this was not the case.

Three papers comment on the role of turbans in two-wheeler accidents. Mohan et al. noted that turbans provide little protection even in single-vehicle crashes with speeds as slow as 15 km/h.[13] In the late 1980s, Sood, examining over 300 cases of head trauma caused by motorcycle accidents in New Delhi, however, noted that "[t]heir head injury incidence and severity was midway between that of drivers with helmets and without, suggesting that the turban offers some degree of protection",[14] in particular in lesser accidents. A 2009 study of fatal two-wheeler accidents at Patiala noted that turbans appeared to provide partial protection.[15] None of these studies provide a comprehensive analysis.

Experimental studies simulating the performance of a turban against blunt head impacts at various locations of the skull have shown that a turban buffers the impact, especially at the sides, front and rear of the head, albeit below the levels of a safety helmet **(Figure 1)**.

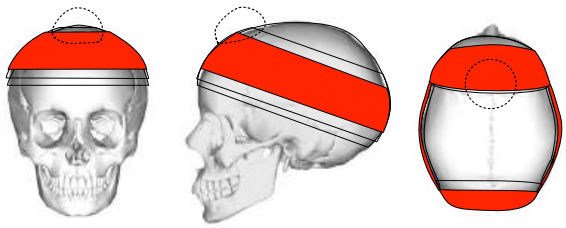


Figure 1. Schematic protection provided by a turban. The darker, the more layers. The dashed outline shows the approximate location of the joora which provides additional buffering (Base image of skull: Wikimedia).

Setting aside the location of the joora (top knot) at the front of the head, the turban has no meaningful effect in the case of a blunt impact on the crown as there the covering with turban material is the thinnest (usually only one layer).[16–17]

It remains unclear, however, to what extent a blunt or sharp impact on the crown of the cranium occurs during two-wheeler accidents, and how frequent this is.

CONCLUSIONS :

What is sorely lacking are systematic, evidence-based

epidemiological studies derived from hospital admissions and forensic examinations. There is a need for a full systematic study that compares the number and nature of fatal vs. non-fatal head injuries sustained during motorcycle or bicycle accidents and correlates these with the wearing of protective head gear (helmet, turban, none). In order to also assess the locational frequency of cranial trauma, the skull should be divided into impact zones that correspond with, but are more fine-grained than standard descriptors and which allow to better assess the differences in head protection **(Figure 2)**.

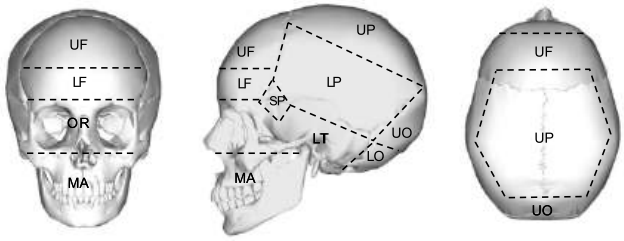


Figure 2. Schematic representation of impact zones on the skull. Abbreviations: B–Basal (not shown), LF–Lower Frontal, LO–Lower Occipital, LP–Lower Parietal, LT-Lower Temporal, MA–Maxillar-Mandibular, OR–Orbital, SP–Sphenoid, UF–Upper Frontal, UO–Upper Occipital, UP–Upper Parietal (Base image of skull: Wikimedia).

The forensic departments of the various public and teaching hospitals in the Punjab are eminently equipped to carry out such studies. Given the global interest in the topic, such studies would be very well received by many jurisdictions.

Ethical clearance : As the study is a review of published literature, a clearance from the Ethics in Human Research committee is not required.

Source of funding : None **Conflict of interest :** None

REFERENCES :

1. An Act to consolidate and amend the law relating to motor vehicles., nº 59 of 1988 Stat. (1988 Oct 14). §129.
2. Motor Vehicles (Amendment) Act, Act 54 of 1994 Stat. (1994 Nov 14). §38
3. Motor Vehicles (Amendment) Act, Gazette of India Extraordinary Part II Section 1, nº 51, 2019, 1–45, Act 32 of 2019 Stat. (2019 Jul 23). exemption maintained in §44
4. Spennemann, D. H. R. (2020). Turbans vs Helmets: The conflict between the mandatory wearing of protective head-gear and the freedom of religious expression. Sikh Formations, 10.1080/17448727.2020.1804197.
5. Spennemann, D. H. R. (2020). Do turbans provide protection against cranial trauma in two-wheeler accidents? A review of the Indian medical literature. Indian Journal of Forensic Medicine & Toxicology, 14(2):938-944
6. Anand, J. (2005). Compulsory helmets for cyclists. Journal of the Royal Society of Medicine, 98(2), 86-86.
7. Goel, A., Sandeep, K., & Bagga, M. K. (2004). Epidemiological and Trauma Injury and Severity Score (TRISS) analysis of trauma patients at a tertiary care centre in India. National Medical Journal of India, 17(4), 186–189.
8. Gupta, A., Jaipuria, J., Bagdia, A., Kumar, S., Sagar, S., & Misra, M. C. (2014). Motorised Two-Wheeler Crash and Helmets: Injury Patterns, Severity, Mortality and the Consequence of Gender Bias. World Journal of Surgery, 38(1), 215. doi:10.1007/s00268-013-2230-3
9. Sharma, B. R. (2008). Motorized two-wheeler crash injuries and the role of helmet use in their prevention–an overview. Journal of Indian Academy of Forensic Medicine, 30(4), 244-248.
10. Sharma, B. R., Gupta, N., Sharma, A., & Sharma, S. (2007). Pattern of fatal motorized two-wheeler crash injuries in Northern India: is safety helmet adequate prevention. Trends in Medical Research, 2(1), 27-36.
11. Sharma, B. R., Gupta, N., Sharma, A. K., & Sharma, S. (2007). Pattern of Fatal Motorized Two-wheeler Crash Injuries in Northern India: Is Safety Helmet Adequate Prevention. Trends in Medical Research, 2(1), 27-36. doi:10.3923/tmr.2007.27.36
12. Swaroop, M., Siddiqui, S. M., Sagar, S., & Crandall, M. L. (2014). The problem of the pillion rider: India's helmet law and New Delhi's exemption. Journal of Surgical Research, 188(1), 64-68.

. doi:https://doi.org/10.1016/j.jss.2014.01.003

13. Mohan, D., Kothiyal, K., Misra, B., & Banerji, A. (1984). Helmet and head injury study of crash involved motorcyclists in Delhi. Paper presented at the Proceedings 1984 International Conference on the Biomechanics of Impacts. Bron, France: IRCOBI.
14. Sood, S. (1988). Survey of factors influencing injury among riders involved in motorized two-wheeler accidents in India: a prospective study of 302 cases. The Journal of Trauma, 28(4), 530-534.
15. Oberoi, S., Aggarwal, K., Walia, D., Kumar, R., & Sandhu, H. (2010). Profile of Fatal Two Wheeler Accidental Cases. Journal of Punjab Academy of Forensic Medicine & Toxicology, 10(2), 72-75.
16. Biokinetics. (1979). An evaluation of the protective capabilities of Sikh headwear, Submitted to the Construction Safety Association of Ontario (Vol. R79-10). Ottowa, ON: Biokinetics and Associates Ltd.
17. Rowland, F.J. (1987). Comparison of the impact protection properties of Sikh turbans and industrial safety helmets. Journal of Occupational Accidents, 9, 47–57.

INSTRUCTIONS TO AUTHORS

•Unpublished, Ethical, Un-Plagiarised original manuscript written in English should be sent to: Dr. Parmod Kumar Goyal, Editor-in-Chief, Journal of Punjab Academy of Forensic Medicine and Toxicology by email at: drparmodgoyal@gmail.com

•Images (Good quality) should be sent separately in JPEG format.

•References should be in Vancouver Style only.

The Publication Particulars

The JPAFMAT is the official publication of the Punjab Academy of Forensic Medicine & Toxicology, published since 2001.

The Contents of the Journal

The journal accepts a range of articles of interest, under several feature sections as follows:

Original Papers: Includes conventional observational and experimental research.

Commentary: Intended for Reviews, Case Reports, Preliminary Report and Scientific Correspondences.

Letter to the Editor

Designed to be an avenue for dialogue between the authors of the papers published in the journal and the readers restricted to the options expressing reviews, criticisms etc. It could also publish letters on behalf of the current affairs in the field of Forensic Medicine in the country.

Editorial

Intended as a platform, for the Editor-in-Chief and for others with a keen interest in forensic medicine that wished to comment on the current affairs.

Special Features

In the History of Indian Forensic Medicine, Book Review, Abstracts, Announcement etc, which appear frequently,

but not necessarily in every issue.

News and Notes

Intended for providing information of members and activities of the Academy and other such other organizations affiliated to the Academy may appear frequently and not in every issue.

General Principles

The text of observational and experimental articles is usually (but not necessarily) divided into the following sections: Introduction, Methods, Results, and Discussion. This so-called "IMRAD" structure is not an arbitrary publication format but rather a direct reflection of the process of scientific discovery. Long articles may need subheadings within some sections (especially Results and Discussion) to clarify their content. Other types of articles, such as case reports, reviews, and editorials, probably need to be formatted differently. Electronic formats have created opportunities for adding details or whole sections, layering information, cross linking or extracting portions of articles, and the like only in the electronic version. Double spacing all portions of the manuscript— including the title page, abstract, text, acknowledgments, references, individual tables, and legends—and generous margins make it possible for editors and reviewers to edit the text line by line and add comments and queries directly on the paper copy. If manuscripts are submitted electronically, the files should be double-spaced to facilitate printing for reviewing and editing. Authors should number all of the pages of the manuscript consecutively, beginning with the title page, to facilitate the editorial process.

International Uniform Requirements

Please visit http://www.icmje.org/ for detailed instructions for manuscript submission.

Note : Manuscript handling charges Rs. 1500/- to be paid after acceptance for Indian Authors.

Life Members (PAFMAT)

No.	Name	No.	Name	No.	Name
1	Dr. R.K. Gorea	43	Dr. Mian Abdur Rashid	85	Dr Iram Khan
2	Late Dr. Sat Pal Garg	44	Dr. Shilekh Mittal	86	Dr Charanpreet K. Pawar
3	Dr. D.S. Bhullar	45	Dr. B.R. Sharma	87	Dr Mukul Chopra
4	Late Dr. A.S. Thind	46	Dr. D.Harish	88	Dr Mohit Gupta
5	Dr. Hakumat Rai	47	Dr. Krishna D. Chavali	89	Dr Rahul Chawla
6	Dr. K.K. Aggarwal	48	Dr. Ashwani Kumar	90	Dr Maneel Grover
7	Dr. Jaswinder Singh	49	Dr. Vikram Bains	91	Dr Y.S. Bansal
8	Dr. Karamjit Singh	50	Late Dr. Kirpal Singh	92	Dr C.S. Gautam
9	Dr. Harjinder Singh	51	Dr. Gurbachan Singh	93	Dr S.P. Mandal
10	Dr. Virender Pal Singh	52	Dr. Sangeet Dhillon	94	Dr Murli . G
11	Dr. Ashok Chanana	53	Dr. Sukhbir Singh Chauhan	95	Dr Anil Kumar Mittal
12	Dr. J.S. Dalal	54	Dr. Parminder Singh Bhatti	96	Dr G.A. Sunil Kumar Sharma
13	Dr. Jagdish Gargi	55	Dr. Rakesh Kumar	97	Dr Abhishek Yadav
14	Dr. R.S. Parsad	56	Dr. Jagbir Singh	98	Dr Jagdev Kullar
15	Late Dr. Ajit Singh	57	Dr. Karnveer Singh	99	Dr Gurpreet Kaur Randhawa
16	Dr. Harish Tuli	58	Dr. Rajiv K. Chowdhary	100	Dr Gursirat Singh Khokhar
17	Dr. S.K. Bal	59	Dr. Parmod Kumar Goyal	101	Dr Saginder Samara
18	Dr. S.S. Sandhu	60	Dr. Ajay Kumar	102	Dr Saginder Samaraj
19	Dr. Akashdeep Aggarwal	61	Dr RK Sharma	103	Dr Neha Sharma
20	Dr. Kuldeep Singh	62	Dr Brij M. Gupta	104	Dr Sunil Mahajan
21	Dr. Vishal Garg	63	Dr Sunil Gambhi	105	Dr Harshdeep Kashyap
22	Dr. S.S. Oberoi	64	Dr Vijal Pal Khangwal	106	Dr Kiran Kumar
23	Late Dr. Ram Lubhaya	65	Dr Rajiv Joshi	107	Dr Swati Tyagi
24	Dr. Amandeep Singh	66	Dr Manpreet Kaul	108	Dr Mini
25	Dr. Harkirat Singh	67	Dr Sheikh AnayatUllah	109	Dr Mandeep Kaur
26	Dr. I.S. Bagga	68	Dr Satinder Pal Singh	110	Dr Gurinder Singh
27	Dr. Harpreet Singh	69	Dr Preetinder Singh Chahal	111	Dr Minal
28	Dr. Parminder Singh	70	Dr Kulbhushan Garg	112	Dr Kanchan Jyoti Heera
29	Dr. Anil Garg	71	Dr Imran Sabri	113	Dr Manpinder Kaur Bhullar
30	Dr. O.P. Aggarwal	72	Dr Bindu Aggarwal	114	Dr Arashdeep Singh
31	Dr. Gaurav Sharma	73	Dr Adish Goyal	115	Dr Chamandeep Singh Bains
32	Late Dr. Madhur Tayal	74	Dr Charak Sangwan	116	Dr Maninder Singh
33	Dr. Gurmanjit Rai Mann	75	Dr Pardeep Singh	117	Dr Akhilesh Agarwal
34	Dr. Didar Singh	76	Dr Ishwer Tayal	118	Dr Guneet
35	Dr. Kuldeep Singh	77	Dr Ripan Chanana	119	Dr Hitesh Bhatia
36	Dr. Pankaj Gupta	78	Dr Gurvinder Singh Kakkar	120	Dr. Deep Rattan Mittal
37	Dr. Karam Singh	79	Dr Ravdeep Singh	121	Dr. Arun Kumar Maria
38	Dr. Baljit Singh	80	Dr Rohit Kumar Singal	122	Dr. S Valliappan
39	Dr. Puneet Khurana	81	Dr Prabhdeep Singh	123	Dr. Preet Inder Singh
40	Dr. Puneet Arora	82	Dr Jasbir Singh	124	Dr. Harvinder Singh Chhabra
41	Dr. Prabhsharan Singh	83	Dr Jatinder Pal Singh	125	Dr. Bhoj Kumar Sahu
42	Dr. Dildar Singh	84	Dr Alok Kandpal	126	Dr. Amarnath Mishra

Life Members (PAFMAT)

No.	Name
127	Dr. Shekhar Chumber
128	Dr. Navroz Goyal
129	Dr. Gurjeet Singh
130	Dr. Deepika Kanwar
131	Dr. Mohd. Amjad Bhatt
132	Dr. Nikhil Mehta
133	Dr. Charan Kamal
134	Dr. Amit Singla
135	Dr. Sukhdeep Singh
136	Dr. Munish Kumar
137	Dr. Arindam Chatterjee
138	Dr. Ranjodh Jeet Singh
139	Dr. Kanika Kohli
140	Dr. Vinka Maini
141	Dr. Ravi Tejpal
142	Dr. Preet Mohinder Singh
143	Dr. Satbir Singh
144	Dr. Kamaljit Singh
145	Dr. Mrinal Kanti Jha
146	Dr. Vijay Arora
147	Dr. Vivek Srivastava
148	Dr. Pankaj Chhikara
149	Dr. Lalit Kumar
150	Dr. Prem Chandra Srivastava
151	Dr. Niraj Kumar
152	Dr. Om Parkash Saini
153	Dr. Rajesh Kumar Verma
154	Dr. Shailender Kumar
155	Dr. B.L. Chaudhary
156	Dr. Parmod Kumar Saini
157	Dr. Rajendra Singh Kulhari
158	Dr. Nidhi Sachdeva Agarwal
159	Dr. Rajeev Varma
160	Dr. Pragnesh Bharatkumar Parmar
161	Dr. Yatiraj Singi
162	Dr. Navpreet Kaur
163	Dr. Kunal Khanna
164	Dr. Smitha Rani Shetty
165	Dr. Vivekanshu Verma
166	Dr. B.V. Naga Mohan Rao
167	Dr. Anju Gupta
168	Dr. Guriqbal Singh
169	Dr. Prashanthi Krishna Dharma
170	Dr. Amarjit Singh
171	Dr. Keshav Soni
172	Dr. Faisal Nasim Gilani
173	Dr. Ashok Sagar
174	Dr. Suresh Chand
175	Dr. Jaswinder Singh
176	Dr. Prateek Rastogi
177	Dr. Varun Garg
178	Dr. Hitesh Chawla
179	Dr. Sanjeev Buri
180	Dr. Sunil M Doshi
181	Dr. Sanjay Kumar
182	Dr. Akhilesh Pathak
183	Dr. Raghvendra Kumar Vidua
184	Dr. Jitendra Kumar Gupta
185	Dr. Manoj Kumar Pathak
186	Dr. Surendra Kumar Pandey
187	Dr. Mayank Gupta
188	Dr. Amandeep Kaur
189	Dr. Mukesh Kumar Meena
190	Dr. Jitender Kumar Jakhar
191	Dr. Kamal Singla
192	Dr. Rajender Kumar Saini
193	Dr. Chandra Pal
194	Dr. Rattan Singh
195	Dr. Jyoti Barwa
196	Dr. Chaitanya Mittal
197	Dr. Atul Shankarrao Keche
198	Dr. Niranjan Sahoo

Punjab Academy of Forensic Medicine & Toxicology

Undertaking format for organizing PAFMATCON/Any Other CME/Workshop under the banner of PAFMAT

To

The President / General Secretary

Punjab Academy of Forensic Medicine & Toxicology

Subject : Consent for Holding the Conference.

Dear Sir

As discussed and decided in the general / executive body meeting of the academy dated …….at ……..……(name the venue), I give my consent to hold the ……annual conference of Punjab Academy of Forensic Medicine & Toxicology on ……..……(Tentative date) in …… (Name of the medical college / venue)

Subject to the following:-

a. The conference and / or the CME programme shall be under the auspices of Punjab Academy of Forensic Medicine & Toxicology. The banner showing the same will be displayed at a suitable area on the main venue.

b. The President and the General Secretary of the Academy will be suitably seated on the dais during the inaugural programme. The President will address the gathering about the policies, programs or other relevant aspects of the Academy. The General Secretary will read out the annual report.

c. The registration of the President, General Secretary, Secretary Finance and the Editor-in-Chief of the Academy will be complimentary.

d. The conference will get accredited with at least 4 CME Credit hours from Punjab Medical Council.

e. The President and / or General Secretary of the Academy along with one member of Punjab Medical Council will be the signatory to the certificate issued to delegate attending the conference / CME / workshop.

f. The organizing committee will send formal invitation to all the office bearers of the academy.

g. The Journal of the Academy will be released during the inaugural programme. The Editor-in-Chief and the Joint Editor will be invited to the dais for the release ceremony.

h. The Organizing Secretary of the programme will hand over the list of the delegates to the General Secretary of the Academy at the end of the conference.

i. The Organizing Committee will collect Rs. 100/- (Rupees one hundred only) per delegate of the programme and will deposit the collected amount in the account of the Journal of PAFMAT / hand over the Cheque for the collected amount favoring Journal of Pb. Aca. Of Forensic Med. & Toxicology to the Editor-in-Chief after the conference.

Sd/-

Organizing Chairman / Secretary

Name:

PAFMATCON :

Format of Application for Subscription of Journal

To

The Editor-in-Chief

Journal of Punjab Academy of Forensic Medicine & Toxicology (JPAFMAT)

Dear Sir,

I wish to Subscribe the Journal of Punjab Academy of Forensic Medicine & Toxicology. I am furnishing the required particulars below with a request to subscribe the Journal. The fee for Journal of Punjab Academy of Forensic Medicine is enclosed.

PARTICULARS

1. Full Name (in block letters)
2. Father's / Husband's name
3. Date of Birth
4. Qualification (with name of university & date of passing)
5. Official Designation & Place of Posting
6. Permanent Address
7. Address for Correspondence (subsequent change of address to be intimated)
8. Phone No. & Email
9. Photo
10. Copy of Medical Council Registration Certificate

Place Yours Sincerely

Date

(Signature)

Note :

1. Payment can be made through online transfer in the Journal Account. For any query related to subscription of the Journal, feel free to talk/whattsapp on mobile no. 98760-05211
2. The above information can be sent by email to editor-in-chief
3. Subscribers of the Journal are entitled for Five (5) CME credit hours per year as per CME Accredition Guidelines issued by Punjab Medical Council.

Glimpse of PAFMATCON-2020

Editorial Board

Editor-in-Chief
Dr Parmod Kumar Goyal

Joint Editor
Dr Amandeep Singh

Subscription rates for Year 2021

Personal: Rs. 1,000/-
Institutions: Rs. 5,000/-

Postal Charges Extra

- Subscription request be sent on email to drparmodgoyal@gmail.com
- Payments be made in Bank Account of Journal of Punjab Academy of Forensic Medicine (A/c No. 65075504236, State Bank of India, Branch Rajindra Hospital Patiala, IFS Code SBIN0050263

Printed & Published by:
Dr Parmod Kumar Goyal
Professor & Head,
Department of Forensic Medicine & Toxicology
Adesh Institute of Medical Sciences & Research,
Bathinda (Pb.) India M. 9876005211, 0164-5055073
E-mail: drparmodgoyal@gmail.com

Printed at:
Subhash Mittal Printing Press
Hospital Bazar, Bathinda
M. 99880-11022
e-mail: mittalpress@gmail.com