

Volume 40
Number 1
Jan. - March
2018

(Official Publication of Indian Academy of Forensic Medicine) Indexed with IndMED, Scopus & IMSEAR, available online at : <http://medind.nic.in> & www.iafmonline.in

Editor
Dr. Dasari Harish

Joint Editor
Dr. Manish Nigam

Publication Quarterly
ISSN : 0971-0973

JOURNAL OF INDIAN ACADEMY OF FORENSIC MEDICINE



(A Peer Reviewed Journal)

(Official Publication of Indian Academy of Forensic Medicine)
www.iafmonline.in



Receipient of the Haq & Bose Lifetime Achievement Award, Prof D S Badkur with Prof Silvano Sapeco, Org. Chaiperson of the Conference & Prof Kalpesh Shah, President IAFM



Prof. S K Kocchar receiving the Fellowship



Prof. Narayana Reddy, receiving the Fellowship



Dr. D S Bhullar, receiving the Fellowship

Indian Academy of Forensic Medicine (IAFM)

(Registration No.349, 12th May, 1972, Panji, Goa)



Governing Council 2016-2019

President

Dr. Kalpesh Shah

General Secretary

Dr. Madhu Godhikirikar

Treasurer

Dr. S.K. Daddu

Vice Presidents

North Zone: Dr. Pankaj Gupta
South Zone: Dr. Cyriac Job
East Zone: Dr. A.J. Patowary
West Zone: Dr. Sudhir Ninave
Central Zone: Dr. Shiv Ratan Kochar

Joint Secretaries

North Zone: Dr. Rajeev Joshi
South Zone: Dr. Krishna Rao GM
East Zone: Dr. Putul Mahanta
West Zone: Dr. Ganesh Govekar
Central Zone: Dr. Manish Kumath

Editor

Dr. Dasari Harish

Joint Editor

Dr. Manish Nigam

Executive Members

Dr. S.D. Nanadkar (Ex. President, IAFM)
Dr. Ajay Kumar
Dr. Sudha R.
Dr. T. K. K. Naidu
Dr. Rai Sudhir Prasad
Dr. Tulsi Mahto

Dr. C.B. Jani (Ex. Secretary, IAFM)
Dr. Rajesh C. Dere
Dr. M. I. Sheikh
Dr. O.P. Murthy
Dr. Abhishek Yadav
Dr. Yogendra Bansal

Journal of Indian Academy of Forensic Medicine (JIAFM)

The Official Publication of Indian Academy of Forensic Medicine

Editor

Dr. Dasari Harish

Professor & Head

Department of Forensic Medicine & Toxicology

Government Medical College & Hospital

Chandigarh, 160030

Ph: 0172-2665253-59 ext 5220

Cell: +91-9646121551

Email: editoriafm@gmail.com,
dasariharish@gmail.com

Joint Editor

Dr. Manish Nigam

Professor & Head

Dept. Forensic Medicine and Toxicology

Deputy Medical superintendent

Sri Aurobindo Medical College and PG Institute

and associated hospitals, Indore (MP)

Cell: +91-9826213412

Email: jointeditorjiafm@gmail.com
jurimanish@gmail.com

Editorial Team

Dr. Amandeep Singh (GMCH, Chandigarh)

Dr. Mandar Sane (GMCH, Chandigarh)

International Advisory Board

Prof. Derrick J Pounder, Dundee, UK

Prof. D N Vieira, Coimbra Portugal

Prof. Dan Dermengiu, Romania

Prof. Peter Vanezis, London, UK

Prof. Roger Byard, Australia

Dr. Michael S. Pollanen, Canada

Prof. Leandro Duarte De Carvalho, Brazil

Dr. Shubhakar K.P. UK

Dr. BL Meel, South Africa

Dr. John Clark, Glasgow, UK

Dr. George Paul, Singapore

Dr. Serap Annette AKGUR, Turkey

Dr. Clifford Perera, Sri Lanka

Dr. B.N. Yadav, Nepal

Dr. K. P. Saha, Bangladesh

Dr. Gorea R.K KSA

National Advisory Board

Srivastava A.K. (U.P.)

Pillay V.V. (Kerala)

Jani C.B. (Gujarat)

Bose T.K (West Bengal)

Pradeep Kumar G. (Karnataka)

Verma S.K. (New Delhi)

Kumar Shantha B. (Tamil Nadu)

Gupta B.D. (Gujrat)

S.C. Mahapatra (Odisha)

Manju Nath K.H., (Karnataka)

Das Sanjoy, (Uttarakhand)

Mahtoo Tulsi, (Jharkhand)

Ravindran K. (Puducherry)

Rastogi Prateek (Karnataka)

Potwary AJ (Assam)

Singh R.K. (Chhatisgarh)

Dongre A.P. (Maharastra)

Sharma Aditya (H.P.)

Yogendra Bansal (Chandigarh)

Khanagwal V. (Haryana)

Rastogi Pooja (U.P.)

Khaja Shaikh (A.P.)

P.P. Mukhopadhyay (W.B.)

Naik R.S. (Maharastra)

Job Cyriac (Kerala)

Vinita K. (U.P.)

Mohite Shailesh (Mumbai)

Yadav Jayanti (M.P.)

Kochar S.R. (Rajasthan)

L. Fimate (Manipur)

K H Chavali (Raipur)

Gaurav Sharma (Haryana)

R S Bangal (Maharashtra)

S S Oberoi (Punjab)

Printed and published by Dr. Dasari Harish, Editor, JIAFM and Dr. Manish Nigam, Joint Editor, JIAFM on behalf of Indian Academy of Forensic Medicine at Sanjay Printers, Chandigarh

Journal of Indian Academy of Forensic Medicine

Volume: 40

•

Number: 1

•

Jan. – March 2018

Contents

Sr.		Page
I.	From the Editor's Desk	3-3
II.	Editorial	4-9

Original Research Paper

1.	Cheiloscopy: A Forensic Aid for Personal Identification and Sex Determination. <i>Geeta Sahu, Jyotish Chandra Choudhury, Debabratta Giri</i>	10-16
2.	Study of Postmortem Cases to Establish the Mortality Patterns in Aurangabad district of Marathwada Region; A Short Communication. <i>Ankush Laxman Rathod, Rakesh K Garg, Kailash V Zine</i>	17-22
3.	Applicability of Willems Method for Dental Age Estimation in Dravidian Children 6-16 Years of Age <i>Kavitha Nedunchezian, Nalini Aswath</i>	23-29
4.	Role of Dental Indexes in Determining Sex: A Forensic Perspective. <i>Qutsia Tabasum, RK Pathak, Manjit Talwar, Dasari Harish, JS Sehrawat</i>	30-37
5.	Profile of Suicides amongst Autopsies at a Tertiary Care Centre in Bangalore North. <i>Udaya Shankar B S, Sujatha P L, Shivakumar B C</i>	38-46
6.	Pesticides - Our Friends or Foe. <i>Pankaj Verma, Manish Nigam, Rashmi Kulkarni, Pradeep Kumar Mishra, Pooja Misar</i>	47-51
7.	Epidemiological Profile of Road Traffic Fatalities: A Retrospective Study of Autopsied Cases at Belagavi, Karnataka. <i>Vishal Koulapur, Anand B Mugadlimath, Kashif Ali, Khaja Azizuddin Junaidi</i>	52-56
8.	Road Safety in Mangalore – An Observation. <i>Prateek Rastogi, Donald Xavier, Esha Mallik, Siddharth Shankar, MS Kotian</i>	57-64
9.	Maximum Cranial Circumference: A Predictor of Sexual Dimorphism of Human Skull. <i>Madhusudan R. Petkar, Sandesh B. Datir, Chandeeep Singh Makhani, Jamebaseer Farooqui, Rajendra S. Bangal, Kalidas D. Chavan</i>	65-68
10.	A study on the Pattern of Rape in Manipur. <i>Soreingam Ragui, Th. Bijoy Singh</i>	69-72
11.	Post Mortem Cooling Pattern In South India – A Basic Approach. <i>Jaffar Hussain AP, Srijiith, Abhijit Subhedar, Sujan Kumar Mohanty, Virendra Kumar</i>	73-79
12.	Estimation of Stature from the Length of the Sternum: An Autopsy Based Study. <i>Sri Jith, Jaffar Hussain AP, Virendra Kumar, Santhosh Chandrappa Siddapa, Sujan Kumar Mohanty</i>	80-84
13.	Correlation of Sexual Dimorphism and Posterior Curve Length with the Help of Discriminant Function Analysis - An Autopsy Study in the Population of Delhi. <i>Rajendra Baraw, Monisha Pradhan, S. K. Khanna, Anuradha Singh</i>	85-90
14.	Diatomological Mapping of Water Bodies of Indore (M.P) Region. <i>Mandar Ramchandra Sane, Pankaj Verma, Rashmi Kulkarni, Pradeep Kumar Mishra, Manish Nigam, P C Sirkanungo</i>	91-95
15.	Awareness, Attitude and Approach of Rural Public to Snakes & Snake Bites. <i>Chidananda PS, Lohith Kumar R, Raksha R, Abhishek Yadav</i>	96-101
16.	Medicolegal Cases for Bone Examination: 11-Year Retrospective Study. <i>H. V. Ambade, A. P. Kasote, M. P. Fulpatil, M. M. Meshram</i>	102-106

Review Research Paper

- 17 **History of Forensic Medicine of India with Reference to Crime and Punishments during British Period (1757 To 1947).** *A.M.M.Patnaik, M. Jagadeesh Naik, Ch. Lakshmi Kumar* 107-113

Case Reports

- 18 **Atypical Missile Wound From an Improvised Firecracker Buster Pipe: A Case Report.** *Narendra Kumar, Hemant Kukde, Ramesh Savardekar* 114-116
- 19 **Sodomy – ‘The Sin of Sodom’: A Report on Five Cases.** *John Deb Barma, Memchoubi Ph, Th Meera Devi* 117-118
- 20 **An Interesting Case of Accidental Smothering in an Unusual Place.** *Abhishek Yadav, Mahesh Kumar, Antara Debbarma, Sudhir Kumar Gupta* 119-121
- 21 **Drug-Induced Aplastic Anemia – A Forensic Overview and Review of Literature.** *Gerard Pradeep Devnath, Siddhartha Das, Rakhee Kar, Rajesh Nachiappa Ganesh* 122-128

Letter to the Editor

129-130

Copy Right © All rights reserved: No part of this publication may be reprinted or publish without the prior permission of the Editor, JIAFM. Submission of all manuscripts to the journal is understood to imply that it is not being considered for publication elsewhere. Submission of multi authored papers implies that the consent of each author has been obtained. In this journal, every effort has been made NOT to publish inaccurate or misleading information. However, the Editor, Joint Editor, Peer Review Group and Advisory Board accept NO liability in consequences of such statements. The Journal of Indian Academy of Forensic Medicine is indexed in **Scopus, IndMED** and **Indian Citation Index**

Print ISSN: 0971-0973. Electronic ISSN: 0974-0848. www.iafmonline.in

Address request for reprint or further information relating to any article may please be made with author and in case of multi authored article, please communicate with Corresponding Author or the First Author

The journal is indexed with Scopus, IndMed & Indian Citation Index and made available online by following website:

www.iafmonline.in

<http://indmed.nic.in>

www.indianjournals.com

Subscription Information

- Members of IAFM will receive the free of cost.
- Non Members and Institutions (Annual Subscription rates)
- Personal: In India, **Rs. 1000/ (Rest of the world: US\$ 200/ or equivalent)**
- Institutions: In India, **Rs. 5000/ (Rest of the world: US\$ 400/ or equivalent)**
- We Accept: Bank Cheque / Demand Drafts (Add Rs. 50/- for outstation Cheques)
- The Scope of the Journal covers all aspects of Forensic Medicine and allied fields, research and applied.

Subscription orders and payments should be made in favour of
“Editor IAFM, payable at Chandigarh”

From the Editor's Desk

JIAFM

A Quarterly Publication
Volume 40, Number 1, Jan.- March, 2018

Dear Friends,

It gives me great pleasure to present the First Issue of 2018 to the Hon'ble Members of the Academy. I wish to thank all the authors and contributors of the scientific material published in this issue. The members of the Editorial Board and the Reviewers strive hard to bring up the standard of the journal. Every person does this task in addition to his professional job and commitments. But, as we have promised you, we are not leaving any stone unturned. We hope that you enjoy and like this Academic Feast as you have enjoyed the previous ones. I, on behalf of the Editorial Team, once again thank you for giving us the opportunity to serve you and this Academy.

*As was decided in the **GBM in Pudicherry**, we are increasing the pages of the Journal from the present **112 to 132**. In our Endeavour to **improve the standard** of the Journal, we are bringing about a **major change in the format** of the articles. From now on, the tables, graphs and diagrams/ photos will be placed within the text, than at the end. This makes each article **more reader friendly** than the previous versions.*

*We are in the process of purchasing **Plagiarism Detecting software**, which we will use from the next issue onwards. The **acceptable limit of Similarity will be 10%**. Any manuscript which surpasses this will be returned forthwith from the office of the EDITOR itself. **Upgrading the standard of the manuscripts** has now become mandatory to upgrade the standard of your Journal, which is, again, **Mandatory for PUBMED Indexing**.*

Jai Hind & Long Live IAFM

*Dr. Dasari Harish
Editor*

Claims for missing issue

A copy will be sent free to the member / subscriber provided the claim is made within 2 months of publication of the issue & self addressed envelop of the size 9+x 12+is sent to the Editor. (Those who want the journals to be dispatched by Registered Post must affix Rs. 50/ worth postage stamps).

Editorial

The Case of the Ten and Half Year Old Pregnant Girl: Medico-legal Issues Involved

¹Dasari Harish, ²Ajay Kumar, ³Mandar R Sane, ⁴Amandeep Singh

Abstract:

Child Sexual Abuse (CSA) has become a pandemic. India has the dubious distinction of having the 2nd maximum number of cases of child sexual abuse victims, the world over.¹ Till 2012, we did not have any law to combat this heinous crime, even though, a survey by the Ministry of Women and Child Development in 2007 stated that 53% of Indian children become victims of CSA.¹ What is more terrifying is that most of these cases are incestuous in nature - the innocent children are victimised by someone from their own family, people whom they are told to trust and respect.

In the recent years, the reporting of early pre-teen pregnancy as a result of rape is on the rise. In some cases, courts allow termination, but in the others, the young girl is forced to carry on the unwanted pregnancy to the full term. The recent case of the 10½ yrs old girl, who underwent caesarean section at 35 - 36 weeks in our institute, is still fresh in the minds of the people.² A similar case had come to PGIMS Rohtak in May this year, where a 10 year old girl was repeatedly raped by her step-dad, but she was lucky that her pregnancy was detected to be between 18 to 22 weeks and hence underwent MTP.³

In this editorial, we will be discussing the physical challenges and various other legal aspects of continuing the pregnancy in such young girls to the full term if termination is denied to the survivor of sexual assault.

Key words: Adolescent Pregnancy, Small Pelvis, Complications, Criminal Law Amendment Act, POCSO Act

Introduction:

Pregnancy in a girl up to 19 years is known by different terms - Teenage Pregnancy,⁴ or Adolescent Pregnancy.⁵ According to the literature, about 16 million girls aged 15 to 19 and some 1 million girls under 15 give birth every year and the related complications have risen as the second most important cause of death in this age group.⁶

Corresponding Author:

⁴Associate Professor,

¹Professor & Head, Editor J Ind Acad For Med,

²Associate Professor,

³Assistant Professor

Dept. Forensic Medicine & Toxicology,
Government Medical College & Hospital, Chandigarh

Email: dramandeep@gmail.com

LM no. IAFM/562/2004

DOI: 10.5958/0974-0848.2018.00001.5

In the Indian subcontinent, 18 -20% of the total pregnancies occur in this age group, with most of them being married.⁷ This is more common in the rural areas as compared to the urban population.⁸ Young primiparas, aged 15 years or less at the time of delivery, form an important obstetric entity in view of the increased hazard to both the mother and the infant. Meticulous prenatal care and close observation should be employed to safeguard both the mother and the infant.⁹

Child Sexual Abuse has now become a grave problem in almost all countries, with far reaching adverse outcomes to the child. The World Health Organisation (WHO) defines CSA as the involvement of a child in sexual activity that he or she does not fully comprehend and is unable to give informed consent to, or for which the child is not developmentally prepared, or else that violate the laws or social taboos of society.¹⁰ The term CSA includes a range of

activities like intercourse, attempted intercourse, oral-genital contact, fondling of genitals directly or through clothing, exhibitionism or exposing children to adult sexual activity or pornography, and the use of the child for prostitution or pornography.¹¹

India has the dubious distinction of having the maximum number of cases of child sexual abuse victims, the world over.¹² A child is sexually abused every 15 minutes.¹³ According to the report on Crimes in India for 2016, 106,958 cases of crimes against children were recorded, of which, 36,022 cases were under the POCSO Act.¹⁴ 89, 423 in cases of CSA were recorded 2014 and 94,172 in 2015.¹³ Till 2012, we did not have any law to combat this heinous crime, even though, a survey by the Ministry of Women and Child Development in 2007 stated that 53% of Indian children become victims of CSA.¹⁵ What is more terrifying is that almost 95% of these assaults are committed by someone known to the child - relatives/ neighbours/ step parents or parents - people whom they learn to trust and respect.¹²

In India, the termination of pregnancy is governed by the MTP Act 1971.¹⁶ It provides for termination up to 20 weeks of gestation period. The problem arises if the legal time for procuring abortion as per the MTP Act is over as the Act does not allow abortions beyond 20 weeks of gestation, except in cases where continuation of pregnancy poses an immediate danger to the mother's life. Any person/ doctor breaching the provisions of the said Act would invite imprisonment up to seven years.¹⁶ In the exceptional life threatening cases, the doctor is immune to any proceedings under the law. Pregnancy as a result of rape results in such a mental trauma as would warrant its termination - Humanitarian Ground.¹⁷

As per the draft bill of amendment of the MTP Act, 2014, the gestation period for termination has been raised to 24 weeks.¹⁸ Studies have also shown that certain neural and cardiac anomalies can only be diagnosed after 20 weeks.¹⁹

Meticulous planning, constant monitoring of the young mother for any complications, both to her and her child, proper decision making as to when and whether to go in

for Caesarean section, proper nutrition of the young mother, etc are some of the important aspects that have to be taken care of for the safety and well being of the mother and the child.

The Case:

A 10½ year old girl was brought to Government Medical College & Hospital, Chandigarh, (GMCH) through a court order on 16.07.17 with a history of several episodes of rape by her maternal uncle since February/March and with ? 29 wks ± 3 wks pregnancy, as opined by the gynaecologist of Government Multi-Specialty Hospital, Sector 16, Chandigarh, (GMSH 16) on 15.07.17. The order stated that the girl was to be examined by a Board to opine regarding:

- a. Length of pregnancy
- b. Whether termination of pregnancy would involve a risk to the life of victim/ cause an injury to her physical / mental health.

A Committee consisting of 8 doctors . 2 from Gynae Obstt, 1 from Radiodiagnosis, 1 each from Paediatrics, Anaesthesia and Psychiatry, with the DMS as the Convenor and the 1st author as the Chairperson, was convened by the Medical Superintendent for the said purpose. The Committee met in the OSCC (One Stop Crisis Centre) of the institute and perused the submitted documents before proceeding for examination of the victim. The documents perused were:

- a. FIR u/s 376 IPC²⁰ and S. 6 of the POCSO Act²¹
- b. Order by the Additional Session Judge regarding the same
- c. Application by the Investigation Officer of the case
- d. Copy of the OPD file of GMSH-16.
- e. The MLR prepared at GMSH-16, with all relevant investigations.

As per the documents perused, the history was that when her parents left for work, her maternal uncle would come to the house, kiss her, give her chocolates and have his way with her. He would then warn her of dire consequences if she reported the same to her parents. The victim had missed her period for the last 5-6 months. The neighbours and

relatives raised doubts regarding the increasing girth of the child's abdomen and that was when the mother too started noticing this. She then confronted her child who told her the whole story. She then lodged a complaint with the police and they took her to the GMSH-16 for a medical checkup before presenting her to the Court.

The Board then talked with the IO, the parents of the girl child and took a detailed history, which came out to be the same. The parents wanted immediate abortion. The concerned members of the constituted Board then examined the girl and, after all relevant investigations, the opinion given by the Board was

1. Duration of pregnancy is 30 \pm 2 weeks, viable foetus, no placenta praevia. Mild anemia.
2. Past history of operated ventricular septal defect for which 'device closure' was done on 10.05.13. Presently asymptomatic. Consultation from cardiologist was sought. Echo was got done, which was Normal.
3. Mental health, as per psychiatrist, was Normal. The child appeared to be completely unaware of the fact that she was pregnant or that the Board and her parents were debating termination of pregnancy. The psychiatrist recommended complete I Q evaluation.
4. Presently, the pregnancy is uncomplicated. However, as most complication occur in 3rd trimester. She is at risk of the same, considering her age.

The Chairperson of the Board and one member gynaecologist were summoned by the Court for an informal discussion regarding the opinion on the next day. The day after, after recording the statement of the gynaecologist, the Court of Additional Sessions Judge, Chandigarh, refused to grant permission for termination of pregnancy. Our contention was that:

1. Termination of pregnancy would be through delivery as the foetus was viable
2. Foetus was still premature and pregnancy needed to be continued for at least 4 more weeks, for its health and well being.

Against the order of the court, a Writ Petition (Civil) was filed in the Hon'ble Supreme

Court, titled: Alakh Alok Srivastava Vs. Union of India and Others,²² requesting another examination by a Superior Board, either from PGIMER, Chandigarh or AIIMS, New Delhi, to get their opinion. The child was re-examined by a constituted committee at PGI, Chd., which also gave similar opinion, which was submitted to the Hon'ble SC. On basis of their report, the Hon'ble Supreme Court:

- a) "Denied permission for termination of pregnancy
- b) Medical care be extended to her at GMCH and it shall be open to the treating doctors to evaluate the health of the girl child for selecting best mode of delivery for the child."

This was on 28th July, 2017. The Supreme Court Bench which disposed of this petition was headed by the then Chief Justice of India, Mr. Justice Jagdish Singh Khehar and Mr. Justice Dr. D. K. Chandrachud.²²

The girl was admitted on 08.08.17 in a private room of the hospital. She was given constant care by the gynaecologists, paediatricians and psychiatrist of the constituted committee. To protect her privacy, a guard was posted outside her room, 24 hrs of the day, from the day of admission to discharge. All relevant documents were placed under the personal custody of the sister on duty.

To smoothen the process of procuring drugs and medicines for the patient, the chief pharmacist and a representative from the Stores Deptt. were co-opted as members. The Chief Dietician and the Head of Cardiology department were included in the Committee, for monitoring her diet and her heart condition.

The parents did not give consent to inform the child of her pregnancy and the prospective surgery, however much, they were requested. They were adamant that their daughter should not know anything and was to be told that the surgery was for some abdominal ailment. In India, the legal age for consenting for medical examination is 12 years and for invasive procedures, 18 years, as per S. 90 & S. 87 of the IPC.²⁰

The child developed gestational hypertension, which progressed to pre-eclampsia. Finally, on 17.08.17, she underwent Caesarian Section under General Anaesthesia,

which was uneventful. She delivered a baby girl, 2.06 kg wt. At the time of delivery, blood samples were collected for DNA analysis from the baby and the girl, to cross match with the alleged perpetrator.

The baby was transferred to Neonatal ICU for observation, and on the second day, to the Intermediate Care Nursery (ICN). She was put on oral feed, underwent phototherapy for neonatal jaundice and was vaccinated as per schedule.

The Child Welfare Committee (CWC), UT, Chandigarh, provided Nursing Attendants to look after the baby as the parents of the girl had given a written undertaking to the hospital that they had nothing to do with the baby, would not accept her, would not even see her face.

Finally, the girl was discharged on 28.08.17 and the baby on 29.08.17. The CWC, UT, Chandigarh, took the custody of the baby.

The Hon'ble Supreme Court was constantly monitoring the case and every week, the constituted Committee had to prepare a status report to be submitted to it.

Further, in Civil Writ Petition Nipun Saxena and Anr. Vs Union of India & ORs,²³ dated 18.08.17 decreed as under [This was an advisory to the health secretaries to all the states and UTs of the Country]

1. All facilities to the girl and her baby would be provided free of cost.
2. The victim be provided compensation . Rs.10 lac, as per victim compensation scheme of the UT Administration. 1 lac to be released immediatly.
3. No one should disclose the identity of the victim, the new born baby, parents of the victim, place of work, place of residence of the parents of the victim. Any defaulter would be dealt with (a) contempt of Court (b) prosecution U/S 228 A IPC.
4. Medical records of the victim as well as the new born baby, after discharge, will be sealed and be under custody of hospital authorities.
5. The identity of the victim and per parents be shown as Ms. X in all the discharge documents.

In furtherance to the orders of the Hon'ble Supreme Court and the directions

issued by the Director Principal of GMCH, all records of the various departments of the GMCH, where in the name of the girl/ her baby was mentioned, the same was struck with black pen and it was written Ms. X or Baby of X along with %as per directions of the Hon'ble Supreme Court on 26.08.17.+ This was done for all investigative, treating departments, hospital administration, etc.

The old CR No. of the girl and the baby were also %frozen+ and a new CR no. was issued to them to safeguard from an inadvertent leaking of the identity. This was linked to the old CR number in such a way that only certain authorized doctors could get access to the old record, if need be.

The compliance of the was then got verified by the DMS under intimation to the Chairperson of the Board. Finally, the Compliance report was submitted to the Hon'ble Supreme Court on its next meeting in September 2017.

Some Interesting Facts:

1. The blood sample from the baby for DNA analysis did NOT match with the alleged maternal uncle of the girl. When she was questioned about this by the Court of Additional Sessions Judge, Chandigarh, the girl alleged that her maternal uncle's younger brother was also involved in raping her.
2. On this, the court ordered his DNA sampling. It was a **perfect match**. The court then sentenced both her maternal uncles under POCSO for aggravated penetrative sexual assault.
3. The baby girl was adopted by a family within the country within a week of the stipulated waiting period of 2 months, as per the Juvenile Justice (Care & Protection of Children) Act 2015.²⁴

Points of Importance:

From the above case, following important conclusions were made:

- It is necessary that such cases be dealt with by a Multi-disciplinary Board so that all the concerned departments can interact and

come up with the best possible solution to the case.

- A Forensic Medicine Expert should be included in the said Board for:
 - Proper interpretation and advice regarding Medico-legal Issues
 - Exact documentation
 - Liaison with various departments of the Government and Hospital Administration
 - Liaison with the investigative agencies and the courts
 - Proper sample collection and initiating the 'Chain of Custody'
 - Liaison with the Child Welfare Committee and NGOs.
- A Spokesperson should be chosen to interact with the Media as the Media, both electronic and print, would be interested in updating the public about the progress of the case. The spokesperson should give accurate and precise data, without any flowery language.
- Co-ordination with all involved departments of hospital for smooth progress of the case, is of paramount importance.

Funding: Nil

Conflict of Interest: None

References:

1. Pande V. The taboo of child sexual abuse in India. Available from: <http://feminisminindia.com/2017/01/09/visiblizing-taboo-child-sexual-abuse-india/>. Accessed on 24th February 2018.
2. Available from: <https://www.hindustantimes.com/punjab/chandigarh-10-yr-old-rape-survivor-is-30-weeks-pregnant-docs-to-perform-natural-delivery/story-N73WNQJkG5hNJEFCV3CtO.html>. Accessed 24th February 2018.
3. Available from: <https://www.hindustantimes.com/india-news/rohtak-rape-10-year-old-girl-s-abortion-process-complete/story-KjpJiNNQiVVL6EcQzIFzsM.html>. Accessed on 18th February 2018.
4. Vidanapathirana M, Rathnaweera RHAJ, Munasinghe KR, Sanjeewanee LKG. Study on pregnant teenagers referred by Obstetricians for medico-legal examination. Available from: https://www.researchgate.net/publication/274689097_Study_on_pregnant_teenagers_referred_by_Obstetricians_for_medico-legal_examination. Accessed 24th February 2018.
5. Treffers PE. Teenage pregnancy, a worldwide problem.[Dutch]. Ned Tijdschr Geneesk. 2003;147:2320-5. As quoted by James DK, Steer PJ, Weiner CP, Gonik B. High risk pregnancy - management options. III rd Ed. Saunders Elsevier. 2006:27-9.
6. Available from: <http://www.who.int/mediacentre/factsheets/fs364/en>. Accessed 24th February 2018.
7. Sharma JB. Text book of obstetrics. 1st. Ed. Avichal Publishing. Kala Amb, Himachal Pradesh. 2014:599
8. Banerjee, B., Pandey, G., Dutt, D., Sengupta, B., Mondal, M., Deb, S. Teenage pregnancy: a socially inflicted health hazard. Ind J Community Med 2009;34(3):227-31.
9. Hassan HM, Falls FH. The young primipara - A clinical study. 1964;88(2):256-69. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/14106723>. Accessed 24th February 2018
10. Guidelines for medicolegal care for victims of sexual violence. Geneva: World Health organization; Child Sexual abuse. Available from: [Whqlibdoc.who.int/publications/2004/924154628x.pdf](http://whqlibdoc.who.int/publications/2004/924154628x.pdf). Accessed 24th February 2018.
11. Putnam FW. Ten year research update review: Child sexual abuse. J Am Acad Child Adolesc Psychiatry. 2003;42:269-78. Available from: [http://www.jaacap.com/article/S0890-8567\(09\)60559-1/abstract](http://www.jaacap.com/article/S0890-8567(09)60559-1/abstract). Accessed 24th February 2018.
12. Singh MM, Parsekar SS, Nair SN. An epidemiological overview of child sexual abuse. J Family Med Prim Care. 2014; 3(4): 430-5.
13. Available from: <http://www.bbc.com/news/world-asia-india-42193533>. Accessed 24th February 2018.
14. National Crime Records Bureau, Ministry of Home Affairs. Available from: <http://ncrb.gov.in/StatPublications/CII/CII2016/pdfs/NEWPDFs/Crime%20in%20India%20-%202016%20Complete%20PDF%20291117.pdf>. Accessed 24th February 2018.

15. Study on child abuse: India 2007. Ministry of Women and Child development Government of India. 2007. Available from: wcd.nic.in/childabuse.pdf. Accessed 24th February 2018.
16. The Medical Termination of Pregnancy Act, 1971; Act 34 of 1971. Available at: <http://tcw.nic.in/Acts/MTP-Act-1971.pdf>. Accessed 24th February 2018
17. Kumar A, Harish D, Singh A: Increasing the limits of gestation period as prescribed in the MTP Act 1971 in light of the recent Supreme Court judgments. *J Ind Acad For Medicine*, 2016;38(4):389-92
18. Available from:
19. <http://www.prsindia.org/uploads/media/draft/Draft%20Medical%20Termination%20of%20Pregnancy%20Amendment%20Bill%202014.pdf>. Accessed 24th February 2018.
20. Todros T, Capuzzo E, Gaglioti P. Prenatal diagnosis of congenital anomalies. *Images Paediatr Cardiol*. 2001;3(2):3-18.
21. The Indian Penal Code. Act 45 of 1860. Available from: <https://www.vakilno1.com/bareacts/indianpenalcode/indianpenalcode.html>. Accessed 24th February 2018
22. The Protection of Children from Sexual Offences Act. Act 32 of 2012. Available from: <http://policewb.gov.in/wbp/misc/2013/22-11.pdf>. Accessed 24th February 2018
23. Civil Writ petition 565/ 2017. Alakh Alok Srivastava & Others Vs. Union of India and Others. 28th July 2017. SC. Available from: <https://indiankanoon.org/doc/173765963/>. Accessed 24th February 2018.
24. Civil Writ Petition 565/ 2012. Nipun Saxena and Anr. Vs Union of India & Others. 1st August 2017. Available from: <https://indiankanoon.org/doc/195579427>. Accessed 24th February 2018.
25. The Juvenile Justice(Care and Protection of Children) Act, 2015. Act 2 of 2016. Available from: www.indiacode.nic.in/acts-in-pdf/2016/201602.pdf. Accessed 24th February 2018.

Original Research Paper

Cheiloscopy: A Forensic Aid for Personal Identification and Sex Determination

¹Geeta Sahu, ²Jyotish Chandra Choudhury, ³Debabratta Giri

Abstract:

Background: Establishing a person's identity is a mammoth challenge, being confounded by the science of criminology. Dental records, fingerprint and DNA comparisons are probably the some of the most common techniques that are used in this context, allowing fast and reliable identification processes. However, under certain circumstances, they cannot always be used so freely and sometimes it is necessary to apply very less known techniques. In forensic identification, lip print patterns can lead us to important information and help in a person's identification. **Objective:** This study aims to ascertain the use of lip print patterns in person's identification and sex differentiation in Odisha population. **Materials and Methodology:** A total of 140 subjects, 70 males and 70 females were selected from Odisha population. The materials used to record lip prints were lipstick, bond paper, cellophane tape, charcoal powder, an ostrich brush for sprinkling the powder to develop latent print, alginate impression material, cold cure powder and liquid, dental stone to cast lip print and a magnifying lens. **Results:** Statistical analysis (applying chi square test for proportion) showed significant difference for type I, I', II, III, IV and V lip patterns ($P < 0.05$) in males and females. **Conclusion:** This study not only revealed that the lip prints are unique to an individual, but also that they have significant reliability for identification of the sex of an individual.

Key Words: Cheiloscopy, Identification, Sex Determination

Introduction:

One of the mammoth challenges in the study of criminal science is to establish the personal identification in the earlier days. The concept of 'Identity'^{1,2} is a set of physical characteristics, functional or psychic, normal or pathological, that define an individual. Identification of humans is a prerequisite for personal, social and legal reasons. Complete identification means the absolute fixation of the identity²⁻⁴ of a person beyond any doubt.

Corresponding Author:

²Associate Professor,

¹Professor and Head, Professor,

³Senior Resident,
Department of Forensic Medicine & Toxicology,
SCB Medical College, Cuttack

E-Mail: jyotischfm@rediffmail.com.

L. M. No: 1149/ODI/2014

DOR: 08/05/2017 DOA: 03/03/2018

DOI: 10.5958/0974-0848.2018.00002.7

The most successful approach utilizes a combination of more than one method. From among these methods, dactylography⁵⁻⁷ and DNA profiling⁸ are the most accurate methods of identification. However, even they have their own disadvantages. In such a situation, it is necessary to find a less known technique such as cheiloscopy⁹⁻¹¹ which is otherwise competitive, comparative, reliable and permanent to provide the evidences as per the need.

Cheiloscopy, as derived from the Greek words cheilos means lips, eskopein means see; is a forensic investigative technique that deals with identification of humans based on lip traces.¹²⁻¹⁴ Wrinkles and grooves present on the labial mucosa called as 'Sulci Labiorum' form a characteristic pattern called 'Lip Prints'^{15,16} the study of which is known as Cheiloscopy.

Characteristics of Lip Prints:

A lip print may be revealed as a stratified surface trace with visible elements of

lines, namely the furrows. If the lines are not clear, only the shape of the lips is printed. Lip prints are unique and genotypically determined;¹⁷ they do not undergo any change from birth until the body undergoes decomposition. Like finger prints, lip grooves are permanent and unchangeable¹⁸ bearing the valor and dexterity in its disposition. The patterns of the lip can be identified as early as in the sixth week of intrauterine life.^{19,20} The purpose of the present study was to ascertain the use of lip print pattern for personal identification, as a sex determinant, to determine the most common pattern in the population of various parts of Odisha, revealing the ethnic dominance.

Materials & Methodology:

Materials used;

Red coloured non glossy lipstick, bond paper, cellophane tape, scissors, magnifying lens (10X), pen for labeling the individuals details, black and white coloured powder taken from forensic science laboratory (FSL), ostrich brush, alginate impression material, cold cure acrylic powder and liquid for making custom tray, dental stone.

Methodology:

This study was carried out in the Department of Oral pathology and Microbiology, S.C.B Dental College & Hospital, after obtaining due consent of the participating subjects. Approval from the Institutional Ethics Committee was taken.

The participants constituted equal number of males and females, in the age group of 1-70 years. They were grouped separately in to seven sets with 10 males and 10 females each, and coded to hide their sex according to the age groups, as follows, set A - age 1 to 10 years, set B - 11 to 20 years, set C - 21 to 30 years, set D - 31 to 40 years, set E - 41 to 50 years, set F - 51 to 60 years, and set G - 61 to 70 years.

Exclusion criteria were as follows;

1. Participants with any active or passive lesions on the lips.
2. With any known hypersensitivity to lipstick components.

Red coloured non glossy lipstick was applied with a single stroke, evenly on the vermilion border. The participants were then asked to rub both the lips to spread the applied lipstick evenly. One set of lip-imprints were then taken on a bond paper by simply rolling the lips from one corner of mouth to the other, by gentle touch until the lip print faded. Then cellophane tape was attached over lip prints to prevent smudging. The name and the sex of the respective individuals were encoded on the paper. Lip prints (latent) were obtained from the individual without applying lipstick on a bond paper. Carbon dust was sprinkled with the help of ostrich brush, then excess was removed by holding and gently shaking the paper. The developed lip print was lifted by glue portion of cellophane tape and fixed to contrast paper. Lip print was also taken by alginate impression material with a custom tray and then poured with dental stone. The casts thus produced were taken for the study of lip prints.

All the lip prints were analysed with the help of magnifying lens. The lip prints were then scanned for digital analysis by using Adobe Photoshop - 7 software. An attempt was made to trace each and every line, quadrant-wise, taking 10mm on either side of the imaginary line passing through the middle part of the lower lip and upper lip. This fragment is almost always visible in any trace, as the determination of the pattern depends on numerical superiority of properties of the lines in these study area. Most lips contain more than one type of patterns and hence, the lips were divided into four quadrants. Each quadrant was studied and various types of lip prints were recorded. Each quadrant was read from the center of the lip outward toward the corner of the lip. The upper and lower lips were divided through the center by an imaginary vertical line, thus producing left and right upper and lower quadrants [Figure-1,2,3,4,5].

Figure 1 - Lip print pattern

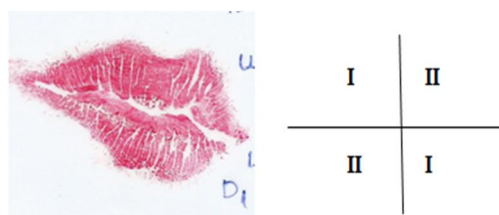
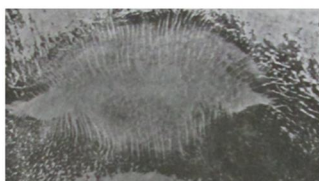


Figure 2 - Lip print pattern

I	I
III	V

Figure 3 - Lip print pattern

IV	IV
IV	IV

Figure 4 - Latent lip print

I	I
I	I

Figure 5 - Cast showing lip print

IV	IV
IV	IV

In this study, the classification of patterns of the lip prints proposed by Y. Tsuchihashi and T. Suzuki²¹ was followed as given under:

Type I : Clear-cut vertical grooves that run across the entire lips

Type I : Similar to type I, but do not cover the entire lip

Type II : Branched grooves

Type III : Intersected grooves

Type IV : Reticular grooves

Type V : Grooves do not fall into any of the types from 1-4 and cannot be differentiated morphologically (undetermined).

The sex of the individual was determined as per the descriptions given by Vahanwala, et al.²²

Type 1, 1 : Pattern dominant . Female

Type 2 : Patterns are dominant . Female

Type 3 : Pattern present . Male

Type 4 : Male

Type 5 : (varied patterns) . Male

Same patterns in all quadrants . Female

Observation and Results :

The distribution of lip print types in males and females in each quadrant was compared. Results were tabulated with a principle that, where lip pattern were found similar in all 4 quadrants, they were called common. Similarly, where similarity was found in 3 quadrants, excepting one, they were also designated as common. Where the similarity was observed in 50% of the quadrants the result of the lower lip was taken into consideration and designated as common due to the reason that the latter was more commonly and widely touched during contact than the upper lip. This has been supported by many authors.^{22,23}

Discussion:

Lip prints have been with us since the beginning of human civilization. R Fischer in 1902²⁴ was the first anthropologist to describe the lip prints. Two Japanese scientists, namely, Y. Tsuchihashi and T. Suzuki,²⁵ during the period 1968-71, established that the arrangement of lines on the red part of the human lip is individualistic and unique for each human being. Apart from identification and evidential use, lip prints may also be used in detection work, as being the referential source of tactical and criminalistic information. A lip print at the scene of crime can be a basis for conclusions as to the nature of the event, the number of the people involved, their sexes, cosmetics used, habits, occupational traits, and the pathological changes by themselves.

Criminals make attempts to conceal their identity through finger prints by wearing gloves during crime or they try to destroy the finger skin pattern either by self-inflicted wounds, application of corrosives or by abrading the skin. Such kind of manipulations are unlikely to be inflicted on their lips. Hence, taking lip prints of all the suspected individuals and comparing

them with the items found at the scene of crime could provide conclusive evidence about the presence of a person at the crime scene. Thus, the other modes of investigation become easier, once the involvement of a suspect at the crime scene is confirmed. Cheiloscopy is applicable mostly in identifying the living, since lip prints are usually left at crime scenes, and can provide a direct link to the suspect. Lipsticks are complex substances which have in their composition containing several compounds, oils, or waxes. While searching for lip prints, one must always consider that, not all lipstick smears are coloured. In fact, in recent years, the cosmetic industry has been developed new persistent lipstick which does not leave a visible smear or mark when they come in contact with different items such as glass, clothing, cutlery, cigarette butts or food items etc. However, all lip prints are important, even the ones that are not visible. These lip prints are characterized by their permanence and are therefore, referred to as "persistent" lip prints. Although invisible, these prints can be "lifted" using materials such as charcoal powder and aluminum powder. The edges of the lips have sebaceous glands and sweat glands. Thus, secretions of oil and moisture from this area enable the development of "latent" lip prints, analogous to latent fingerprints. Identifiable lip prints can be obtained

within 30 days²⁵ after they are imprinted. Use of lip prints as evidence in Indian courts has not attained wide popularity till date, despite their high performance of objective accuracy.

In our study, lip prints of 140 individuals in the age range of 1-70 years were observed by using magnifying lens and analysing further distinct lip patterns by utilizing Adobe Photoshop software -7 and comparing the lip grooves from the median line towards the corner of the mouth, as the lip does not contain only one type of groove, but a mixture of varieties of the same. **(Table-1)** They differ from individual to individual, according to their position or distance from the median line towards the corner of the mouth in respect of type of lip print pattern and character of each type of print.²⁶ Similar observations were also recorded in work of other authors.^{27,28}

It was found that of the 140 participants, type . I lip print pattern was found to be the predominant pattern, with 37.9 %, the second most common was type-IV with 25.7 %, type - III pattern of lip prints were found in 23.6% and the type . II in 8.6 %. Similarly, type-I in 3.6% and type-V was the least, 0.7% **(Table-2)**. Of the 70 females, the type-I pattern was found as the predominant pattern in 48 individuals (68.6%), while 9 (12.9%) showed type-IV pattern, 7 (10%) showed type-II pattern and type-I and type-III

Table-1: Common lip print pattern among males and females

Type	Sex	RUQ	LUQ	LLQ	RLQ	COMMON LIP PRINT PATTERN
Type I	Males	14	5	16	12	5
	Females	44	40	47	50	48
Type I'	Males	3	5	7	5	2
	Females	4	5	3	3	3
Type II	Males	3	4	12	14	5
	Females	5	10	10	8	7
Type III	Males	21	26	23	24	30
	Females	2	6	4	4	3
Type IV	Males	29	29	11	14	27
	Females	15	9	6	5	9
Type V	Males	0	1	1	1	1
	Females	0	0	0	0	0
"p" value		0.0001	0.0001	0.0001	0.0001	0.0001

Table-2: The common lip print pattern of males, females and total

Lip print patterns	Male(70)	%age(70)	Females(70)	%age(70)	Total(140)	%age(140)
Type- I or Long vertical grooves	5	7.14%	48	68.57%	53	37.86%
Type – I' or Short vertical grooves	2	2.86%	3	4.29%	5	3.57%
Type – II or Branching grooves	5	7.14%	7	10%	12	8.57%
Type – III or diamond grooves	30	42.86%	3	4.29%	33	23.57%
Type – IV or reticular grooves	27	38.57%	9	12.86%	36	25.71%
Type – V or other types of grooves	1	1.43%	0	0%	1	0.71%

were found in 3 females, each. **(Table-2)** Of the 70 males in our study, type-III pattern was found to be predominant pattern in 30 persons (42.9%), followed by type-IV in 27 persons (38.6%). The above results were found similar in some studies²⁹ and dissimilar in other studies, as in the literature.³⁰⁻³² Such variation could be explained due to the different sampling of subjects in different groups, expressing ethnic variation. The analysis of lip line in 4 different quadrants of individuals showed that 49 females showed similar lip line in all the 4 quadrants, being a dominant feature with 70%. Other studies found similar results.³¹ Whereas, in males, 7 showed similar lip line patterns in the 4 quadrants and 63 showed dissimilar patterns in the same, which were found to be predominant one. The features were similar to that as found in other researchers work.^{31,33} Our study also showed 83% accuracy in identifying males and 90% accuracy in identifying females. The overall accuracy of sex identification was 87%. (Table-3).

Table-3: Table of accuracy in sex determination

	Males(70)	Females(70)
Diagnosed correct %age	58 82.86%	63 90%
Diagnosed wrong %age	12 17.14%	7 10%
Undecided	0	0

Summary & Conclusion

Any process that possesses the possibility of assisting the forensic field in identifying the suspect should be pursued and if discovered pertinent, utilized in the act of criminal investigation and legal proceedings. The use of lip prints falls into this category. Its

proven testimony of reliability is trustworthy to link a suspect to a crime with substantial high degree of accuracy and hence emphasis should be given to this field. Lip print analysis is a process that provides both qualitative and quantitative analytical results. Thus its application in the forensic field may be widely accepted as a contributory tool for law enforcement and the legal professionals. Lip prints are unique to the individual which can be explained on the basis that no two individuals in the studied group have an exactly matching lip print in all four quadrants. No significant difference was found in the change of pattern in lip print images collected after 12 months from the same individual, even after exposure of the lips to the seasonal variations and minor or superficial trauma.

The technique followed for collection of the lip prints using lipstick as recording media and bond paper as transferring media with proper stabilization of the lips, while recording, can be adopted as a good technique to obtain a definable lip print image. In case of non lipsticks user or lip sticks that gives no trace on contact, latent lip print can be developed, which gives same result with visible lip print.

The digital method of analyzing the lip print images using Adobe Photoshop-7 software serves as a convenient method that provides better visualization and ease in recording and identification of the lip print pattern. It also serves as an ideal method of permanently storing the data which will help in keeping an ante-mortem record of an individual. Lip prints are similar to finger prints with a high level of accuracy.

Lip prints can be used as an evidence or a positive means of person's identification just like fingerprints. They can also be used for sex determination. They are easy and unbiased

unlike the presentation of dental evidences. It is permanent, sustainable and the factors for distortion like self infliction or other means are less likely. Although it is widely acceptable in other countries round the globe, but is yet to be popular and acceptable in Indian court of law. This study is an honest approach with a novel method of personal identification and to facilitate the criminal justice system converging the credential of prima facie evidence for support.

Future Prospects

Similar to the finger print banks, lip print banks may be made available in all police stations for matching the lips for the purpose of identification. However, the process is technique sensitive due to high flexibility of lips and their smudging offering great difficulty in taking appropriate lip print. Larger sample study may still be required to determine the predominant type as well as their subtypes to revise the classification.

Conflict of interest: None

Financial assistance: None

References

- Sharma P, Saxena S, Rathod V. Comparative reliability of cheiloscopy and palatoscopy in human identification. *Indian J Dent Res* 2009;20(4): 453-7.
- Gondivkar S M, Indurkar A, Degwekar S, Bhowate R. Cheiloscopy for sex determination. *J Adv Dental Research* 2009;1(2):56-60.
- Kapali S, Townsend G, Richards L, Parish T. Palatal rugae patterns in australian aborigines and caucasians. *Aust Dent J* 1997; 4:129-33.
- Utsuno H, Kanoh T, Tadokoro O, Inoue K. Preliminary study of post mortem identification using lip prints. *Forensic Sci Int* 2005;149:129-32.
- Rajendran R, Sivapathasundharam B. Shafer's textbook of oral pathology. 5th Ed. New Delhi: Elsevier Publication. 2006:1223-4.
- Reddy KSN. The essentials of forensic medicine and toxicology. 21st Ed. Hyderabad: K Suguna Devi. Publisher; 2005:49-84.
- Molano M A, Gil J H, Jaramillo J A, Ruiz S M. Revista facultad de odontologia Universidad de Antioquia. *Rev. Fac. Odonto. Univ. Antioquia*. 2002; 14: 26-33. Available from: <https://bases.bireme.br/online/ADOLEC/6023>. Accessed on: 2nd March 2017.
- P Ahuja, A Manchanda. Application of oral hard and soft tissue structures in sex determination. *Internet J Forensic Science*. 2009;4:2.
- Sanghar J, Jaishankar S, Shanmugam S. Lip prints in personal identification. *J Ind Acad Dental Specialists* 2010; 1(4): 23-6.
- Annie J Verghese, Somasekar M, Umesh Babu R. A study on lip print types among the people of kerela. *J Ind Acad For Med* 2010;32(1): 6-7.
- Nagasupriya A, Dhanapal R, Reena K, Saraswathi T R, Ramachandran C R. Patterns: A crime solver. *J Forensic Dent Sci* 2011; 3:3-7.
- Venkatesh R, David M P. Cheiloscopy: an aid for personal identification. *J Forensic Sci* 2011;3(2): 67-70.
- Russell L W, Welch A E. Analysis of lip sticks. *Forensic Sci Int*. 1984;25:105-16. Available from: [https://doi.org/10.1016/0379-0738\(84\)90019-7](https://doi.org/10.1016/0379-0738(84)90019-7). Accessed on: 2nd March 2017.
- Ragab AR, El Dakroory S.A.E.A, Rahman R.H.A. *Int J Legal Med* 2013;127:521-27. Available from: <https://doi.org/10.1007/s00414-012-0784-5>. Accessed on: 2nd March 2017.
- Sognnaes R F. Forensic Science and oral biology. In: Shaw J H, Sweeney EA, Cappuccino C C, Meller S M, editors. Textbook of oral biology, Philadelphia: W B Saunders; 1978, p. 1123-58.
- Oq Shangnessy P E. Introduction to forensic science. *Dent Clin North Am* 2001; 45: 217-27.
- Tobias P. The skull, endocast and teeth of Homo habilis. Olduvai Gorge, New York: Cambridge University; 1990: 4.
- Reddy L V K. Lip prints: an overview in forensic dentistry. *J Adv Dental Research* 2011;1:17-20.
- Kasprzak J. Cheiloscopy. In: Siegal J A, Saukko P J, Knupfer G C, editors. Encyclopedia of forensic sciences. Vol 1, London: Academic Press; 2000, p. 58-61. 10
- Warren H. Look, ask, listen and note. In: Henry K, Editor. Dental Identification and Forensic odontology, London: Henry Kimpton Publishers; 1976, p. 22-3.
- Suzuki K, Tsuchihashi Y. A new attempt of personal identification by means of lip print. *Can Soc Forensic Sci J* 1971; 4: 154-8. Available

- from:
<https://doi.org/10.1080/00085030.1971.10757287>
. Accessed on: 2nd March 2017
22. Vahanwala S P, Parekh B K. Study of lip prints as an aid to forensic methodology. *J Forensic Med Toxicol* 2000;17:12-8.
23. Ghimrie N, Nepal P, Upadhyay S, Budhathoki S S, Subba A, Kharel B. Lip print pattern: an identification tool. *Health Renaissance* 2013;11(3):229-33.
24. Segu M A, Feucht M M, Ponce A C, Verdu Pascal F A. Persistent lipsticks and their lip prints: New hidden evidence at the crime scene. *Forensic Sci Int* 2000;112:41-7.
25. Tsuchihashi Y. Studies on personal identification by means of lip prints. *Forensic Science* 1974;1-3:233-48. Available from:
[https://doi.org/10.1016/0300-9432\(74\)90034-X](https://doi.org/10.1016/0300-9432(74)90034-X).
Accessed on: 2nd March 2017
26. Prabhu R, Dinakar A, Prabhu V. Collection of lip prints as forensic evidence at the crime scene- An insight. *J Oral Health Res* 2012;1:129-35.
27. Padmavathi B N, Makkad R S, Rajan S Y. Gender determination using cheiloscopy. *J Forensic Dent Sci* 2014;4:52-6.
28. Kinra M, Ramalingam K, Sethuraman S, Rehman F, Lalawat G, Pandey A. Cheiloscopy for sex determination: A study. *Univ Res J Dent* 2014;4:48-51.
29. Vijay Kautilya D, Bodkha P, Rajamohan N. Efficacy of cheiloscopy in determination of sex among South Indians. *J Clin Diagn Res* 2013;7(10): 2193-6.
30. Sharma P, Saxena S, Rathod V. Cheiloscopy: The study of lip prints in sex identification. *J Forensic Dent Sci*. 2009;1:24-7.
31. Dwivedi N, Agarwal A, Kashyap B, Raj V, Chandra S. Latent lip print development and its role in suspect identification. *J Forensic Dent Sci* 2013;5(1):22-7.

Original Research Paper

Study of Postmortem Cases to Establish the Mortality Patterns in Aurangabad district of Marathwada Region; A Short Communication

¹Ankush Laxman Rathod, ²Rakesh K Garg, ³Kailash V Zine

Abstract:

Death is serious tragedy, whatever be the occasion, in whatsoever form and the way it occurs. The study of death trends is an important parameter to know the cause of deaths among the population of particular area. Each place has its own cause and pattern due to variable reasons. Death records can also provide information regarding fatality rates, age and sex distribution, which are of enormous importance in planning health care services and help in building rugged strategy to minimize the possible un-natural deaths in future.

The present study was undertaken as an initial step to meet the sole objective of finding the mortality trends in population of Aurangabad district of Maharashtra, by studying post-mortem (PM) records conducted at Govt. Hospital and Medical College, Aurangabad. 1745 PM records were collected and studied. It was observed that RTA (Road traffic accident) was the foremost cause of death, followed by deaths due to burns and poisoning. Predominance of males (69.5%), as compared to females, (29.5%) was found in the total autopsy samples studied. Deceased individuals in the age group of 21-30 years were highest (27.1%) and it was least in the age group of 91-100 years (0.1%).

This study indicates that the major cause of fatalities taking place in this region of the state is the lack of awareness of traffic rules, carelessness in the handling of flammable liquids, common and abrupt use of easily available agricultural poisons, etc. Further data in other regions of the state needs to be explored with respect to the years, sex, age group and cause.

Key Words: Mortality, Post-mortem, Unnatural Death, Poisoning, Pesticides, Burning

Introduction:

India is a vast country with a great regional variations and diversity among its population in their living, food habit, other daily

livelihood; and this regional variation may affect the mortality trends. Therefore, determination of mortality pattern from one region to other region is required. This regional variation may turn out to be as great within states, as between them. The regional variation at local levels necessitates a district-level analysis of mortality pattern. Such district level estimates are not, by and large, studied in the country, since India is undergoing rapid epidemiological transition as a result of economic and social changes. The pattern of mortality is a key indicator of the consequent health effects.¹ Meaning of Mortality is that the state of being subject to death on a large scale, therefore it becomes significant to study trend when a particular cause is responsible for huge numbers of loss of life. Study of mortality patterns may help in identifying a general direction in which deaths

Corresponding Author:

²Professor,

Dept. of Forensic Science, Punjabi University, Patiala

¹ Research student,
Punjabi university, Patiala/Sub-inspector (FP), NCRB,
New Delhi

³Prof. & Head,
Dept. of Forensic Medicine & Toxicology,
Govt. Medical College, Aurangabad (MH)

E Mail: rkgvpbi11@yahoo.com.

L. M. No: 294/1994

DOR: 10/03/2017 DOA: 24/01/2018

DOI: 10.5958/0974-0848.2018.00003.9

occur. Causes of mortality in developing countries are very different from that of developed countries.

National crime record bureau (NCRB) released the data in 2014 and 2015, from which it is estimated from that 36 & 38 persons died every hour, respectively, throughout the country by unnatural accidents including trauma, electrocution, poisoning, drug abuse, etc. The Maharashtra state was leading the tally in both the consecutive years in all the unnatural accident cases reported in the country, with 11.5% in 2014 and 15.3% in 2015. The deaths due to road traffic accident were recorded at 83.7% in 2014 and 83.8% in 2015 and poisoning deaths were 17.9% and 22.7%, in respective years. The ratio of male to female fatality due to unnatural causes was 79.5:20.5 and 80:20 in 2014 and 2015, respectively. The rates of accidental deaths in 2014 and 2015 were 36.3 and 32.8 per Lac of population, respectively.² and rate of suicidal deaths remained constant on 10.6 per Lac of population in both the years

Globally these two causes of death contribute much more than any other unnatural cause of deaths. It is estimated that till 2020, road traffic accidents will account for 90% of world road traffic related fatalities in developing nations.³ Similarly, death due to poisoning in developing world is more than that in developed nations. Several studies showed that 99% fatal poisoning occurs into developing nations; it is estimated that every day nearly 700 people die and several are affected around the world due to poisoning.^{4,5}

The present study can help in knowing about the fatalities occurring in a selected area, determining the cause of deaths, establishing the age and sex distribution among deaths reported. It can also assist in finding out the pattern of deaths reported in the hospital and it may help to uncover the most vulnerable cause of mortality in the region. The people of developing nations are at great risk of such unnatural deaths than the developed nations and India is one of the major countries among the developing nations, where development is achieving at faster rate by compromising people's health and living.

The present study will also help in understanding the variety of unnatural causes of mortality in the region and also to know the gravity of the different causes of unnatural deaths. It also aimed to know the age and sex distribution in the autopsies performed during the duration of study, which shows the magnitude of deaths occurring in this region. The study of hospital death records can also give vital clues and information in order to design the policy for prevention of such preventable causes of deaths in this particular region. There are hardly any up-to-date, precise and reliable mortality pattern statistics generated on the basis of PM records at present, at district-level, particularly in rural areas of the country. Therefore this effort in this direction has been undertaken to reach at some point by studying and classifying PM records applying various parameters to present them in systematic way to draw the significant conclusions.

Materials and Methodology:

The records of all the postmortem cases performed during the period from 1st January to 17th September 2015 were collected and studied from the department of Forensic Medicine and Toxicology, Government Medical College, Aurangabad, Maharashtra. A scrutiny was done from the records of postmortem examinations and the information was recorded of 1745 cases were studied from January to September 2015. Various parameters were observed from the records such as number of PM conducted, sex of deceased, age of deceased, cause of death. The causes of deaths have been classified into major causes like trauma, thermal injuries, poisoning, asphyxia and miscellaneous causes/other deaths in which cause could not be classified. Majority of the cases (90%) were referred from primary health centre or rural health center situated in various parts of the district.

In the present study the causes of deaths have been recorded on the basis of PM findings and not based on the chemical examiners report/opinion. The data for the present study was collected only from the Government Medical College, Aurangabad, but needs to be included from other such hospital

situated within the district where postmortem examinations are conducted. This study is limited to one particular area of Maharashtra.

Observations:

The present study has been conducted in a Government Hospital of district Aurangabad (Headquarter of Marathwada region of Maharashtra state). The Aurangabad Administrative division includes eight districts and covers the population of 18731872. The Aurangabad district holds 3695928 of population alone roughly equal to the nation of Liberia and stand 72 most populated district in India and 10 in Maharashtra.⁶ In this study, a total of 1745 PM records from the department of Forensic Medicine and Toxicology, Government Medical College, Aurangabad were collected, studied and subsequent observations were drawn (**Table 1**). The findings obtained after studying the collected postmortem data, from which a systematic and statistical representation has been made and discussed further.

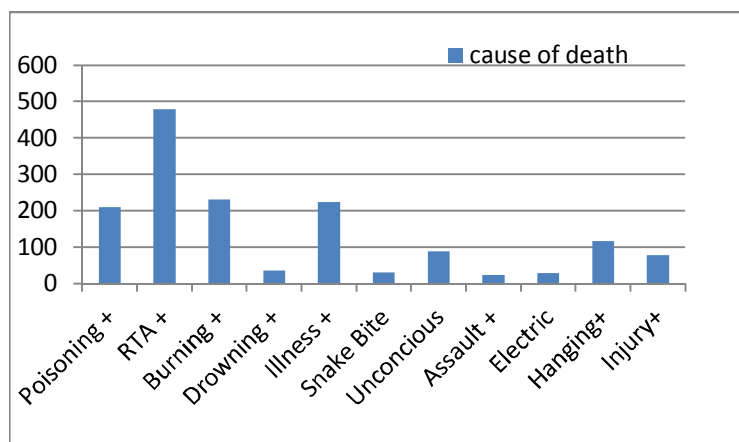
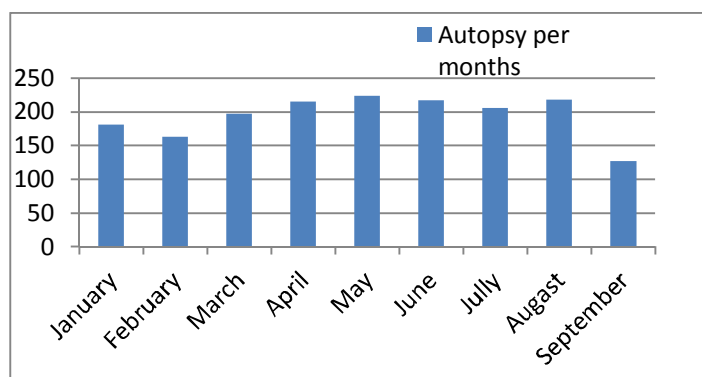
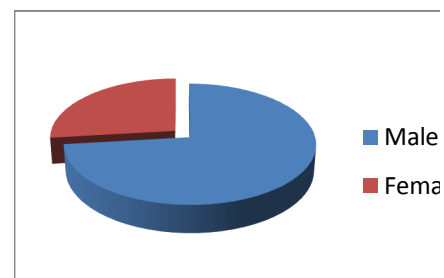
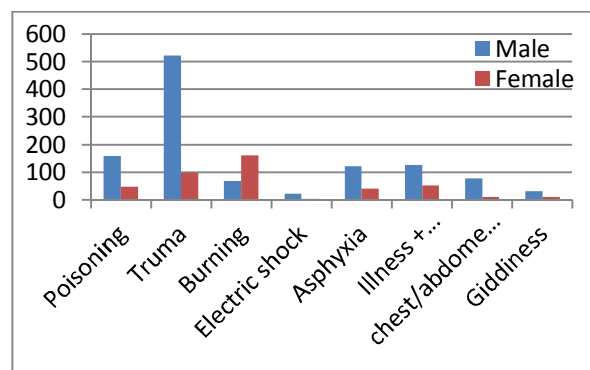
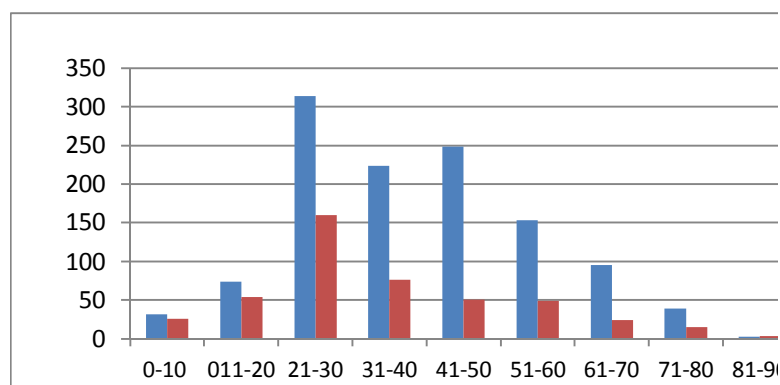
From the data it is observed that in 624 (35.8%) cases, the victims died due to trauma including RTA, railway, assault and fall. Deaths due to thermal injuries accounted for 262 cases, including burns (234) and electric shock (28);

among 252 deaths, it was observed that poisoning was due to food poisoning, agricultural poisons, alcohol intoxication and snake bites, etc. One hundred sixty (160) deaths occurred due to asphyxia, including strangulation, hanging, throttling and drowning, of which 35 occurred due to drowning, 106 people died by hanging and 10 died due to strangulation/throttling. It was also observed that 324 deaths occurred due to illness, which included TB, chest pain, pain in abdomen, cancer, fever, ache, giddiness, etc as per records. In this study, nearly 138 (7.9%) deaths could not be classified because of the difficulties encountered in screening (**Figure 1**). Similarly, Joshi, et al and Godale and Mulaje reported that 18% and 6-7% of the deaths respectively, could not be classified because of some technical difficulties.^{1,9} Maximum autopsies were performed in a month of August and minimum in a month of February (**Figure 2**). Deaths in males (70.5%) were more common, as compared to females (29.5%) and the difference was statistically significant (**Figure 3**). Deaths due to burns were more common in females (69.7%) (**Figure 4**). Mortality is higher among the 21-30 years (27.1%) of age group (**Figure 5**).

Table 1: Showing distribution of deaths by cause

Causes of Deaths		No. of Males	No. of Females	Total	Percentage (%)
RTA*	Trauma	377	54	624	35.75
Rail Accident		49	4		
Assault		17	7		
Fall		82	34		
Burning	Thermal Injury	71	163	262	15.01
Electric Burn		23	5		
Various Poisons	Poisoning	160	49	252	14.44
Alcohol Intoxication		12	0		
Snake Bite		16	15		
Hanging	Asphyxia	95	21	160	9.2
Strangulation		4	6		
Drowning		22	13		
Illness		50	40	309	17.7
Chest/abdomen pain		79	11		
Giddiness		31	10		
Unconsciousness		76	12		
Other/Miscellaneous		84	54	138	7.9
Total		1248 (71.46%)	498 (29.54%)	1745	100

*RTA= Road Traffic Accident

Figure 1: Showing Causes of Deaths**Figure 2: Month-wise PM performed****Figure 3: Total PM (sex-wise)****Figure 4: Cause of Death (sex-wise)****Figure 5: Showing Age Wise Distribution****Discussion:**

Understanding of mortality pattern is essential to know the frequency of deaths and cause of death occurring in that particular area, it will act as an indicator of people's health in that region in particular time and help the Government for designing intervention programs, making awareness in people,

allocation of resources, implementation of rules and signifying priorities. Rapid urbanization, migration of major population towards cities, everyday addition of large number of vehicles running onto the narrow roads and streets with poor traffic regulation coincides with major increase in incidence of road traffic accidents and related deaths. Mortality is high during the

thirtieth and fortieths years of the age and it is most common among the 21-30 years (27.11%) of age group. Similar studies have also been found that victims mostly from this age group.^{8,9} Predominance of male deaths (70.5%) was observed in the present study and similar finding were observed in other such studies.¹⁻⁹ The ratio of male deaths to female deaths was 2.56:1. Maximum deaths were found in a month of August and minimum in a month of February, behind this no probable reason could be assigned.

Although accidents are preventable, but still they account for a large number of deaths than any other cause of deaths; death due to trauma is the leading cause of mortality that includes RTA, rail accident, assault and due to fall. It may be because of increase in urban population and over burden on transport services. Mortality due to RTA (n=431) was predominant among traumatic deaths and main contributors in RTA deaths are human errors, violation of traffic rules, vehicle maintenance, road factors and negligence towards other preventive measures, etc. Similar studies have been reported in RTA.^{7-9,11}

Burn (262) injuries had also contributed in large number of deaths, particularly among young women due to kitchen accidents, self-immolation and domestic violence; making it the second highest cause of deaths, similar findings were also observed by other studies.^{9,10} Meera et al reported that the nature of death in burning was accidental in 50% cases, suicidal in 38.46% cases and homicidal in 11.54% cases.¹² The percentage of deaths due to poisoning is 15%, in which fatalities due to agriculture poisons was more than any other cause of poisoning. Easy availability, lack of regulations, improper storage facility, easily available over the counter, accessibility almost to all, absence of proper monitoring are the few reasons behind this type of poisoning cases. Death due to illness was observed in 12.8% of cases and due to asphyxia, was 9.2%.

In such circumstances, Government needs to take strong measures to promote safety at the workplace and households by educational campaigns and workshops. From this current hospital-based study of post-mortem

deaths, it is concluded that fire-related deaths are not only a public-health issue but also leave some space for suspicion behind their occurrences and manner in which they occur in India. Identification of populations at risk and explanation of structural determinants from existing hospital records is required, so that interventions can be immediately implemented.

Conclusion:

Trauma (RTA) is the most common cause of death in this region followed by burning, poisoning. The age group of 21- 30 years is the most commonly involved in all death events which shows their vulnerability in meeting the death due to any cause of death. More number of women died due to burning which increases the suspicion of homicide in these types of deaths.

Suggestions:

From this present study, an inferences have emerged out that could be supportive in reducing different types of deaths that is Laws related to road safety and traffic rules throughout the country needs to be strengthened. Storage and selling of pesticides and different poisonous compound should stringently be controlled. In order to avoid pesticide poisoning in farmers, the community based Strategic program should be organized regularly to pull them out from depressions and protect them from pesticides hazardous effect and injuries. People engaged in use of insecticide and pesticide should be educated about safety and precaution in handling of such substances. Since accidents are multi-factorial in causation, there is always a need for development in road safety protocols to prevent accidents, enhancing roads and provide safety to human being.

Approval: Approval for this study was obtained from the Head of the Department of Forensic Medicine and Toxicology, Govt. Medical College and Hospital, Aurangabad.

Conflict of interest: None

Financial Assistance: None

References:

1. Joshi R, Cardona M, Iyengar S, Sukumar A, Raju CR, Raju KR. Chronic diseases now leading cause in rural India mortality data from the Andhra Pradesh rural health initiative. *Int J Epidemiol* 2006;35:1522-9.
2. National crime record bureau. (2014 and 2015): Accidental deaths and suicides in India. Ministry of home affairs, govt. of India. New Delhi. Available from: <http://ncrb.gov.in/StatPublications/ADSI/ADSI2015/ADSI2015.asp>. Accessed on 22nd Feb 2017.
3. Bansude ME, Kachare RV, Dode CR, Kumre VM. Trends of unnatural deaths in latur district of maharashtra. *J Forensic Med Sci Law* 2012;21(2):1-8.
4. Batra AK, Keoliya AN, Jadhav GU. Poisoning: an unnatural cause of morbidity and mortality in rural India. *J Assoc Physicians India* 2003;51:955-9.
5. Varma NM, Kalele SD. Study of profile of deaths due to poisoning in Bhavnagar region. *J Ind Acad Foren Med* 2011;33(4):313-8.
6. District Census 2011. Available from: Census2011.co.in. 2011. Retrieved on 08-02-2017
7. Reddy A, Balaraman R. Epidemiological study of two wheeler accident victims in rural south India. *J Ind Acad For Med* 2016;38(1):32.
8. Godale, L, Mulaje, S. Mortality trend and pattern in tertiary care hospital of solapur in maharashtra. *Indian J Community Med* 2013;38(1):49-52.
9. Cardona M, Joshi R, Ivers RQ, Iyengar S, Chow CK, Colman S, Ramakrishna G, Dandona R, Stevenson MR, Neal BC. The burden of fatal and non-fatal injury in rural India. *Injury Prevention* 2008;14:232-7.
10. Mishra PK, Tomar J, Sane MR, Saxena D, Yadav A. Profile of death in bun cases: A post-mortem study. *J Ind Acad Fore Med* 2016;38(1):8-10.
11. Sharma R, Dubey MK, Garg RK, Garg JR. Pattern of deaths in chhattisgarh. *Ind Police J* 2013;LX (3):199-214.
12. Meera Th, Nandeibam P, Slong D, Nabachandra H. Burn deaths: a study on female victims in manipur. *J Ind Acad Forec Med.* 2015;37(4):358-60.

Original Research Paper

Applicability of Willems Method for Dental Age Estimation in Dravidian Children 6-16 Years of Age

¹Kavita Nedunchezian, ²Nalini Aswath

Abstract:

Aim: Assessment of tooth development to estimate the age of living being is required for treatment, criminal and legal aspects. Demirjian's method (1973) was the most widely used method of age estimation, and has mostly been reported to overestimate the age of an individual. Later in 2001, Guy Willems, modified Demirjian's scoring system by assigning numerical values for each developmental stages of tooth. This study was done to test the efficacy of Willems *et al.*, method of age assessment in Dravidian children aged between 6-16 years, using Digital Ortho-pantomographs (OPG).

Materials and Methodology: Retrospectively, thirty existing digital OPGs of children aged between 6-16 years, who had visited the dental hospital for various treatment purpose were reviewed. Willems *et al.*, scoring criteria was used to estimate the dental age. The data was calculated using SPSS version 20 and subjected to Unpaired t test, Wilcoxon signed ranks test and Pearson's correlation.

Results: The overall mean difference between the estimated dental age and chronological age for males was 0.3898 ± 1.24200 years, while for females, it was 0.182 ± 2.7800 years. The total mean difference between DA and CA was 0.286 ± 2.011 .

Conclusion: Willems method can be used effectively for age estimation in Dravidian children.

Key Words: Willem's Method, Dental Age Estimation, Orthopantomogram

Introduction:

Age estimation in children has been used successfully for identification & treatment. It is helpful in cracking criminal cases (victims of child abuse, child labour, homicides or suicides, in identification of missing persons, subjected to rape etc.), in establishing the veracity of legal documents like birth certificates (to prevent child

trafficking), marriage certificates (to avoid child marriage) and other official documents (adoption).

In the absence of any clinching evidence, forensic reports have been considered as the only source of evidence in medico-legal cases. Various methods have been proposed for assessing dental development, which is generally referred to as dental aging.

Dental aging appears in two forms: tooth mineralization and tooth eruption patterns, both biological and developmental patterns.¹ Eruption refers to the emergence of the tooth through the gum rather than to the emergence from the bone or reaching the occlusal plane.¹ This makes it impossible to use eruption for age estimation on skeletal remains in forensics. Tooth emergence may be influenced significantly by local exogenous factors such as infection, obstruction, crowding, and premature extraction

Corresponding Author:

² Professor & Head,

Department of Oral Medicine and Radiology,
Sree Balaji Dental College and Hospital,
Narayanapuram, Pallikaranai, Chennai

¹Consultant Oral Physician and Maxillofacial
Radiologist, Private Practice, Chennai

Email ID: naliniaswath@gmail.com.

L. M. No: Not a Member

DOR: 08/05/2017 DOA: 07/02/2018

DOI: 10.5958/0974-0848.2018.00004.0

of the deciduous predecessor or adjacent permanent teeth. The methods of dental age (DA) estimation relying on the evaluation of the mineralization and growth stage of the teeth seem to be scarcely affected by local and systemic factors,² but are dependent on the genetics of the population as they show ethnic variability.³ The estimation of age by observing the calcification of permanent teeth has been demonstrated to provide reliable and accurate results.

Different methods are available for estimating the dental age, as advanced by Nolla⁴, Haavikko⁵, Demirjian⁶, and modified Demirjian method by Willems, et al.⁷ In order to quantify the continuous process from first traces of cusps mineralization until root apex closure, many authors suggested different number of radiographic stages. In the Demirjian method,⁶ the tooth formation is divided into eight stages and criteria of these stages for each tooth were given separately. Each stage of the left mandibular seven teeth was allocated a score and the sum of the scores gave an evaluation of the subject's dental maturity and the DA was calculated using the sex specific tables. When applying this method, towards the end of dental maturation fewer stages contribute more, so that a single stage change can lead to a large jump in dental age.

Nolla's study⁴ was one of the first to assess tooth formation longitudinally and quantify dental maturation. In this method, a sum of tooth scores against each age was given and were used to predict age into 1 year age groups. It also provides an age at each stage for each tooth.

Haavikko, et al⁵ suggested adoption of an age estimation method based on the determination of one of the 12 radiographic stages of each permanent teeth. The difficulty with Haavikko method was deciding if the children who were considerably delayed in one tooth, were to be included in the full analyses in order to compare with other methods. Even though, other methods have been used, the most widely used method for dental age estimation was described in 1973 by Demirjian, et al⁶ because of its simplicity. This method has been tested in various populations and has been

mostly reported to overestimate the age of an individual.⁸⁻¹²

In 2001, Guy Willems⁷ adapted scoring system, which resulted in new age scores expressed in years and had a higher accuracy compared to the Demirjian's original method in Belgian Caucasians. Willems had actually modified Demirjian's original method and tried it in Belgian Caucasian population and his modification has been evaluated among various communities and has been reported to be more accurate¹³⁻¹⁷ compared with the original method.

The aim of the present study was to test the efficacy of Willems method of age assessment in Dravidian children aged between 6-16 years using Digital Ortho-Panatomography (OPG).

Materials and Methodology:

A retrospective cross sectional study using existing Digital Orthopantomographs of children aged between 6-16 years, who had visited the hospital for various treatment purposes were included in the present study. 30 OPGs of 18 male and 12 female children were assessed. Seven left mandibular permanent teeth were considered for evaluation. Inclusion criteria were children aged from 6-16 years belonging to Dravidian origin, with presence of all the 7 left mandibular permanent teeth. Exclusion criteria were children with OPGs showing missing left permanent mandibular teeth, surgically treated or syndrome and pathology related. Distribution of entire sample according to age and sex is given in **Table 1**.

Table 1- Distribution of Samples according to age and sex

Age Interval	Gender		Total (N)
	Male (N)	Female (N)	
8-9.99	6	2	8
10 - 11.99	3	4	7
12-13.99	4	4	8
14-15.99	5	2	7
Total	18	12	30

Chronological age of an individual was calculated by subtracting the birth date from the date on which the radiographs were exposed for that particular individual. Two evaluators (Oral and maxillofacial radiologists), carried out the

interpretation. Demirjian's method (Table 2)⁷ was used for staging (A-H) the tooth

Table 2- Demirjians developmental scoring criteria

Stage	Description
A	Beginning of calcification is seen at the superior level of crypt in the form of cones. There is no fusion of these calcified points
B	Fusion of the calcified points forms one or several cusps, giving a regularly outlined occlusal surface
C	Enamel and dentin formation is complete at the occlusal surface and converge at cervical region Dentin deposition is seen The outline of the pulp chamber has a curved shape at the occlusal border
D	Crown formation is completed down to the cementoenamel junction Superior border of pulp chamber in uniradicular teeth has a definite curved form; projection of pulp horns gives an umbrella top. In molars, pulp chamber has a trapezoidal form Beginning of root formation is seen in the form of a spicule
E	Uniradicular teeth The walls of pulp chamber form straight lines, whose continuity is broken by the pulp horn The root length is less than the crown height In molars Initiation of radicular bifurcation is seen as a calcified point or a semi-lunar shape Root length is less than crown height
F	Uniradicular teeth The walls of pulp chamber form isosceles triangle. Apex ends in a funnel shape The root length is equal to or greater than the crown height In molars: The bifurcation has developed down to give the roots a distinct outline with funnel shaped endings Root length is equal to or greater than crown height
G	The walls of root canal are now parallel and its apical end is partially open (distal root in molars)
H	The apical end of the root canal is completely closed Periodontal membrane has a uniform width around the root and apex

developmental process. Tooth formation is divided in to eight stages and criteria of these stages for each tooth were given separately. After noting all stages of teeth from central incisor to the second molar by the two examiners, the developmental status of a

particular tooth was calculated in years on the basis of tables given by Willems et al (Table 3).¹ All the values from central incisor to the second molar thus obtained were summed to obtain an overall maturity score, which will indicate the DA of that particular patient.

Table 3- Willems Scoring Criteria

Boys								
Tooth	A	B	C	D	E	F	G	H
Central Incisor			1.68	1.49	1.5	1.86	2.07	2.19
Lateral Incisor			0.55	0.63	0.74	1.08	1.32	1.64
Canine				0.04	0.31	0.47	1.09	1.9
First Bicuspid	0.15	0.56	0.75	1.11	1.48	2.03	2.43	2.83
Second Bicuspid	0.08	0.05	0.12	0.27	0.33	0.45	0.4	1.15
First Molar				0.69	1.14	1.6	1.95	2.15
Second Molar	0.18	0.48	0.71	0.8	1.31	2	2.48	4.17
Girls								
Tooth	A	B	C	D	E	F	G	H
Central Incisor			1.83	2.19	2.34	2.82	3.19	3.14
Lateral Incisor				0.29	0.32	0.49	0.79	0.7
Canine			0.6	0.54	0.62	1.08	1.72	2
First Bicuspid	-0.95	-0.15	0.16	0.41	0.6	1.27	1.58	2.19
Second Bicuspid	-0.19	0.01	0.27	0.17	0.35	0.35	0.55	1.51
First Molar				0.62	0.9	1.56	1.82	2.21
Second Molar	0.14	0.11	0.21	0.32	0.66	1.28	2.09	4.04

Data was analyzed by Statistical Package for the Social Sciences computer software (SPSS, version 20.0) using Pearson's chi square test. $P < 0.05$ was considered to be significant. Reliability of Willems method was verified by testing inter observer variability using Wilcoxon Signed Ranks test. The differences between Dental Age and Chronological Age in different age groups in both sexes were tabulated using descriptive statistics and the differences were compared using ANOVA test. [Table 4 to Table 7]

Results:

Comparison of the DA applying the Willems method, the CA and differences between DA and CA (DA and CA) of both

Table 4-Unpaired t test between DA and CA for South Indian male and female children with the mean difference between both

Age interval	SEX	N	CA		DA		DA-CA		95% CI OF DA-CA		t-Value	p-Value
			Mean	SD	Mean	SD	Mean	SD	Lower	Upper		
8-9.99	Male	6	8.33	0.516	9.365	1.3401	1.0317	1.13602	-1.29876	2.8521	0.916	0.395
	Female	2	8	0	8.255	0.14849	0.255	0.14849				
10 - 11.99	Male	3	10.67	0.577	10.7667	1.05453	0.1	1.26835	-1.91867	1.73367	-0.13	0.901
	Female	4	10.75	0.5	10.9425	0.84528	0.1925	0.60786				
12-13.99	Male	4	12	0	12.3275	1.08911	0.3275	1.08911	-1.76184	2.49184	0.42	0.689
	Female	4	12.25	0.5	12.2125	1.19895	-0.0375	1.35493				
14-15.99	Male	5	14.4	0.548	14.5	1.48241	0.1	1.47904	-3.13259	2.70259	-0.189	0.857
	Female	2	14.5	0.707	14.815	1.37886	0.315	0.67175				
Total	Male	18	11.35	.410	11.7400	1.24200	0.39	1.24200				
	Female	12	11.38	.428	11.5500	.89250	0.182	2.78000				
			11.37	.419	11.6450	1.0686	0.286	2.01100				

The mean difference between DA and CA according to Willems method was 0.39 years and in the present study it was 0.28 which is statistically significant ($P < 0.001$). Mean absolute differences and standard deviations for age cohort for males and females are presented in Table 5. The mean absolute differences were 0.18 years for females and 0.389 years for males and showed that absolute accuracy was better for females compared with males.

Pearsons correlation showed a significant correlation between DA and CA in

gender and age groups are presented in Table 4.

The unpaired t test results indicated that the mean CA was $11.37 \pm .419$ and the mean DA was 11.6450 ± 1.0686 . The mean age difference between DA determined using the Willems method (from the Belgian Caucasian population) and the CA of this study population was 0.389 years for males and 0.182 years for females and independent t test showed that these differences were statistically not significant ($P > 0.05$). [Figure 1] demonstrate the distribution of estimated DA in comparison with CA in males and females respectively. They show that underestimation was more common than overestimation in both sexes.

both males ($r = 0.879$) and females ($r = 0.928$) with a p value 0.01. Depicted in Table 6. Wilcoxon test showed no statistically significant differences in assessing dental age between readings of two observers ($Z = 0.317; P > 0.05$) 0.751) Table 7.

Discussion:

The need to evaluate age to consider legal responsibility, or for application of different laws for young people, requires reliable methods. The study of the morphological

Table 5: Absolute Difference For (DA-CA)

Age Interval	Sex	N	Mean	SD	Median
8-9.99	Male	6	1.0317	1.13602	0.75
	Female	2	0.255	0.14849	0.255
10 - 11.99	Male	3	0.1	1.26835	0.73
	Female	4	0.1925	0.60786	0.015
12-13.99	Male	4	0.3275	1.08911	0.395
	Female	4	-0.0375	1.35493	-0.47
14-15.99	Male	5	0.1	1.47904	1.03
	Female	2	0.315	0.67175	0.315
Total	Male	18	0.389	1.243	0.726
	Female	12	0.18	0.69	0.028
	Total	30	0.2845	0.9665	0.377

Table 6: Correlation: Male & Female

		Male Correlations ^a			Female Correlations ^a		
		Sex	Chro Age	Dent Age	Sex	Chro Age	Dent Age
Sex	Pearson Correlation						
	Sig. (2-tailed)						
	N	18	18	18	12	12	12
Chro Age	Pearson Correlation		1	.879**		1	.928**
	Sig. (2-tailed)			0			0
	N	18	18	18	12	12	12
Dent Age	Pearson Correlation		.879**	1		.928**	1
	Sig. (2-tailed)		0			0	
	N	18	18	18	12	12	12

** . Correlation is significant at the 0.01 level (2-tailed).

Table 7: Inter Observer Variability (Wilcoxon Signed Ranks Test)

	N	Min.	Max.	Mean	Std. Deviation	Z value	P value
Observer1 Chronological Age	30	8	15	11.3	2.322	.000 ^a	1
Observer 2 ChronologicalAge_2	30	8	15	11.3	2.32156		
Observer 1 Dental Age	30	7.59	16.03	11.64	2.30738	-.317 ^b	0.751
Observer 2 DentalAge_2	30	7.55	16.03	11.68	2.18331		
Valid N (list wise)	30						

parameters of teeth and hand/ wrist X-rays of children is more reliable than most other methods for age estimation and is most commonly used to determine age in living

humans.¹⁸ Tooth formation is widely used to assess maturity and to predict age. Within clinical dentistry, such information aids in diagnosis and treatment planning.¹⁹

The evaluation of mineralization from OPGs is the most suitable method for age estimation using teeth in children because a single radiograph gives the complete developmental status of dentition in children. Digital OPGs were used as the images can be magnified to make analysis easier.

Although various age assessment methods showed high degrees of reliability, ethnic differences between various population groups were found to affect the accuracy resulting in overestimation or underestimation of the DA. It has been reported that development of each individual can be affected by genetic, racial, nutritional, climate, hormonal and environmental factors.²⁰

Demirjian's method considers OPG assessment of 7 Left mandibular molars and rated according to developmental criteria like Dentinal Deposition, shape change in Pulp chamber, etc., Eight stages from A to H was allotted, in Canadian Children. It also resulted in a significant and consistent overestimation of the chronological age, as reported in literature when applied on a population of Belgian Caucasian origin. Willems method for dental age estimation in a Belgian Caucasian population was found to be more accurate compared to Demirjian's method.¹

The present study showed a significant correlation between DA and CA in both males ($r = 0.879$) and females ($r = 0.928$). The overall mean difference between the estimated DA and CA for males was 0.3898 ± 1.24200 years while for females, it was 0.182 ± 2.7800 years. The total mean difference between DA and CA was 0.286 ± 2.011 . The inter observer variation was not statistically significant this could be attributed to the low sample size. Since this is a pilot study we would require to try this out on a large population scale.

Grover, et al²¹ estimated dental age using 215 (OPGs) of children aged 6 - 15 years belonging to North Indian population using Willems method. It was stated that Willems method produced a significant mean overestimation of 0.36 years in boys and 0.24 years in girls in their study which is in accordance with our present study, where the overall mean difference for male was 0.38 and 0.18 for female

children. They also mentioned that the mean overestimation for was less for girls as compared to boys, which is also consistent with the present study.

Mohammed, et al¹ studied 332 digital OPGs (166 males, 166 females) of South Indian descent children, the estimated difference in mean age for males was by 0.69 years and females was 0.08 years. There was a significant over estimation of male children age in their study(0.69) compared to our present study(0.38). While comparing female children, there was a significant overestimation of dental age in our present study (0.18) compared to Mohamed RB et al., study(0.08). The variation could be attributed to variation in sample size.

Conclusion:

Willems method can be used effectively for age estimation in Dravidian children. Since the present study is a pilot study, it has to be tested on a larger sample.

Conflict of Interest : None

Financial Assistance: None

References

1. Mohammed RB, Krishnamraju PV, Prasanth PS, Sanghvi P, Lata Reddy MA, Jyotsna S. Dental age estimation using Willems method: A digital orthopantomographic study. *Contemp Clin Dent* 2014;5:371-6.
2. Demirjian A, Buschang PH, Tanguay R, Patterson DK. Interrelationships among measures of somatic, skeletal, dental, and sexual maturity. *Am J Orthod* 1985;88:433-8. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/3864376>. Accessed on 13th March 2015
3. Cunha E, Baccino E, Martrille L, Ramsthaler F, Prieto J, Schuliar Y, et al. The problem of aging human remains and living individuals: A review. *Forensic Sci Int* 2009;193:1-13.
4. Nolla C. The development of the permanent teeth. *J Dentistry for Children* 1960;27:254-66. Available from: https://www.dentalage.co.uk/wp-content/uploads/2014/09/nolla_cm_1960_development_perm_teeth.pdf . Accessed on 13th March 2015
5. Haavikko K. The formation and the alveolar and clinical eruption of the permanent teeth. An

- orthopantomographic study. Suom Hammaslaak Toim 1970;66:103-70. Available from: https://www.dentalage.co.uk/wp-content/uploads/2014/09/haavikko_k_1970_tds_c_complete.pdf. Accessed on 13th March 2015
6. Demirjian A, Goldstein H, Tanner JM. A new system of dental age assessment. Hum Biol 1973;45:211-27. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/4714564>. Accessed on 13th March 2015.
 7. Willems G, Van Olmen A, Spiessens B, Carels C. Dental age estimation in Belgian children: Demirjian's technique revisited. J Forensic Sci 2001;46:893-5.
 8. Maber M, Liversidge HM, Hector MP. Accuracy of age estimation of radiographic methods using developing teeth. Forensic Sci Int 2006;159 Suppl 1:S68-73.
 9. Koshy S, Tandon S. Dental age assessment: The applicability of Demirjian's method in south Indian children. Forensic Sci Int 1998;94:73-85.
 10. Liversidge HM, Speechly T, Hector MP. Dental maturation in British children: Are Demirjian's standards applicable? Int J Paediatr Dent 1999;9:263-9.
 11. Eid RM, Simi R, Friggi MN, Fisberg M. Assessment of dental maturity of Brazilian children aged 6 to 14 years using Demirjian's method. Int J Paediatr Dent 2002;12:423-8.
 12. Rai B, Anand SC. Tooth developments: an accuracy of age estimation of radiographic methods. World J Med Sci 2006;1:130-2.
 13. Mani SA, Naing L, John J, Samsudin AR. Comparison of two methods of dental age estimation in 7-15-year-old Malays. Int J Paediatr Dent 2008;18:380-8.
 14. Pinchi V, Norelli GA, Pradella F, Vitale G, Rugo D, Nieri M. Comparison of the applicability of four odontological methods for age estimation of the 14 years legal threshold in a sample of Italian adolescents. J Forensic Odontostomatol 2012;30:17-25.
 15. Liversidge HM, Smith BH, Maber M. Bias and accuracy of age estimation using developing teeth in 946 children. Am J Phys Anthropol 2010;143:545-54.
 16. Ramanan N, Thevissen P, Fleuws S, Willems G. Dental age estimation in Japanese individuals combining permanent teeth and third molars. J Forensic Odontostomatol 2012;30:34-9.
 17. EL Bakary AA, Hammad SM, Ibrahim FM. Comparison between two methods of dental age estimation among Egyptian children. Mansoura J Forensic Med Clin Toxicol 2009;17:75-86.
 18. Cameriere R, Ferrante L. Age estimation in children by measurement of carpals and epiphyses of radius and ulna and open apices in teeth: a pilot study. Forensic Sci. Int 2008 (174):59-62.
 19. Tunc ES, Koyuturk AE. Dental age assessment using Demirjian's method on northern Turkish children. Forensic Sci. Int 2008;175(1):23-6.
 20. Kullman L, Johanson G, Akesson L. Root development of the lower third molar and its relation to chronological age. Swed Dent J 1992;16:161-7.
 21. Grover S, Mojan CH, Avinash J, Pruthi N. Dental age estimation of 6-15 year old North Indian children using Willems Method. Revista Latinoamericana de Ortodoncia y Odontopediatria Depósito Legal N°: Available from: pp200102CS997 - ISSN: 1317-5823 - RIF: J-31033493-5 - Caracas . Venezuela. <http://www.ortodoncia.ws/publicaciones/2011/art17.asp>. Accessed on 13th March 2015

Original Research Paper

Role of Dental Indexes in Determining Sex: A Forensic Perspective

¹Qutsia Tabasum, ²RK Pathak, ³Manjit Talwar, ⁴Dasari Harish, ⁵JS Sehrawat

Abstract:

Background: Human identification in Forensic Odontology mainly involves assessment of dental morphology and their specific traits. Analysis of non-metric traits has been largely studied for sex assessment in Forensic Odontology. However, sexing from metric features of dental remains also facilitates significant aspect. One of the non-metric methods for determining sex includes measuring of different odontometric dimensions such as linear, diagonal and their indexes. **Aim:** Determination of sex from contemporary extracted molars using dental indexes. **Materials & Methodology:** Three dental indexes – crown/ cervical area, crown/ cervical module and crown/ cervical index – were calculated in a total number of 368 (male and female) extracted permanent molars. Univariate and multivariate (discriminant and regression) analysis were performed using appropriate statistical tools. **Results:** All the ratios are statistically significant ($p < 0.005$), as demonstrated by t-test. The general pattern of males having larger values was observed and further the results depict reverse sexual dimorphism. More than 70% of the samples were classified by crown indexes in both discriminant function (stepwise) and regression analysis (forward conditional) to their original sex category. **Conclusion:** It was concluded that dental index can aid in narrowing down the data by assigning sex in the forensic scenario.

Key Words: Dimorphism, Odontometrics, Sex Determination, Discriminant Analysis

Introduction:

The process of decomposition and fragmentation destroys facts associated with the

evidence and obstructs the process of sex identification. In such instances, teeth provide sufficient information to determine the sex of an individual. Determination of sex in forensic odontological investigations involves analysis of morphological features, tooth dimensions, and molecular analysis.¹⁻³

The assessment of sex from the measurements of different tooth dimensions plays an important role in the forensic investigation. Such studies are apparently easier, cheaper and convenient to perform and yet so informative. Therefore prior exposures to any destructive technique, analysis of simpler methods are suggested which ensure the integrity of forensic samples for further analyses. The difference in size and shape between the two sexes is often expressed as sexual dimorphism.⁴ The degrees of sexual dimorphism manifested by anthropological as well as odontological samples are analyzed and interpreted using statistical tools. Commonly the population-specific variation in anthropometric

Corresponding Author:

¹Senior Research Fellow,

Institute of Forensic Science & Criminology,
Panjab University, Chandigarh

²Professor,
Department of Anthropology,
Panjab University, Chandigarh

³Associate Professor,
Oral Health Centre,

⁴Professor and Head,
Department of Forensic Medicine and Toxicology,
Government Medical College & Hospital, Chandigarh

⁵Assistant Professor,
Department of Anthropology,
Panjab University, Chandigarh

Email: tabasumjafri786@gmail.com.

L. M. No: Not a Member.

DOR: 04/07/2017 DOA: 07/02/2018

DOI: 10.5958/0974-0848.2018.00005.2

standards is accepted and it is obligatory to revise these persisting standards to accommodate greater diversified population-specific data. In forensic settings, sex identification scales down the mass process of investigation to approximately half.⁵ Identification from forensic odontological samples relatively stands at par as compared to other biological samples due to the survival and resistance potential of the dental tissues.⁶

The theoretical approach of forensic dentistry lies in the fact that no two mouths are alike and so their morphological and anatomical variations are considered in the identification purpose. The science of forensic dentistry accounts for an understanding of the relationship between teeth and jaws as evidence to law and justice, and one of the principal objectives in this field is the personal identification and sex determination.⁷ Teeth are the most indestructible part and chemically the most stable tissues in the body and exhibit the least turnover of natural structure.⁸ Hence, teeth can provide excellent material for generating identification standards.

Sex identification, one of the important aspects of biological profiling, is essential not only for medico-legal purpose but on account of humanity. For instance classifications of sex especially in mass disasters remain the foremost duty of all the official personnel involved in the investigation. Buthz and Ehrhardt, in 1938, reported that measurements of the crowns of teeth can estimate human dental sexual dimorphism.⁹ Differences in male and female odontometric features have been identified.¹⁰ The present study attempts to demonstrate the importance of indexes in evaluating sexual dimorphism in Indian population. Though not many studies have been carried to determine sex from dental indexes, however, the statistical analysis has eventually uplifted the approach.

Materials and Methodology:

The samples for the present study consisted of contemporary extracted molars from population belonging to Punjab, Himachal Pradesh, Haryana and Chandigarh. The study examined the applicability of dental indexes in assessing sex from contemporary Indian population. These indexes were extracted from

linear and diagonal dental dimensions at crown and cervix junction of human molars. A total of 368 (Males: 225, Female 143) were collected from individuals visiting the Oral Health Centre of the Government Medical College & Hospital, Chandigarh. Extraction of molars was performed as recommended by dentist due to some dental pathological conditions in the concerned patients. Written, informed consent was taken from the patients followed by recording their information such as age, sex and tooth number.

Dental indexes are derived from simple mathematical combinations of linear measurements. They include crown area, crown module and crown index which are extracted from measurements at the crown.¹¹ Further, in this study cervical index ratios formed from cervical diameters taken at the cemento-enamel junction and the proper definition of each was also given as follows:

Crown area (CA) / Cervical Area (CVA) - The product of linear dimensions Buccolingual and Mesiodistal at crown region and cervix (cemento-enamel junction) represents the Crown area and Cervical Area.

$$CA = BL \times MD \quad CVA = BLCV \times MDCV$$

Crown module (CM)/ Cervical Module (CVM) - The average of linear dimensions Buccolingual and Mesiodistal at crown region and cervix (cemento-enamel junction) represents the Crown Module and Cervical Module.

$$CM = (BL + MD)/2 \quad CVM = (BLCV + MDCV)/2$$

Crown index (CI)/ Cervical Index CVI - It is the ratio of linear dimension Buccolingual and Mesiodistal at crown region and cervix (cemento-enamel junction) region and is expressed in percentage.

$$CI = BL/MD \times 100 \quad CVI = BLCV/MDCV \times 100$$

In order to establish the correlations different statistical tools (Descriptive and Multivariate) were applied using IBM SPSS Statistics 20 and plots presented the differences graphically.

Results:

Univariate Analysis:

The results of univariate descriptive statistics separately for male and female are summarized in **Table 1** and **Table 2**,

respectively. It was observed that the mean of majority parameters was greater in males than in females. A reverse dimorphism was also noticed, where the mean values of Crown Index (CI) and Cervical Index were greater in females than males. The spread of analytical data, as measured from variance values, illustrates the greater contribution of female dental ratios in

discriminating the two sex group of the dataset. All the ratios estimated in the study are statistically significant ($p < 0.05$) indicating that the observed difference is not by chance alone but likely by some existing force. Box plot graph (**Figure 1**) depicts the statistical distribution of the two sexes from the indices measured in the study.

Table 1: Descriptive statistics for dental indexes of male molars (n= 225) in the study.

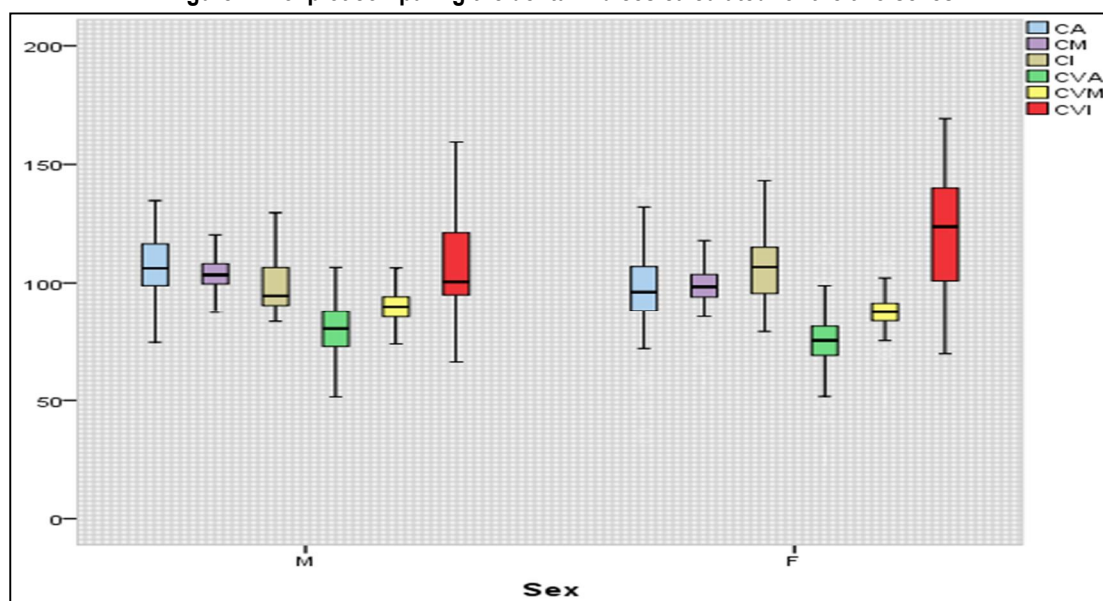
Dental Index	Mean	SE	SD	V	Range	Minimum	Maximum
CA	107.36	0.82	12.29	151.16	70.07	74.61	144.68
CM	10.36	0.04	0.60	0.36	3.38	8.66	12.04
CI	99.12	0.79	11.80	139.21	62.61	83.42	146.03
CVA	80.79	0.73	10.91	119.03	61.56	51.42	112.99
CVM	9.01	0.04	0.61	0.38	3.25	7.39	10.63
CVI	108.57	1.32	19.74	389.49	96.49	66.32	162.81

Table 2: Descriptive statistics for dental indexes of female molars (n= 143) in the study.

Dental Index	Mean	SE	SD	V	Range	Minimum	Maximum
CA	96.81	1.48	17.66	311.93	105.56	33.40	138.95
CM	9.82	0.08	0.95	0.91	6.00	5.79	11.79
CI	107.98	1.22	14.61	213.34	75.42	79.21	154.63
CVA	74.74	1.16	13.85	191.92	95.30	23.96	119.26
CVM	8.6762	.073	0.87	0.76	6.065	4.90	10.96
CVI	121.57	1.93	23.09	533.05	99.63	69.68	169.31

CA= Crown Area; CM= Crown Module; CI= Crown Index; CVA= Cervical Area; CVM= Cervical Module; CVI= Cervical Index; M= Mean; SE= Standard Error, SD= Standard Deviation; V= Variance, R= Range; Min. = Minimum, Max = Maximum.

Figure 1: Boxplot comparing the dental indices calculated for the two sexes



Multivariate Analysis:

The data subjected to multivariate analysis further validated the sex determination potential of calculated dental indices. The

comparative results of both discriminant and regression analysis (**Table 3** and **Table 4**) showed that the classification percentage of males were higher as compared to females.

Table 3: Results of discriminant analysis and logistic regression analysis using enter method of selection.

V	Discriminant Function Analysis (Enter Method)									
	WL	SCDFC	CDFC	GC	SP	CFC		Classification (%)		
						M	F	M	F	Total
CA	0.889	1	0.068 -7.067	0.281 -0.442	-0.06	0.503 -27.484	0.453 -22.889	89.30	38.50	69.60
CM	0.891	1	1.323 -13.433	0.278 -0.438	-0.06	18.141 -94.493	17.193 -85.383	89.80	35.00	68.50
CI	0.990	1	0.077 -7.914	-0.266 0.418	0.06	0.590 -29.739	0.643 -35.652	84.90	32.20	64.40
CVA	0.944	1	0.082 -6.463	0.193 -0.304	-0.06	0.548 -22.644	0.507 -19.907	92.00	17.50	63.00
CVM	0.953	1	1.378 -12.234	0.177 -0.278	-0.04	17.103 -77.507	16.476 -72.419	93.30	14.00	62.50
CVI	0.917	1	0.047 -5.385	-0.239 0.377	0.07	0.244 -13.731	0.273 -17.543	80.40	41.30	65.20
Logistic Regression Analysis (Enter Method)										
V	B	S.E	Wald	Sig	Exp.	O	Classification (%)			
							M	F	Total	
CA	-0.052 4.854	0.009 0.904	34.632 28.859	1 1	0.000 0.000	0.949 128.266	88.40	42.00	70.40	
CM	-1.030 9.975	0.178 1.800	33.569 30.706	1 1	0.000 0.000	0.357 21490.406	88.40	42.00	70.40	
CI	0.050 -5.661	0.009 0.916	32.913 38.158	1 1	0.000 0.000	1.052 0.003	84.90	32.20	64.40	
CVA	-0.042 2.853	0.010 0.770	18.598 13.711	1 1	0.000 0.000	0.958 17.333	91.60	17.50	62.80	
CVM	-0.651 5.313	0.166 1.472	15.392 13.033	1 1	0.000 0.000	0.521 202.897	92.40	15.40	62.50	
CVI	0.028 -3.636	0.005 0.608	28.715 35.714	1 1	0.000 0.000	1.028 0.026	80.40	41.30	65.20	

V= Variables, WL= Wilk's Lambda, SCDFC= Standardised Canonical Discriminant Function Coefficient, CDFC= Canonical Discriminant Function Coefficient, GC= Group Centroids, SP= Sectioning Point, CFC= Fisher's Canonical Function Coefficient

Table 4: Results of discriminant analysis (stepwise) and logistic regression analysis (forward conditional)

Function	Discriminant Function Analysis (Stepwise Method)										
	SV	WL	SCDFC	CDFC	GC	SP	CFC		Classification (%)		
							M	F	M	F	Total
FI	CA CI	0.889 0.814	0.71 -0.675	0.049 -0.052 0.280	0.381 -0.599	- 0.081	0.520 0.608 -58.550	0.417 0.660 -59.384	87.6	48.3	72.30
FII	CVM CVI	0.864	-0.655 0.833	-0.903 0.039 3.525	-0.315 0.496	0.090	16.512 0.180 -84.601	15.789 0.212 -82.269	86.2	49.0	71.70
FIII	CA	0.889	1	0.068 -7.067	0.281 -0.442	- 0.080	0.503 -27.484	0.453 -22.889	89.3	38.5	69.60
FIV	CM	0.891	1	1.323 -13.433	0.278 -0.438	- 0.059	18.141 -94.493	17.193 -85.383	89.8	35.0	68.50
FV	CI	0.900	1	0.077 -7.914	-0.266 0.418	0.076	0.590 -29.739	0.643 -35.652	84.9	32.2	64.40
Logistic Regression Analysis (Stepwise Method)											
Function	SV	B	S.E	Wald	Sig	Exp.	Classification (%)				
							M	F	Total		
FI	CA CM CI	0.569 -12.562 0.072 61.014	0.188 3.857 0.012 19.024	9.128 10.608 35.330 10.286	1 1 1 1	0.003 0.001 0.000 0.001	84.90	53.10	72.60		
FII	CVM CVI	-0.786 0.031 2.956	0.184 0.006 1.620	18.312 31.831 3.328	1 1 1	0.000 0.000 0.068	86.70	50.30	72.30		
F III	CA	-0.052 4.854	0.009 0.904	34.632 28.859	1 1	0.000 0.000	88.40	42.00	70.40		
F IV	CM	-1.030 9.975	0.178 1.800	33.569 30.706	1 1	0.000 0.000	88.40	42.00	70.40		
FV	CI	0.050 -5.661	0.009 0.916	32.913 38.158	1 1	0.000 0.000	84.90	32.20	64.40		

SV= Selected Variables, WL= Wilk's Lambda, SCDFC= Standardised Canonical Discriminant Function Coefficient, CDFC= Canonical Discriminant Function Coefficient, GC= Group Centroids, SP= Sectioning Point, CFC= Fisher's Canonical Function Coefficient

In case of discriminant analysis (enter method, **Table 3**), cervical module classified maximum males (93.3%) whereas cervical index assessed the sex of maximum female (41.3%) samples in the present study. The calculated percentage of the cervical index (males: 80.4%) and cervical module (14%) followed by cervical area (17.5%) were among the least contributed

indices in classifying the two sexes. The order of total percentage of sex classified from dental indices was as follows: CVM (62.5%), CVA (63), CI (64.4%), CVI (65.2%), CM (68.5) and CA (69.6%)

In case of regression analysis also (**Table 3**), a majority cases of males were classified than females as observed in discriminant

analysis. The maximum cases of males (92.4%) were classified from cervical module and females (42%) from the CA and CM. The total sex classification percentage from regression analysis was in the following order: CA (70.4%), CM (70.4%), CVI (65.2%), CI (64.4), CVM (62.8%) and CVI (62.8%). Thus, it is clearly evident that dental indices of males presented a greater degree of sexual dimorphism.

To perform stepwise analysis, the parameters (dental indices) studied were grouped to form functions. Later these functions were subjected to regression and discriminant test, to predict the sexing capability of molars from different indices of dental dimensions. The functions so formed present the following combinations:

Function I- Crown Indices

Function II- Cervical Indices

Function III- Crown Area and Cervical Area

Function IV- Crown Module and Cervical Module

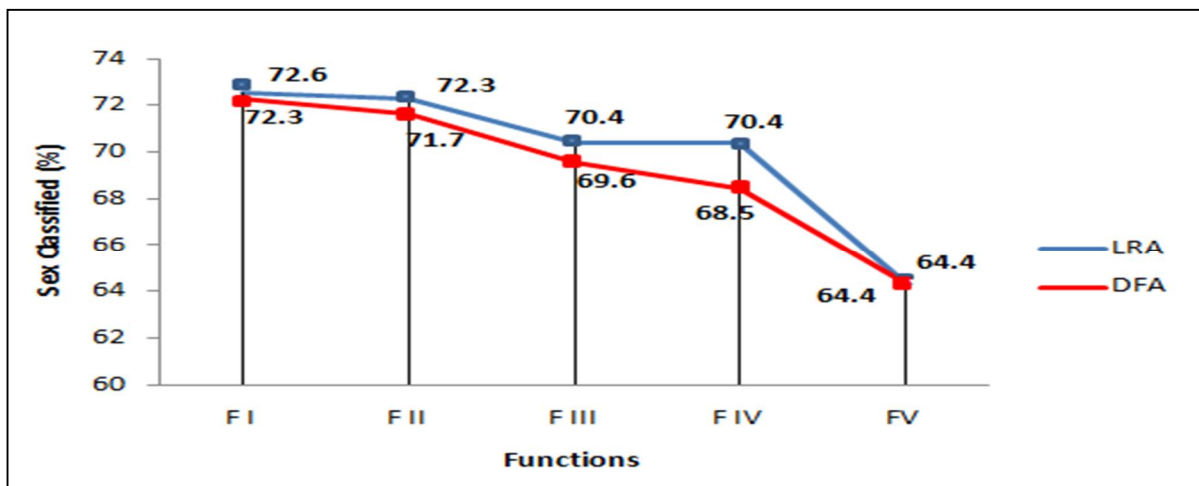
Function V- Crown Index and Cervical Index

In case of DFA (**Table 4**), the Function I selected CA and CI and assigned sex of more than 70% of the sample. Function II, also selected two variables CVA and CVI. Function III, IV and V each selected single variables CA, CM and CI respectively and estimated sex of nearly 64%- 69% of the original sex group.

Regression analysis (**Table 4**) selected three variables (CA, CM and CI) from Function I and two variables (CVM and CVI) from Function II correctly classified sex of more than 70% of the total samples. Likewise, discriminant analysis, regression analysis also selected one variable from Function III, IV and V. The classification of sex was in the range 64%- 70% for Function III, IV and V.

The comparison of percentage of total sex classified by (**Figure 2**) of both Discriminant Function Analysis (DFA) and Logistic Regression Analysis (LRA) maximum samples in the two sexes than DFA respectively.

Figure 2: The comparison of percentage of total sex classified by discriminant function analysis and regression analysis



Discussion:

Various methods have been used in forensic investigations for gender identification. Broadly, morphological and molecular changes are recorded to determine sex. But a method of odontology due to its own importance and value remains as an important adjunct in gender determination.¹²

Townsend and Brown highlighted the statistical summary of dental indices, however,

the sexual dimorphism was not explored. Later the approach got associated with sexing of samples with a forensic perspective. Though much of the research was found on the influence of direct dental dimensions to the rate of sexual dimorphism the sexing potential of the dental index was yet to be studied.¹³⁻¹⁵

Descriptive statistics represents the simplest yet informative facts of the raw data in order to investigate the basic differences.

Multivariate analysis, on the other hand, aims at optimizing the results examined from variables to predict the relevant relationship between numbers of variables.¹⁶ Acharya and Mainali¹¹ reported that the univariate analyses of the crown area and the crown module were found similar to that of linear measurements. However, crown index exhibited a unique univariate result. Similar uniqueness in crown and cervical index was seen in the current study. Further, they explained that the crown index marked variation may be associated with the reason of it not being a direct representation of tooth size. However, it may be considered as a better indicator of the shape of the tooth which is expressed as the difference between BL and MD dimensions and may be better suited as an indicator of tooth shape.

Kondo, et al¹⁷ stated that Crown Index represents the comparative size of mesiodistal and buccolingual diameters. In other words, it expresses one linear measurement in terms of the other and also believed that crown index indicates shape than size while others found it to be independent of the absolute values of linear dimensions. Litha, et al¹⁸ calculated maximum sex determination accuracy of 99.8% from BL variables and 69.9% from MD variables. Similar results were found when BL and MD were compared in a study by Sonika, et al¹⁹ among the population of Haryana, India. In contrary to this, Townsend and Brown demonstrated that MD dimension determined sex better than BL dimension asserting the influence of arch size on tooth size correlating larger jaw size in males to the larger MD dimension of the tooth as compared to female. This was further supported by Acharya and Mainali²⁰ where MD dimension was better suited for discriminating sexes than BL dimension. Introna, et al²¹ examined dental dimension ratios and reported 80% sexing accuracy from discriminant analysis of maxillary deciduous molars.

The accuracy of sex determination from dental indices at crown area calculated by Acharya and Mainali¹¹ in their study using stepwise discriminant analyses gave moderate to high accuracy rates of sexing (69.8. 81.1%) which was comparatively low as compared to linear measurements.

Acharya, et al²² compared regression and discriminant results of dental measurements and found Logistic Regression Analysis (LRA) enabled optimal sex prediction (100%) when all teeth (except for third molars) were pooled and analyzed. When both the jaws are combined the LRA correctly classified sex of 76% to 100% of the samples while ~52%-71% samples were classified to their original sex category from discriminant analysis. Despite the fact that there is insufficient information available depicting the correlation of sexual dimorphism and dental indices, but the researcher has been able to show sex differences in dental indices. Therefore, such findings alone cannot contribute directly in sex differentiation but in combination with other identification techniques may give reliable results.

Conclusion:

Odontometric methods are simple, cost-effective, easy, convenient to apply are some of the advantages due to which it is often considered of using odontometrics. The factor that hampers is the presence of dental anomalies which may destroy the requirement of preserve proximal edges of the teeth. The magnitude and pattern of variation in the dimorphism depend on the number of factors biological, environmental, cultural and physical. It is concluded that molars were able to produce sexual differences on the basis of dental indices. In order to maintain the integrity of forensic evidences it is suggested that these techniques may be applied along with other sophisticated analytical methods of identification.

Acknowledgment:

The authors acknowledge all the participants who consented to take part in the study and the staff for their cooperation.

Conflict of interest: None

Financial Assistance: None

References:

1. Imaizumi K. Forensic investigation of burnt human remains. Res. Rep. Forensic Med. Sci. 2015;5:67-74.
2. Smith BC, Fisher DL, Weedn VW, Warnock GR, Holland MM. A systemic approach to the

- sampling of dental DNA. J Forensic Sci. 1993;38:1194. 209.
3. Sweet D, Hildebrand D, Phillips D. Identification of skeleton using DNA from teeth and a PAP smear. J Forensic Sci. 1999;44:630. 3.
4. Banerjee A, Kamath VV, Satelur K, Rajkumar K, Sundaram L. Sexual dimorphism in tooth morphometrics: An evaluation of the parameters. J Foren Dent Sci 2016;8(1):22.
5. Balachander N, Babu NA, Jimson S, Priyadharsini C, Masthan KM. Evolution of forensic odontology: An overview. J Pharmacy & Bioallied Sciences 2015;7(Suppl 1):S176.
6. Dental DNA fingerprinting in identification of human remains KL Girish, Farzan S Rahman, and Shoaib R Tippu
7. Pramod JB, Marya A, Sharma V. Role of forensic odontologist in post mortem person identification. Dent Res Jour 2012;9(5):522.
8. Pretty IA, Sweet D. forensic dentistry: A look at forensic dentistry. Part 1: The role of teeth in the determination of human identity. Brit Dent Jour 2001;190(7):359-66.
9. Buthz, Erhrhardt, R.M. Nossintchouk, Manuel d'odontologie médico-légale, Paris, Masson, 1991. Available at :<https://translate.google.co.in/translate?hl=en&sl=fr&u=https://tatahynomja.firebaseapp.com/2225820880.pdf&prev=search> accessed on 03/03/2017
10. Vodanovi M, Demo Ž, Njemirovskij V, Keros J, Brki H. Odontometrics: a useful method for sex determination in an archaeological skeletal population? J Archaeol Sci 2007;34(6):905-13.
11. Acharya AB, Mainali S. Are dental indexes useful in sex assessment? J Forensic Odontostomatol. 2008 Dec 1;26(2):53-9.
12. Sabarinath B. Age and sex determination. J Foren Dent Sci 2011;3(1):46.
13. Townsend GC, Brown T. Tooth size characteristics of Australian aborigines. Occas Pap Hum Biol 1979;1:17-38. Available at :<http://www.healthinonet.ecu.edu.au/key-resources/bibliography/?lid=12279> accessed on 03/03/2017
14. can MY, Kedici PS. Sexual variation in buccolingual dimensions in Turkish dentition. F S I 2003;137(2):160-4.
15. Astete JC, San Pedro Valenzuela J, Suazo Galdames I. Sexual dimorphism in the tooth dimensions of Spanish and Chilean peoples. Int J Odontostomatol 2009;3(1):41-50.
16. Walliman N. Research methods: The basics. Routledge; 2017 Sep 1
17. Kondo S, Townsend GC, Yamada H. Sexual dimorphism of cusp dimensions in human maxillary molars. Am J Physical Anthropol 2005;128(4):870-7.
18. Litha HC, Murgod S, Savita JK. Gender determination by odontometric method. J Foren Dent Sci 2017;9(1):44.
19. Sonika V, Harshaminder K, Madhushankari GS, Sri Kennath JA. Sexual dimorphism in the permanent maxillary first molar: A study of the Haryana population (India). J Foren Odontostomatol. 2011;29(1):37-43.
20. Acharya AB, Mainali S. Univariate sex dimorphism in the Nepalese dentition and the use of discriminant functions in gender assessment. F S I 2007;173(1):47-56
21. Introna Jr F, Cantatore F, Dragone M, Colonna M. Sexual dimorphism of deciduous teeth in medico-legal identification. Bollettino della Societa italiana di biologia sperimentale. 1993 Apr;69(4):223-30. Available at : <http://europepmc.org/abstract/med/8129902> accessed on 03/03/2017
22. Acharya AB, Prabhu S, Muddapur MV. Odontometric sex assessment from logistic regression analysis. International journal of legal medicine. 2011 Mar 1;125(2):199-204.. F S I 2007;173(1):47-56.

Original Research Paper

Profile of Suicides amongst Autopsies at a Tertiary Care Centre in Bangalore North

¹Udaya Shankar B S, ²Sujatha P L, ³Shivakumar B C

Abstract:

The study of Profile of suicides amongst autopsies was carried out at a tertiary care centre over a period of 36 months with aims to identify methods and reasons of suicides and to correlate them with age and sex.

A total of 357 cases fulfilled the criteria. The most vulnerable age group was 21-30 years (30.4 %); males (64 %) outnumbered females; 275 cases (77 %) were due to hanging and 73 (20 %) due to poisoning, 6 (2 %) and 3 (1 %) due to burns and drowning, respectively. More victims died in morning hours (29%), followed by night (27%). 47 cases (13%) had consumed alcohol, more prevalent in 31-40 year age group (21 cases). Hesitation cuts were seen in 11 cases (3%) and previous attempts of suicide in 7 cases (2%) were more prevalent in 21-30 year age group.

Depression (42 cases) was the commonest reason for suicide and was more prevalent in the 21-30 year age group. Chronic illness/pain (29 cases), conflicts with spouses and debt/loss (23 cases) were the other main reasons; few were due to exam/love failure, being single and financial difficulties.

Efforts to increase social interaction in depressed and isolated individuals especially in 21-30 year age, treating mental disorders such as depression, drug and alcohol addiction and those who have attempted suicide in past with cognitive behavioral therapy are recommended. Thus this study emphasizes that psychological autopsy is the gold standard in reconstructing proximate and distal causes of an individual's death by suicide.

Key Words: Suicide, Depression, Hanging, Poison

Introduction:

Suicide is the act of intentionally causing one's own death.¹ Suicide rate in India is approximately 11.4 per 1 lakh in males and 8.0 per 1 lakh in females.² India and China account for 30% of all cases of suicide worldwide.³ India ranked 43rd in descending order of rates of suicide with a rate of 10.6/100,000 reported in 2009 (WHO suicide rates).⁴

This represented a 1.7% increase in suicides since 2008.⁵ In NCRB report, rate in 2010 rose to 11.4 per 100,000 populations; an increase of 5.9% in number of suicides.⁶ Suicide resulted in 842,000 deaths in 2013 up from 712,000 deaths in 1990. Globally, as of 2012, suicide is the tenth leading cause of death and occurs about 1.8 times more often in males than females.⁷

Even people with low suicidal intention may end up in completed suicides as a result of using more lethal methods and inadequate treatment. This phenomenon of successful completion of suicide is a dangerous trend in India. While the population increase in the last decade was 25%, the suicide rate increased by 60%.³

In most cases, direct or indirect verbal communication of suicidal thoughts were documented before the suicide.⁸ Significant risk

Corresponding Author:

¹Assistant Professor,

²Assistant Professor,

³Professor & Head,

Dept. of Forensic Medicine, Sapthagiri Institute of Medical Sciences & Research Centre, Bengaluru

Email: udayashankarbs83@gmail.com.

L. M. No: Not a Member

DOR: 03/06/2017

DOA: 07/02/2018

DOI: 10.5958/0974-0848.2018.00006.4

factors for suicide include loss events, suicidal behaviour in first-degree relatives, ICD-10 major depressive episodes, emotionally unstable personality disorder and substance abuse and dependence.⁹ Others are impulsive acts due to stress such as from financial difficulties, troubles with relationships, or from bullying⁷ and a poor handling of emotions.¹⁰ Those who had previously attempted suicide are at higher risk for future attempts.⁷ A number of psychological states increase the risk of suicide including: hopelessness, loss of pleasure in life, depression and anxiousness. Over 200,000 farmers in India have died by suicide since 1997, partly due to issues of debt.³

The suicide rates vary widely across the different states of India, ranging from 0.5/100,000 in Nagaland to 45.9/100,000 in Sikkim against the national average of 11.4/100,000 in 2010.¹¹ A greater understanding of region-specific factors related to suicide would enable prevention strategies to be more culturally sensitive. This focus is also highlighted in the September 10, 2012 World Suicide Prevention Day theme %Suicide Prevention across the Globe: Strengthening Protective Factors and Instilling Hope+.⁶ Thus, these types of studies are known to give a comprehensive view of the root of the problem and help us draw various strategies to prevent suicide.

Aims & Objectives:

1. To identify the reasons of suicides and to correlate them with age and sex.
2. To know the methods and socio-demographic profile of suicides.

Materials and Methodology:

Source of Data: All cases with history of suicide, subjected for medico-legal autopsy at the Department of Forensic Medicine in a tertiary care centre, Bengaluru.

Method of Collection of Data: History was furnished by police in forms 146 (i) and (ii) and further proforma was filled by interviewing the relatives and friends of deceased, who

accompanied the dead body. This proforma was used to collect the socio-demographic details of each suicide case (age, sex, time of incidence, past medical history, personal history, etc.). This proforma assessed various psycho-social variables associated with suicide (interpersonal relationship, various stressors, substance abuse, psychiatric illness, physical illness, chronic pain and disablement, suicide note, method used, and previous attempts, etc.). Postmortem examination of each case was carried out as per standard procedure and various causes of death were recorded. Further, comparative evaluation of data was analyzed.

Inclusion Criteria: All cases with history of suicide brought for autopsy.

Exclusion Criteria: Cases where bodies were in advanced state of decomposition.

Sample Size Determination: Proportion of psychiatric illness amongst suicide victims was 33.6% in a study by Chavan BS et al³. So, $p = 33.6$

$$q = 100 - p = 100 - 33.6 = 66.4$$

$$\text{Relative precision} = d = 15\% \text{ of } p = 15\% \text{ of } 33.6 = 5.04$$

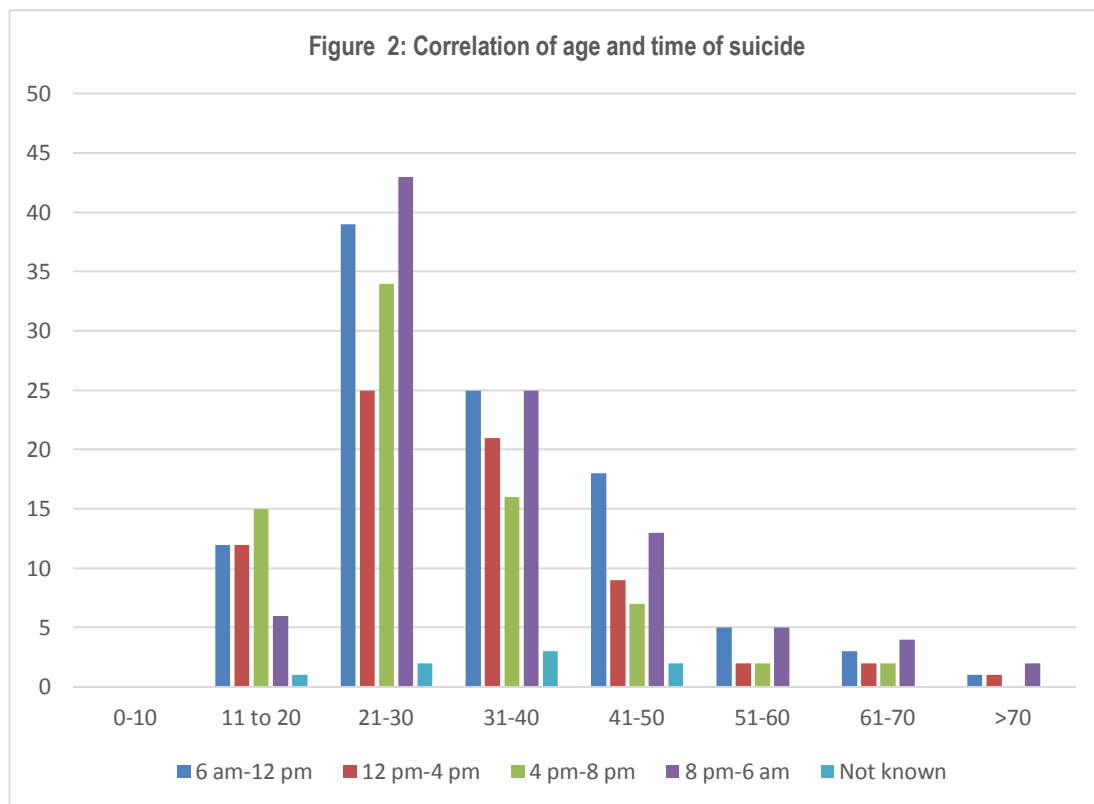
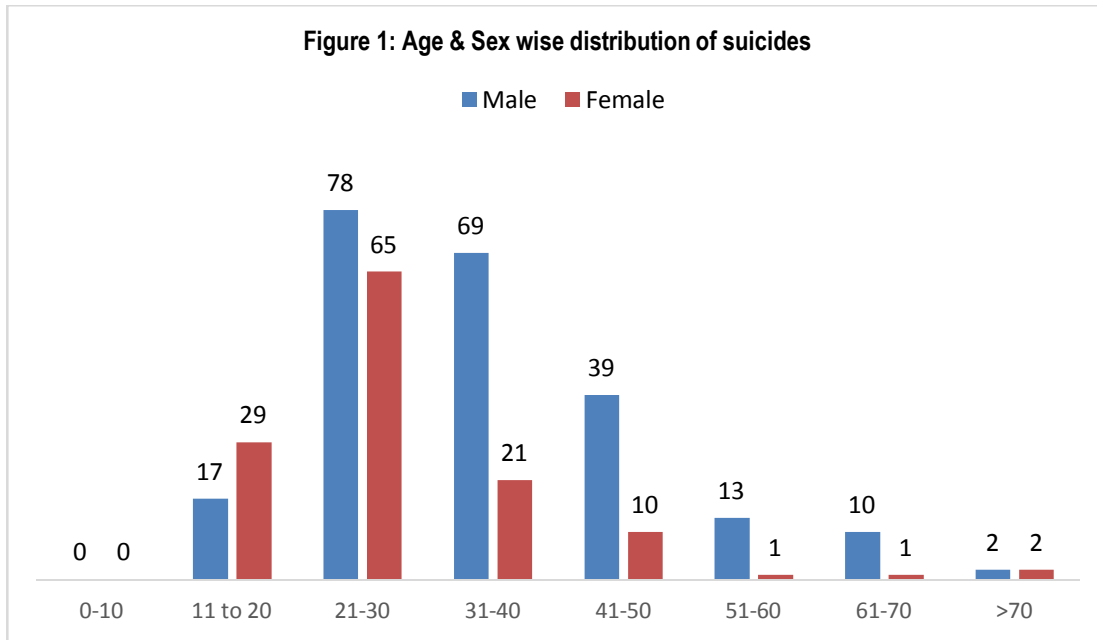
$$\text{Sample size} = n = \frac{4pq}{d^2} = 351 \text{ (Approx. 355)}$$

Prior ethical clearance was obtained.

Results:

From prospective record analysis of suicidal autopsy cases over a period of 3 years fulfilling inclusion criteria, 357 cases were eligible.

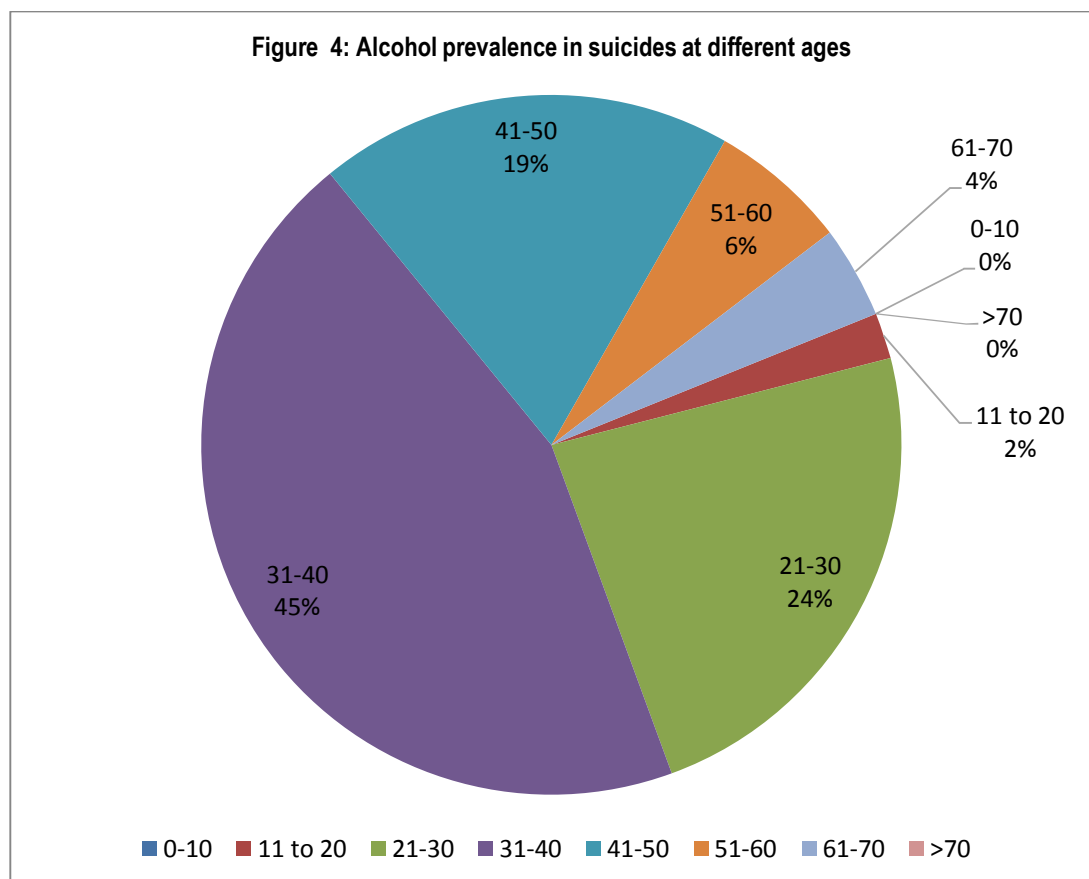
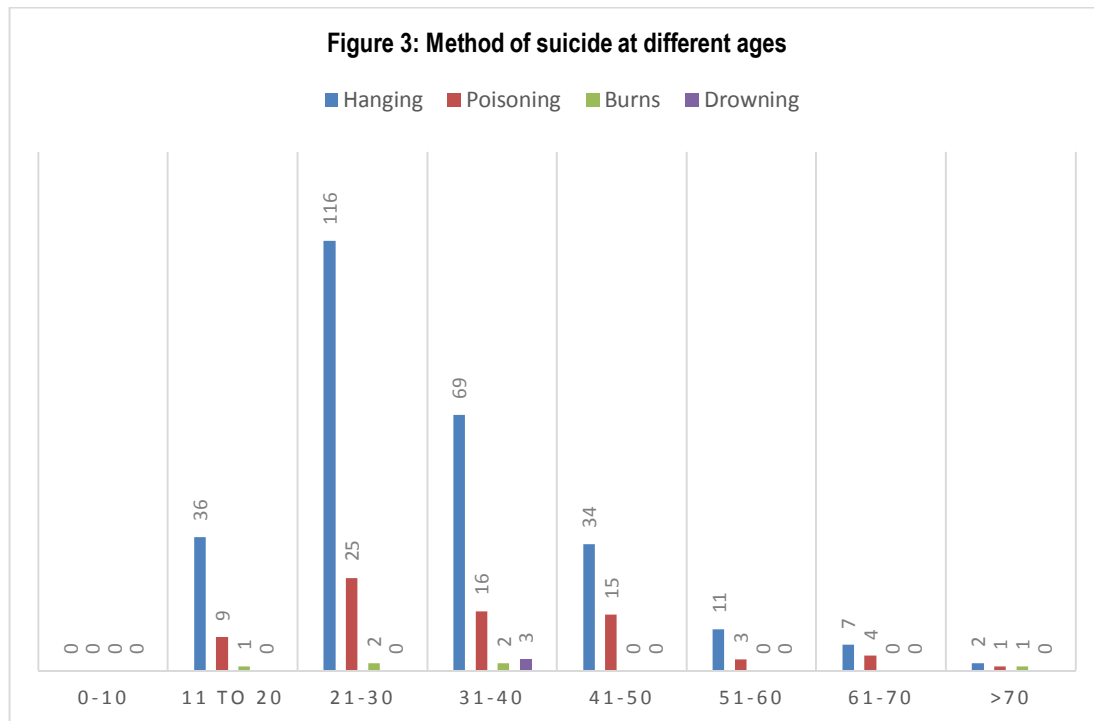
143 cases were in the 21-30 year age group (**Figure 1**) followed by 90 cases in 31-40, while there were 4 cases in >70 year age groups. 228 cases (64%) were males and they outnumbered the females in all age groups; except in 11-20 year age group wherein females (29 cases) were more. As age advanced, females succumbed less often, compared to males.



103 cases (29%) died during morning hours 6 a.m-12 p.m (**Figure 2**), followed by 98 cases (27%) in night hours 8 p.m-6 a.m. In 8 cases (2%), timing of death could not be determined. 275 cases (77 %) were due to hanging (**Figure 3**) and 73 cases (20 %) due to poisoning. In our study, there were no suicidal

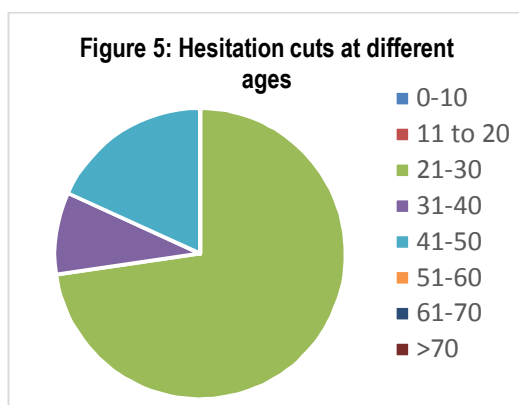
deaths due to other causes like fall from height, gunshot injuries, electrocution etc.

47 cases (13%) had consumed alcohol (**Figure 4**). Alcohol consumption was more prevalent in 31-40 year age group (21 cases), followed by 21-30 year (11 cases), 41-50 year (9 cases), etc.



11 cases (3%) had hesitation cuts (**Figure 5**). Hesitation cuts were more prevalent in 21-30 year age group (8 cases), followed by

41-50 year (2 cases) and 31-40 year (1 case) age groups.



Various reasons for suicides and their prevalence in different age groups in both sexes are tabulated (**Table 1**). Of the 357 cases, no reason could be found in 126 cases, amongst which 32 were female victims and 94 were male victims. Depression (42 cases) was the commonest reason for suicide and was more prevalent in 21-30 year age group. Chronic illness (29 cases), conflicts with spouses and debt/loss (23 cases) were the other main reasons.

Table 1: Various reasons for suicide & its relation with age & sex

Age	0-10		11-20		21-30		31-40		41-50		51-60		61-70		>70		Total
Sex	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	
Alcohol	0	0	0	1	0	2	0	4	0	1	0	1	0	0	0	0	9
Affair	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	3
Debt/loss	0	0	0	0	1	5	0	11	0	3	0	3	0	0	0	0	23
Depression	0	0	4	2	7	10	3	8	1	2	1	0	0	4	0	0	42
Dowry	0	0	2	0	17	0	1	1	0	0	0	0	0	0	0	0	21
Dysmenorrhoea	0	0	2		3	0	0	0	0	0	0	0	0	0	0	0	5
Exams fail	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	4
Harassment/Torture	0	0	1	1	2	1	0	0	0	0	0	0	0	0	0	0	5
Headache	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2
Husband/wife related	0	0	0	0	6	3	6	4	1	2	0	2	0	2	0	0	23
Chronic illness	0	0	0	0	3	4	4	3	3	7	0	1	0	3	0	1	29
Love failure	0	0	4	1	2	8	0	0	0	0	0	0	0	0	0	0	15
Mental illness	0	0	1	2	5	4	0	2	2	1	0	0	0	0	0	0	17
Not known	0	0	8	6	13	33	7	30	2	18	0	6	0	1	2		126
Single/orphan	0	0	0	0	2	3	0	2	0	0	0	0	0	0	0	1	8
Stomach pain	0	0	5		1	0	2	3	1	2	0	0	0	0	0	0	14
Unemployed/poverty	0	0	1	1	0	4	1	1	0	2	0	0	1	0	0	0	11
Sub-total	0	0	29	17	65	78	21	69	10	39	1	13	1	10	2	2	357
Total	0		46		143		90		49		14		11		4		357

Failure in exams accounted for 3 deaths in 11-20 year and 1 death in 21-30 year age group. 15 cases died due to love failure, out of which 10 cases were in 21-30 year and 5 cases in 11-20 year age groups. Females (4 cases) mature early and hence outnumbered males in 11-20 year whereas males (8 cases) outnumbered females in 21-30 year age groups.

Discussion:

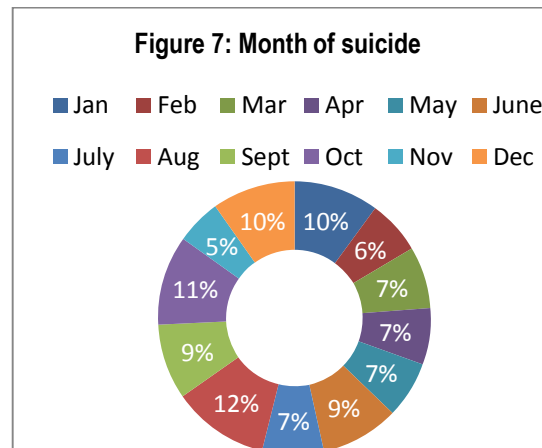
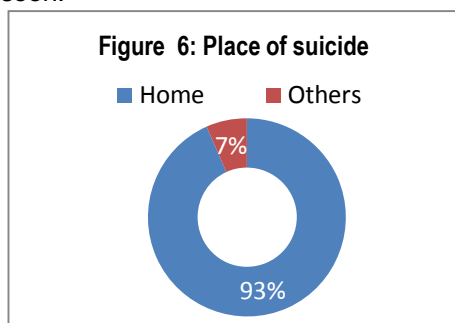
The vulnerable age group was those in 21-30 years (30.4 %) followed by age group of 31-40 years (22.1 %). The reason being that

they form the work group and hence prone to lots of stress and succumbed due to poor impulse control and poor ability to solve problems arising out of managing family and work. 228 cases (64 %) were males since they are mostly the earning members of family and have to take care of the needs of family hence more prone to suicides whereas females succumbed mainly due to conflicts related to adjustment with her spouse or spouse's family at their new residence.

Similar observations were made in study done by Chavan BS et al, wherein majority

(59.4%) of suicide victims were in age group of 20 to 29 years, followed by age group 30 to 39 years (14.8%). Males (57.4%) slightly outnumbered females (42.57%).³ Tanna JA found that 85% of suicide cases being in 15-44 yrs age group.¹² A study by Gururaj and Issac showed that the suicide rate in various age groups as follows: 38 per 100,000 population in the age group of 15. 29 years, 34 per 100,000 in those 30. 44 years, 18 per 100,000 population in those 45. 49 years, 7 per 100,000 population in those ≥ 60 years. The incidence was higher in men than in women (men 59%, women 41%).¹³ Male/female ratio was 3:1.¹⁴ But, in a study by Govekar G, et al, major age group among the victims was 31.40 years (i.e. 22.06%). In 62.84% cases, the victims were male.¹⁵

Overall, more victims died in morning hours (29%) indicating the time of maximal tendency for suicide i.e after they get up from bed. Second commonest time being night (27%) as they are unable to sleep due to the stress. Victims in 11-20 year age group died more commonly in evening hours 4 p.m-8 p.m (15 cases) after they returned from their schools and colleges and less often during nights (6 cases) as they had sound sleep compared to older ones. 21-30 year victims had a contrast of more deaths during nights (43 cases) followed by mornings (39 cases). In this study, 333 cases (93%) committed suicides at their homes (**Figure 6**), only 24 cases (7%) committed at other places such as workplace, farm and roadside which is exactly the same as in study by Tanna JA, et al.¹² August-October (111 cases) had more cases followed by December-January (71 cases)(**Figure 7**). Also, steep rise (21.17%) in number of suicides seen in third quarter of the year, that is, in beginning of monsoon.¹⁵



Hanging (77%) was the most common method of suicide in all age groups accounting for 49% of male suicides and 28% of female suicides, followed by poisoning (20%); both together accounting for 97% of cases. Similar results were drawn in studies by Chavan BS et al and Soole R et al where hanging (72.2%) was the most frequent method.^{3, 16} In contrast, the chief method of suicide in a study by Govekar G et al was poisoning, used by 40.50% of deceased, involved in 45.53% of cases.¹⁵ In our study, hanging was the preferred method in both sexes. In contrast, in a study in Athens, men died primarily by hanging or shooting by a firearm while women preferred jumping from height instead ($p < 0.001$).¹⁴

Only 7 cases (2%) had previous attempts of suicide, all victims in 21-30 year age group. Only 10 cases (3%) had the patience and courage to leave behind suicide note, out of which 6 victims were in 21-30 year age group. In Athens, 26.0% of victims had history of prior attempts (64.4% once, 20.3% twice and 15.3% more times) and 6.6% left a suicide note.¹⁴ Previous suicide attempts were an important risk factor.¹⁶ About 15- 40% of people leave a suicide note.¹⁷

Alcohol consumption was more prevalent in 31-40 year age group (21 cases) as this is the age group which sees alcohol as a medium for relaxation and mode of forgetting stress and pain. Also, Alcohol intoxication (9 cases) was exclusively seen in males, more prevalent in 31-40 year age group (4 cases) followed by 21-30 year age group (2 cases)

indicating the ages for counseling and de-addiction.

Hesitation cuts were more prevalent in 21-30 year age group (8 cases) indicating that these age group victims' mental status regarding the fear of not completing suicide and the desire. 21-30 year was the vulnerable age group for depression (42 cases) which was the commonest reason for suicide in our study. Whereas chronic illness was seen in 29 cases more common in 41-50 year and in males indicating their decreased tolerance to illness. But, chronic pain due to stomach pain (14 cases) and headache (2 cases) was more prevalent in young age groups and in females indicating their decreased tolerance to pain. Dysmenorrhoea (5 cases) was the reason in women in her early age-3 cases in 21-30 year and 2 cases in 11-20 year age groups, indicating if women could bear the pain of menses in her early age, it will not be difficult for her later on due to various factors like pregnancy, lactation etc. Chronic pain was rated positively if it had been present in marked degree for at least 6 months. Serious illness included terminal/non-terminal malignant and non-malignant illness.⁹ The diagnosis of cancer approximately doubles the subsequent risk of suicide.⁷

Only 2 cases (both in 21-30 year age group) had their spouse's affair as the reason for their death, suggesting as the years pass by, the couples got committed to their spouses and to family. In our study, females expressed their deep suffering or intention to end their life and the reason for it at any time prior to suicide compared to males who concealed it. In a study by Stefenson et al, three months preceding death, 20 of 21 subjects had described one or more negative critical experiences, typically physical illness, loss of contact with an important other, loss of "home", and intolerable side effects of medication. In most cases the suicide appeared to be the culmination of prolonged suffering and suicidal deliberations.⁸ In studies by Paraschakis A et al, as many as 48.8% had expressed their intention to die to their relatives.¹⁴ 121 of 248 (48.8%) had verbally communicated their intention to die -or their profound suffering- to their family members. Suicide communicators were older ($p<0.001$),

less educated ($p=0.04$), more frequently divorced or separated and less often single ($p<0.01$) than non-communicators.¹⁸

23 cases had debt/loss, more prevalent in 31-40 year (11 cases) followed by 21-30 year (5 cases) age groups. This states the weak mind of young victims who could not bear the loss incurred and could not assure themselves of the various other ways of earning to compensate for the loss. 11 cases had problems of poverty/unemployment, out of which 4 male victims were in 21-30 year age group, indicating the stress on males to start earning at this earning age. 2 female victims each in 21-30 year and 31-40 year age group died due to their inability to conceive child. 1 male victim died in >70 year age due to he being single. 1 male victim in 21-30 year age even died as his parent couldn't buy him a bike. Socio-economic problems such as unemployment, poverty, homelessness, and discrimination may trigger suicidal thoughts.⁷ Effects of social factors such as adverse marital and employment status were relatively small.¹⁷ In contrast, in an Indian study, it was reported that predominant suicidal victims were unemployed males(55.4%).³ Parent-child conflicts were the most common precipitant.¹⁶

Seventeen cases succumbed to their mental illness; only 8 of them sought treatment. In a study by Chavan BS et al, psychiatric illness was found in 34 cases (33.6%). However, out of them only 16 (48.5%) suicide victims sought treatment prior to the attempt.³

Conclusion:

The vulnerable age group was 21-30 years including hesitation cuts, suicide note and victims who had previous attempts. Males outnumbered females, and as age advanced, females succumbed less often compared to males. More victims died in the morning hours followed by night. Hanging was the most common method of suicide. Alcohol consumption leading to intoxication was more prevalent in 31-40 year age group. Depression was the commonest reason for the suicide and was more prevalent in 21-30 year age group. Chronic illness/pain, conflicts with spouses, debt/loss were the other main reasons; few were due to exam/love failure, being single and

financial difficulties. Although no reason was found in majority, more females expressed their intention to die and the reason for it compared to males who concealed it. The World Health Theme-2017 %Depression: Let's Talk+ seems to be apt.

Recommendations:

Efforts to increase social connection in depressed and isolated individuals especially in 21-30 year age are recommended. Suicide prevention efforts should include limiting access to method of suicide such as poisons including alcohol such as reducing the number of bars, treating mental disorders such as depression and improving economic conditions. Treatment of drug and alcohol addiction and those who have attempted suicide in the past with cognitive behavioral therapy may also be effective. In India, after the repeal of law in 2014, victims of attempt of suicide have to be treated and monitored rather than punishment.

The media, which includes the Internet, should follow recommended reporting guidelines and stop detailed descriptions of how to kill oneself by a specific means, high volume, prominent, repetitive coverage glorifying or romanticizing suicide; as there is some concern that such sites may push those predisposed over the edge. The Internet, however, may also help prevent suicide by providing a social group for those who are isolated.

More awareness to be created with the World Suicide Prevention Day observed annually on September 10 with the support of International Association for Suicide Prevention and the World Health Organization.

Conflict of Interest: None.

Financial Assistance: None

References:

1. Stedman's Medical Dictionary (28th ed.). Philadelphia: Lippincott Williams & Wilkins. 2006. ISBN 978-0-7817-3390-8.
2. World Health Organization. Figures and Facts about Suicide (Doc.WHO/MNH/MBD /99.1) Geneva: WHO; 1999.
3. Chavan BS, Singh GP, Kaur J, Kochar R. Psychological autopsy of 101 suicide cases from northwest region of India. Indian J Psychiatry 2008;50(1):34-38.
4. World Health Organization. Suicide rates per 100,000 by country, year and sex. Available from: http://www.who.int/mental_health/prevention/suicide_rates/en/index.html. Accessed on 15.12.2016.
5. Accidental Deaths and Suicides in India 2006. New Delhi: Ministry of Home Affairs, Government of India; 2008. National Crime Records Bureau.
6. Radhakrishnan R, Andrade C. Suicide: an indianperspective. Indian J Psychiatry 2012;54(4):304-19.
7. Available from: <https://en.wikipedia.org/wiki/Suicide>. Accessed on 15/12/2016
8. Stefenson A, Titelman D. Psychosis and Suicide. Crisis 2016;37(3):224-31. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/26831212>. Accessed on 15/12/2016
9. Andrew T, Cheng A, Tony H, Chen H, Chen CC, Jenkins R. Psychosocial and psychiatric risk factors for suicide: Case-control psychological autopsy study. The British Journal of Psychiatry 2000;177(4):360-365.
10. Chávez-Hernández AM, Macías-García LF. Understanding suicide in socially vulnerable contexts: psychological autopsy in a small town in mexico. Suicide Life Threat Behav 2016;46(1):3-12. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/25893954>. Accessed on 15/12/2016
11. Accidental Deaths and Suicides in India 2008. New Delhi: Ministry of Home Affairs, Government of India; 2010. National Crime Records Bureau.
12. Tanna JA, Patel PN, Kalele SD. Psychological autopsy of suicide cases in bhavnagar region of gujarat, India. Medico-legal Update 2013;13(1):27-32.
13. Khan FA, Anand B, Devi MG, Murthy KK. Psychological autopsy of suicide: a cross-sectional study. Indian J Psychiatry 2005;47(2):73-8.
14. Paraschakis A, Michopoulos I, Christodoulou C, Koutsaftis F, Lykouras L, Douzenis A.. A 2-year psychological autopsy study of completed suicides in the athens greater area, Greece. Psychiatry 2015;12(2):212-7. Available from:

- <https://www.ncbi.nlm.nih.gov/pubmed/25866522>.
Accessed on 15/12/2016
15. Govekar G, Chandegara P, Patel J, Zanzrukiya K. Trend of suicidal autopsy cases at government medical college & new civil hospital, surat. *Int J Med Sci Public Health* 2015;4(10):1334-7.
16. Soole R, Kolves K, De Leo D. Suicide in children: a systematic review. *Arch Suicide Res* 2015;19(3):285-304. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/25517290>. Accessed on 15/12/2016
17. Yoshimasu K, Kiyohara C, Miyashita K. Suicidal risk factors and completed suicide: meta-analyses based on psychological autopsy studies. *Environ Health Med* 2008;13(5):243-56. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/19568911>. Accessed on 15/12/2016
18. Paraschakis A, Michopoulos I, Christodoulou C, Koutsaftis F, Douzenis A. Characteristics of suicide victims who had verbally communicated suicidal feelings to their family members. *Psychiatr Danub* 2015; 27(3):230-5 Available from: <https://www.ncbi.nlm.nih.gov/pubmed/26400130>. Accessed on 15/12/2016

Original Research Paper

Pesticides - Our Friends or Foe

¹Pankaj Verma, ²Manish Nigam, ³Rashmi Kulkarni, ⁴Pradeep Kumar Mishra, ⁵Pooja Misar

Abstract:

Pesticides were discovered as a savior of crops from pests and insects, but their overuse or misuse lead to killing of self or others. Poisoning from pesticides is a serious health problem in developing countries like India. Statistically, Organophosphorus compounds and Aluminium phosphide are rated at the top. The present study was conducted at Sri Aurobindo Medical College, Indore, from October 2015 to May 2017, with an objective to study the demographic, clinical, investigational profile and post mortem finding of cases with alleged history of Organophosphate poisoning (OPP) and Aluminium Phosphide poisoning (ALP). Of the 120 cases of acute poisoning that came to the Emergency department, 75 cases had history of Organophosphate and Aluminium Phosphide poisoning, against which 50 cases of Organophosphate and 25 cases of Aluminium phosphide were admitted within this period. The number of cases of Organophosphate poisoning were double of the Aluminium phosphide cases but mortality rate of aluminium phosphide was higher than that of organophosphorus. Government should ban or make strict rules for sale of such chemicals.

Key Words: Pesticides, Organophosphate, Aluminium Phosphide, Mortality Rate

Introduction:

The word 'Poison' came from a Latin word 'Poton' i.e. to drink for health.¹ India is an agriculture based country. To get maximum outcome from the fields, farmers are using various kinds of pesticides and insecticides and this increases direct or indirect exposure to them. In the past, poisoning due to pesticide was mostly un-intentional, but now it is mostly consumed to commit suicide and sometimes for homicidal purposes.²

Corresponding Author:

²Professor & Head

¹PG Resident 3rd Year,

³Research Associate,

⁴Professor,

Department of Forensic Medicine & Toxicology,
Sri Aurobindo Medical College & Post Graduate
Institute, Indore

⁵PG Resident 3rd Year,

Department of Conservative Dentistry and
Endodontics, Sri Aurobindo College of Dentistry,
Indore

Email ID: jurimanish@gmail.com.

L.M. No: LM/ IAFM: - 414/ MP/ 2001.

DOR: 01/01/2018 DOA: 22/02/2018

DOI: 10.5958/0974-0848.2018.00007.6

As per WHO records, more than 2 lakh deaths occur per annum due to poisoning, of which maximum number of cases were agricultural professionals from developing countries.³ Acute poisoning is a medical emergency and morbidity and mortality related to poisoning is increasing day by day. In India, annually more than 50 thousand people die due to poisoning.⁴ Pesticides, followed by sedatives, alcohol and household poisons are the most common toxicological emergencies in India. Since 1940s, Aluminium phosphide has been used as a pesticide and the first known case was recorded in 1981 from M.G.M. Medical College, Indore.⁵ On exposure to air or moisture, Aluminium phosphide liberates phosphine gas which is a systemic poison and inhibits cytochrome c oxidase enzyme.⁶ A bulk of pesticides is produced in form of Organophosphates in India. Organophosphates are esters of phosphoric acid, metabolized in liver and inhibitors of carboxylic esterase enzymes.⁷

Materials and Methodology:

The present study is a prospective observational study conducted on acute

poisoning cases that came to the Emergency Department, Intensive Care Unit (ICU) and mortuary of the dept. of Forensic Medicine and Toxicology, at Sri Aurobindo Medical College, Indore, from October 2015 to May 2017. Of the 120 acute poisoning cases, 75 were diagnosed as Organophosphate and Aluminium Phosphide poisoning. The data about brief history, age, sex, marital status, education level, socio-economic status, type of family, vitals and post mortem findings in case of death was collected from patients, relatives, police and suicide notes, if any, in a standardized proforma, specially designed for the purpose and were analyzed. Vomit material, gastric lavage, blood and urine was collected after taking consent and sent to Analytical Toxicology Lab of the department for investigation and confirmation of poison was made. For screening of Organophosphates, ammonium molybdate test was conducted and confirmation was done by thin layer chromatography (TLC). Aluminium phosphide was detected by silver nitrate test.

Observations and Results:

In this present study it was observed that males outnumbered females. Age group of 21-30 years was more prone to poisoning than any other age group. Consumption of poison was more common in married people i.e. 76% and 80 % for Organophosphate and Aluminum Phosphide poisoning respectively. Education was the most promising factor as the maximum numbers of cases of poisoning were observed in primary and higher secondary education. Out of 75 pesticides poisoning cases, maximum cases were reported as housewives and un-employed. Maximum cases belonged to joint family and with lower socio- economic status. On the subject of environmental conditions, summer season showed increased number of cases with selected incidence on Wednesday. (**Table 1 & 2**)

Table 1: Demographic Profile of OPP and ALP Cases

Sr. No	Titles		OPP n-50	ALP n- 25
1	Marital Status	Married	76%	80%
		Un-married	24%	20%
2	Education Status	Illiterate	20%	16%
		Primary	26%	36%
		Higher Secondary	30%	32%
		Graduate	20%	16%
		Post Graduate	4%	0
3	Occupation	Farmers	16%	16%
		Students	10%	16%
		Housewife/ Un-employed	42%	32%
		Self employed	6%	16%
		Service	26%	20%

Table 2: Demographic Profile of OPP and ALP Cases

Sr. No.	Titles		OPP n- 50	ALP n-25
1	Type of Family	Joint	62%	72%
		Nuclear	34%	28%
		Single	4%	0
2	Socio-Economic Status	Lower Class	14%	4%
		Upper Lower	22%	20%
		Lower Middle	40%	56%
		Upper Middle	24%	20%
		Upper Class	0	0
3	Season	Summer (March-June)	54%	52%
		Winter (Nov. - Feb.)	26%	36%
		Rainy (July- Oct.)	20%	12%
4	Week Days	Monday	22%	12%
		Tuesday	8%	12%
		Wednesday	16%	24%
		Thursday	16%	8%
		Friday	10%	16%
		Saturday	16%	8%
		Sunday	12%	20%

The most common symptom observed was abdominal pain or discomfort secondarily with semi consciousness of the patients. Duration of hospitalization was 3-4 days in maximum number of cases in both of the poisonings. (**Table 3**)

Table- 3: Clinical Signs and Symptoms of OPP and ALP Cases:

Sr. No	Titles		OPP n- 50	ALP n- 25
1	Pain in abdomen	Yes	74%	64%
		No	10%	28%
		Un-known	16%	8%
2	Level of Consciousness	Conscious	48%	48%
		Semi-Conscious	36%	48%
		Un-Conscious	16%	4%
3	Blood Pressure	Normal	20%	36%
		High	32%	8%
		Low	46%	52%
		Not-detectable	2%	4%
4	Fever	Present	42%	8%
		Absent	58%	92%
5	Days of Hospitalization	<2	16%	24%
		3-4	46%	68%
		5-6	28%	8%
		7-8	8%	0
		>9	2%	0

Mortality rate was more in aluminium phosphide (32%) than the organophosphate poisoning (18%). Pathological changes were seen with respect to numerous organs during autopsy such as brain and lungs were edematous and congested in utmost cases. Stomach was hemorrhagic in 80-90 % of cases. Liver congestion was evident in both the poisoning. (Table 4)

Table- 4: Post Mortem Findings of OPP and ALP Cases:

Sr. No.	Title		OPP n- 9	ALP n- 8
1	Death Percentage		18%	32%
2	Brain	Edematous & Congested	77.78%	62.50%
		Congested	22.22%	37.50%
3	Trachea	Grossly Normal	44.44%	37.50%
		Slightly Congested	33.33%	50%
		Congested	22.22%	12.50%
4	Lungs	Petechial Hemorrh	0	25%
		Edematous & Congested	55.56%	37.50%
		Congested	44.44%	37.50%
5	Stomach	Hemorrhagic	88.89%	87.50%
		Congested	11.11%	12.50%
6	Liver	Yellowish, Enlarge, Hard And Gritty	22.22%	37.50%
		Congested	77.78%	62.50%
7	Kidneys	Cortico- Medullary Junction Altered	22.22%	12.50%
		Enlarged	11.11%	12.50%
		Congested	66.67%	75%

Discussion:

In the present study, males dominated over females in consumption of both Organophosphate and Aluminium phosphide poisons. Maximum affected age group, as per the present study was 21-30 years. Similar results were observed in studies of Siddapur KR¹, Haloi M⁸, Singh J⁹ and Naik SB.¹⁰ Again, 64% cases in our study were from urban area. These results are similar with that of Gargi J¹¹, but not with Prajapati T¹², K umar S¹³ and Raut PK¹⁴, where urban cases were more in number.

Incidence of poisoning was maximum in summer (March to June), followed by winter (Nov to Feb). Similar results were observed in various other studies^{15,16}. In the study by Varma NM¹⁷, Gupta BK¹⁸ and Singh K¹⁹, it was observed that maximum number of cases were in Rainy season (July- Oct.).

The incidence of poisoning was more in housewives and un-employed population, followed by in-service people. This may be due to family quarrels and workloads. These data matches with various other studies^{1,5}.

The most common time of poisoning was in the evening between 6 pm -12 am (37.5%), followed by afternoon, i.e. 12 pm - 6 pm (32.5%). Similar results were obtained in the study by Gopal BK¹⁵, Haloi M⁸ and Tandale RM²⁰. While, in the study by Dash SK²¹, and Guntheti BK²³, day time i.e. 6 am - 6 pm recorded maximum number of cases.

Organophosphate was the commonest type of poisoning, which was also observed in the study by Haloi M⁸, Gopal BK¹⁵, Siddapur KR¹ and Sandhu SS²³. Some brands sell their products with combination of OPP and other chemicals to increase the toxicity, for example - OPP + Carbamates (Jallad) and Properofos - 40% + Cypermethrin - 4%, and patients presented after consumption of such products. Pupils were constricted in 58% of cases, followed by pin-point in 24% in Organophosphorus poisoning. Aluminium Phosphide was the most commonly used at other places as per the studies of Gargi J¹¹, Garg V²⁴ and Patel NS²⁵. Organophosphate was consumed under the influence of alcohol in 12%

cases and 8% Aluminium phosphide poisoning cases.

Gastric lavage was administered in almost all cases, irrespective of the nature and type of poison, if patient came to the hospital within a reasonable time. Nausea, vomiting and gastric irritation were observed in 74% patients of OPP. These findings correlate with the findings observed in the study of Patel NS et al²⁵ and Patel DJ et al.²⁶ In the present study, it was observed that 18 (36%) cases consumed 21-50 ml of Organophosphate, followed by 51-100 ml in 14 (28%) of cases. Atropine with PAM and Oximes were given in Organophosphate poisoning. Of the 9 fatal cases of Organophosphate poisoning, 5 (55.6%) cases consumed 20-50 ml and 4 (44.4%) cases consumed 50-100 ml.

In Aluminium phosphide poisoning cases, gastrointestinal irritation was produced by liberation of phosphine in the stomach. In this study, nausea and vomiting was present in 95% cases, burning epigastric pain in 64% of cases. Similar observations were observed in the study of Vijayanath et al⁵ and Khurana et al²⁷.

Though gastrointestinal symptoms were common in both the poisoning cases, burning pain in abdomen was more common with Organophosphate poisoning. Peculiar odor was another differentiating feature - Kerosene like smell in Organophosphate poisoning and Garlicky odor in Aluminium Phosphide poisoning.

Conclusion:

India is an agricultural country and this increases risk of various pesticide poisoning, especially to farmers and factory workers. Suicide by pesticide is becoming common among housewives and students, and to reduce such incidences, we have to respect them and give fruitful environment. Government has to take strict action against their easy availability and ban highly hazardous and toxic chemicals by replacing them with chemicals that are less toxic to humans. Secondly, there must be national programs and mobile apps to teach the farmers how to use pesticides as we are growing towards digital India. And lastly it is very important to open poison control centre in every

state which will definitely help physicians to save precious lives.

Conflict of Interest: None

Financial Assistance: None

References:

1. Siddapur KR, Pawar GS, Mestri SC. Trends of poisoning and gross stomach mucosal appearance in fatal poisoning cases: An autopsy study. *J Indian Acad Forensic Med* 2011;33(2):12-7.
2. Singh SP, Aggarwal AK, Oberoi SS, Aggarwal KK, Thind AS, Bhullar DS et al. Study of poisoning trends in north India - A perspective in relation to world statistics. *Journal of Forensic and Legal Medicine* 2013;20:14-8.
3. Kumar S, Mangal HM, Pathak A. Trends of fatal poisoning in Saurashtra region of Gujarat a prospective study. *J Indian Acad Forensic Med* 2011;33(3):197-9.
4. Aggarwal P, Handa R, Walia JP. Common poisoning in India. *Journal of Forensic Medicine and Toxicology* 1998;15(1):73.
5. Jain AK, Nigam M, Garg SD, Dubey BP, Arora A. Aluminium phosphide poisoning autopsy findings. *J Indian Acad Forensic Med* 2005;27(1):35-9.
6. Vijaynath V, Anita MR, Raju GM, Vijayamahantesh SN. Forensic view on aluminium phosphide poisoning. *J Indian Academy of Forensic Medicine* 2011;33(4):289-91.
7. Reddy KSN, Murty OP. The essentials of forensic medicine and toxicology. 33rd ed. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd 2014;520-21.
8. Haloi M, Haloi MD, Patowary A. Death due to poisoning in District of Kamrup, Assam- A medico-legal study. *J Indian Acad Forensic Med* 2013;35(1):17-20.
9. Singh J, Kaur J, Kumar V, Shah KA, Tandon RN, Pail VR. Trends of poisoning in a tertiary care centre of North West Uttar Pradesh. *J Indian Acad Forensic Med* 2015;37(4):396-9.
10. Naik SB, Mohan AM, Shetty D. Profile of acute poisoning at Moodabidri, Karnataka (South India): Retrospective survey. *Journal of the Indian society of toxicology* 2011;7(1):32-7.
11. Gargi J, Rai H, Chanana A, Rai G, Sharma G, Bagga IJS. Current trends of poisoning- A

- hospital profile. Journal of Punjab Academy of Forensic Medicine and Toxicology 2003;3:41-5.
12. Prajapati T, Prajapati K, Tandon RN, Merchant S. A study of acute poisoning cases excluding animal bites at civil hospital, Ahmedabad. J Indian Acad Forensic Med 2013;35(2):120-2.
 13. Kumar S, Patil R, Dal GL. A retrospective study of poisoning cases at a tertiary care teaching hospital of southern Rajasthan. Medico-legal update 2016;16(2):235-9.
 14. Raut PK, Tingne C, Gajbhiye SM, Dixit PG. Socio-demographic study of poisoning cases at I.G.G.M.C. Nagpur. Indian journal of forensic medicine & toxicology 2016;10(1):189-93.
 15. Gopal BK, Viswakanth B, Shruti P, Varma RK. A retrospective analysis of suicidal poisoning deaths in a metropolitan city of South India. J Indian Acad Forensic Med 2015;37(2):140-43.
 16. Palimar V, Kumar GP. Poisoning deaths in children. Journal of Indian Academy of Forensic Medicine 2009;31(3):218-21.
 17. Varma NM, Kalele SD. Study of profile of deaths due to poisoning in Bhavnagar region. J Indian Acad Forensic Med 2011;33(4):311-6.
 18. Gupta BK, Rastogi P, Singh R. Retrospective study of poisoning cases at tertiary care hospital in western Uttar Pradesh. J Indian Acad Forensic Med 2016;38(1):11-4.
 19. Singh K, Oberoi SS, Bhullar DS. Poisoning trends in the Malwa region of Punjab. Journal of Punjab academy of forensic medicine & toxicology 2003;3:26-9.
 20. Tandale RM, Kadu SS, Deshpande VL, Waje DR. Study of acute poisoning cases at rural tertiary care hospital in Ahmednagar, Maharashtra. Medico-legal update 2016;16(2):42-5.
 21. Dash SK, Raju AS, Mohanty MK, Patnaik KK, Mohanty S. Socio-demographic profile of poisoning cases. J Indian Acad Forensic Med 2005;27(3):133-8.
 22. Guntheti BK, Khaja S, Panda SS. A study of serum cholinesterase levels in organophosphorus poisoning cases. J Indian Acad Forensic Med 2010;32(4):332-5.
 23. Sandhu SS, Dalal JS. Trends of poisoning in Faridkot region of Punjab- A retrospective study of one year. J Indian Acad Forensic Med 2010;32(1):8-10.
 24. Garg V, Verma SK. Trends of poisoning in rural area of south-west, Punjab. J Indian Acad Forensic Med 2010;32(3):189-93.
 25. Patel NS, Srivastava AK, Kumar A, Kumar JKV, Nandwani S. Trends of poisoning in western Uttar Pradesh a clinico-pathological study. J Indian Acad Forensic Med 2014;36(2):142-5.
 26. Patel DJ, Tekade PR. Profile of organophosphorus poisoning at maharani hospital, Jagdalpur, Chhattisgarh: A three years study. J Indian Acad Forensic Med 2011;33(2):8-11.
 27. Khurana P, Dalal JS, Multani AS, Tejpal HR. The study of aluminium phosphide poisoning in a tertiary care hospital, Amritsar. J Indian Acad Forensic Med 2011;33(4):330-4.

Original Research Paper

Epidemiological Profile of Road Traffic Fatalities: A Retrospective Study of Autopsied Cases at Belagavi, Karnataka

¹Vishal Koulapur, ²Anand B Mugadlimath, ³Kashif Ali, ⁴Khaja Azizuddin Junaidi

Abstract:

Road traffic accident is one among the top five causes of morbidity and mortality in South-East Asian countries including India. Its socio-economic repercussions are a matter of great concern. This present study has been conducted to assess the prevalence and epidemiological factors related to road traffic accidents and its fatalities. Victims with alleged history of road traffic accidents, who were admitted to Dr. Prabhakar Kore Hospital and Research Centre, Belagavi and subsequently died and underwent autopsy were included in the present study. A total of 1300 medico-legal autopsies were conducted during the period, of which 642 were road traffic fatalities, constituting nearly 50% of the total cases. Road traffic accidents are a major cause of death among all un-natural deaths. Our study intends to find out the epidemiological factors, risk factors, use of safety measures, compliance with traffic rules and regulations, presenting injuries and interventions required in victims of road traffic accidents to prevent morbidity.

Key Words: Epidemiology, Road Traffic Accident, Morbidity, Autopsy

Introduction:

An accident has been defined as "an unexpected, unplanned occurrence which may involve injury".¹ A WHO Advisory Group in 1956 defined accident as an "unpremeditated event resulting in recognizable damage".² Accidents, tragically, are not often due to ignorance, but are due to carelessness, thoughtlessness and over confidence. Road accidents are associated with numerous problems, each of which needed to be addressed separately.

Corresponding Author:

¹Associate Professor,

^{3,4}Post-graduate Student,
Department of Forensic Medicine and Toxicology,
KAHER s J N Medical College, Belagavi, Karnataka

²Associate Professor,
Department of Forensic Medicine and Toxicology,
S N Medical College, Bagalkot, Karnataka

Email: drvishalk@gmail.com

L. M. No: Not a Member

DOR: 10/04/2017 DOA: 03/03/2018
DOI: 10.5958/0974-0848.2018.00008.8

Human, vehicle and environmental factors play important role before, during and after a trauma event. Accidents, therefore, can be studied in terms of agent, host and environmental factors and epidemiologically classified into time, place and person distribution. Road traffic accidents are increasing at a very high rate throughout the world and pose themselves as a major epidemiological problem. Road traffic accidents are considered as the third deadly killer next to heart disease and cancer.³ In a study conducted by National Transportation Planning and Research Center (NTPRC), Trivandrum, every 4 minute a person is killed or injured in road traffic accidents in India.⁴

Accidents represent a major epidemic of non communicable disease in the present century. The death rate is the highest and growing in developing countries like India, where pedestrians, motorcycles and passengers are more vulnerable because of the poor road conditions and less knowledge of traffic laws. In India, road accident fatalities contribute to 10% of the fatalities worldwide and nearly half in Asia-Pacific region.⁵ Road traffic accidents in India

have crossed over 130000 deaths, yearly, and have overtaken China. India has the worst road traffic accidents rate worldwide.⁶ According to the WHO report of 2002, about the global burden of injury, 30.3% morbidity and 28.7% mortality occurred in the South-East Asia region.⁷

Accidents have their own natural history and follow the same epidemiological pattern as any other disease - that is, the agent, the host and the environment interacting together to produce injury or damage. Road traffic injuries are among the three leading causes of death for people between 5 - 44 years of age and the most common cause of death in the age group 5 - 25 years of age.⁸ The reasons for higher rate of road traffic fatalities amongst this age group are minimal information about road safety, immaturity and inexperience in the necessary driving skills and capabilities.⁹ These deaths are very much preventable through the concerted efforts of institutions and the society, thereby implementing effective road safety measures that tackle leading risk factors and enable a comprehensive and safe road traffic system all over the world.

As there is no literature available regarding the epidemiological profile of road traffic fatalities from this part of country, the present retrospective study is conducted to study the demographic and injury profile in fatal cases with alleged history of road traffic accidents.

Materials & Methodology:

This present retrospective study was carried out for a period 5 consecutive years from 1st Jan 2011 to 31st Dec 2015 on unnatural deaths due to road traffic accidents at Department of Forensic Medicine and Toxicology, KLE University's, Jawaharlal Nehru Medical College, Belagavi, which is attached to the mortuary of Dr Prabhakar Kore Hospital and Research Centre, Belagavi. Relevant information and subjective data like age, sex, habitat, marital status and manner of road traffic fatalities of victims have been collected from medico legal autopsy register. Cases were included in group of road traffic fatalities, on the basis of confirmation by investigating officer,

hospital records and corroborative finding at medico legal examination.

Results:

Table 1: Year-wise distribution of cases - Of the 1300 medico-legal autopsy cases conducted during the study period, a total of 642 cases (49.3 %) of deaths due to road traffic accidents were recorded.

Table 1: Year-wise distribution of cases

Year	Total no of cases	RTA s	%
2011	282	152	53.9
2012	260	128	49.2
2013	246	118	47.9
2014	274	132	48.1
2015	238	112	47
Total	1300	642	49.3

Table 2: Sex wise distribution of road traffic fatalities. The total number of male cases were 401(62.5%). Male victims were more in number as compared to females.

Table 2: Sex-wise distribution of cases

Year	Male (%)	Female (%)	Total
2011	98 (64.5)	54 (35.5)	152
2012	79 (61.7)	49 (38.3)	128
2013	70 (59.3)	48 (40.7)	118
2014	81 (61.4)	51 (38.6)	132
2015	73 (65.2)	39 (34.8)	112
Total	401	241	

Table 3: Age-wise distribution of cases. Majority of cases were in the age group 21 . 30 years, 168 cases (26%), followed by 31 . 40 years, 134 cases (21%) and 110 cases(17%) were seen in the age group 41 . 50 years. Least number of cases were seen in the group 0 . 10 years, 25 cases(4%).

Table 3: Age-wise distribution of cases

Age group (In years)	No of cases	%
0-10	25	4
11-20	70	11
21-30	168	26
31-40	134	21
41-50	110	17
51-60	64	10
61-70	51	8
71	20	3

Table 4: Distribution in urban and rural areas - Of the total 401 male victims, 245 (61%) were from urban areas, 140 (35%) were from rural areas and 16 (1%) cases were unknown. Of the total 241 females victims, 162 (67%) were from urban areas, 75 (31%) were from rural areas and 4 cases (2%) were unknown. Urban cases outnumbered the rural ones.

Table 4: Distribution in urban and rural areas

	Total Male cases	(%)	Total Female cases	(%)
Urban	245	61	162	67
Rural	140	35	75	31
Unknown	16	4	4	2
Total	401	100	241	100

Table 5: Distribution of deaths on road traffic fatalities in relation to marital status. In males, married were 154 i.e. 38.4 %, unmarried were 247 (61.6%). In females, 89 victims (36.9%) were married, 152 victims (63.1%) unmarried. In our study male unmarried deaths on road traffic fatalities dominated over females.

Table 5: Distribution of cases in relation to marital status

Marital status	Total male cases	%	Total female cases	%
Married	154	38.4	89	36.9
Unmarried	247	61.6	152	63.1

Table 6: Distribution of cases in relation to religion. Of the total 642 cases, 451(70.2%) were Hindus, 111(17.3%) were Muslims and 80 (12.5%) were Christians.

Table 6: Distribution of cases based on religion

Religion	No of cases	Percentage
Hindu	451	70.2
Muslims	111	17.3
Christians	80	12.5

Table 7: Season-wise distribution of cases. Majority of the accidents occurred in rainy season, 363, 56.5%; followed by summer, 178 cases, 27.7% and 101 cases, 15.8% were seen in winter.

Table 7: Season-wise distribution of cases

Season	No of cases	Percentage
Summer	178	27.7
Rainy	363	56.5
Winter	101	15.8

Table 8: Of the total 642 cases, 439 (68.3%) cases were of occupants of vehicles and 203(31.7%) were pedestrians.

Table 8: Distribution of cases

	No of cases	Percentage
Vehicle occupants	439	68.3
Pedestrians	203	31.7

Table 9: Vehicle wise distribution of road traffic fatalities. Of the 439 cases of vehicle occupants, majority of the cases were 2 wheeler occupants, 143 (32.6%) cases, followed by 112 (25.5%) cases of 4 wheeler occupants, 81(18.5%) cases of 3 wheeler occupants and 103 (23.4%) cases were of other type of vehicles

Table 9: Vehicle-wise distribution of cases

Type	No of cases	Percentage
2 wheeler	143	32.6
3 wheeler	81	18.5
4 wheeler	112	25.5
Others	103	23.4

Table 10: Distribution of cases based on injuries sustained and cause of death. Majority of the cases had head injury, 392 (61%), followed by abdominal injuries, 141 (22%) cases, 64 (10%) cases had gross musculoskeletal injuries and 45 (7%) had thoracic injuries.

Table 10: Distribution of cases based on injuries sustained and cause of death

Injuries	No of cases	%
Head injury	392	61
Thoracic injuries	45	7
Abdominal injuries	141	22
Gross musculoskeletal injuries	64	10

Discussion:

India has 1% of vehicles in the world but it accounts for about 6% of total cases of unintentional injury.¹⁰ There is a rapid increase

in the number of road traffic accidents in present era. The rapid growth in road transport sector and population explosion act as risk factors for increased number of accidents. Since accidents are multifactorial in causation, intersectorial approach to both prevention of accidents and taking care of injured person is needed.

In our study, male deaths due to road traffic fatalities dominated over females. Males are usually the earning member of families makes them more vulnerable to accidents as compared to females who are mostly indulged in household activities. Our study shows that male constituted 62.5% of the total victims. Similar studies have found that male fatality was higher than the female fatality.^{11,12}

Age group most commonly involved in both the sexes was 21-30 years; the next most affected age group was 31-40 years, followed by 41-50 years. The subjects in the age group 21-30 years lead more active life. They have a tendency to take risk, thrill seeking behavior, personal problems like hyperactivity, low tolerance levels, casual attitude and inattentiveness thereby subjecting themselves to dangers of road traffic accidents and injuries. Similar findings were also reported by Meera T.H. et al¹³ and Palimar V. et al¹⁴

Incidence of road traffic fatalities is more in urban areas as compared to rural areas because of the fact that the vehicular density is increasing day by day with the existing road transport facilities, availability of more powerful engine versions of bikes and also people now days are more in hurry to reach the destination and have less patience.

The number of road traffic fatalities with unmarried status was more in both the sexes as compared to the married counterparts because of the natural tendency of the unmarried youth for being less responsible as compared to the married population and also the easily availability of the vehicles to the youth provided by their parents because of their stubbornness to have their own vehicles. These groups are in there most socially, economically and physically dynamic period of life and are found frequently outdoors.

Maximum number of road traffic fatalities were seen in the rainy season because

of the fact that roads being slippery and also poor visibility conditions which acts as risk factors. Other study shows that in winter season there were more fatalities due to road traffic accidents due to fog, snow which is not seen in this region.¹⁵

Maximum fatalities were the occupants of the vehicle (68.3%) and pedestrian being next (31.7%). On considering the victims of vehicle occupants it is clear that more emphasis of passenger preparedness and the enforcement of national passenger and driver related laws need to be greatly improved. These vehicle occupants were again classified into 2-wheelers, 3-wheelers and 4-wheelers occupants of whom maximum fatalities were seen in 2-wheelers followed by 4-wheelers.

Again, majority of the road traffic fatalities were due to head injury followed by abdominal injuries, next common being gross musculoskeletal injuries and thoracic injuries.¹⁶

Conclusion:

The present study revealed that most victims were young age group posing loss of valuable workforce and resources in developing countries like India. This situation can be improved by educating public through the mass media and initiating road safety training campaign. Road traffic injuries can be prevented, and their consequences can be alleviated. Many countries have achieved sharp reductions in the number of crashes and injuries by creating and enforcement laws, governing speed limits, alcohol impairment and the use of seat-belts, child restraints and crash helmets; making vehicles more protective for occupants, pedestrians and cyclists; and formulating and implementing transport policies that encourage safety. The real pressure and motivation to improve driving skills can come only through licensing authorities by adopting stricter, more comprehensive and scientifically based test laying a stress on road rules, regulations and traffic control devices.

Availability of first aid to the victims of road traffic accidents and providing high quality modern trauma centers along with appointment of well trained trauma specialists will help to

minimize the morbidity and mortality effects of road traffic accidents.

However, partnerships need to be formed with public, private and non-governmental organizations to address more visibly the problems and press harder for improvements. Political leadership, good governance, policy support and a reliable technical team are the key components to be focused on.

Conflict of Interest: None

Financial Assistance: None

References:

1. Health and Safety Executive, UK. Available at: <http://www.hse.gov.uk>. Accessed on 2-6-2017
2. World Health Organization. Advisory Group on Prevention of Accidents in Childhood 1956, WHO, Geneva. Available at: <http://www.who.int>. Accessed on 2-6-2017
3. District Statistician. A view on statistics of Belgaum district 2003-04. Belgaum: Zilla Panchayat;2005.
4. Manthihran K, Patnaik Ak. Railway Injuries. Modi's Medical Jurisprudence and toxicology; 23rd Ed; Lexis Nexis publication; pp:783.
5. World Health Day 2004: Road safety is no accident. Available at: <http://www.thinkroadsafety.gov.uk>. Accessed on 2-6-2017.
6. Global status report on road safety 2009, WHO. Available at: <http://www.who.int>. Accessed on 2-6-2017
7. The Government of India, Ministry of Home Affairs, National Crime Record Bureau, Accidental deaths and suicides in India 1999. Available at: <http://www.ncrb.gov.in>. Accessed on 2-6-2017
8. World Health Report 2002, WHO, Geneva. Available at: <http://www.who.int>. Accessed on 2-6-2017
9. Malhotra VM. Prevention of road accidents-role of health services. Swasth Hind. 1990, p 92-93.
10. Verma PK, Tewari KN; Epidemiology of road traffic injuries in Delhi: Result of a survey; regional health forum who south-east Asia region 2004; 8(1), WHO Regional Office for South-East Asia 2007. Available at: <http://www.searo.who.int>. Accessed on 2-6-2017
11. Singh H, Dhatarwal SK. Pattern and distribution of injuries in fatal road traffic accidents in Rohtak (Haryana), J Ind Acad Forensic Med 2004;26(1):20-3.
12. Choudhary BL, Singh Deepak, Tirpude BH, Sharma RK, Meel V. Profile of road traffic accidents cases in Kasturba hospital of MGIMS, Sevagram, Wardha, Maharashtra, India; Medico Legal Update 2005;5(4):1-12.
13. Meera Th. Nebha Chandra h. A study of pattern and injury severity score in blunt thoraco-abdominal trauma cases in Manipal. Medico-Legal Update:2005.5(2):47-52.
14. Palimar V, Arun M, Singh B, Mohanty MK. Victimologic study of road traffic fatalities. Medico Legal Update 2004;4(1):91-3.
15. Norman L.G; Road Traffic Accidents; WHO Geneva; 1962. Available at: <http://www.who.int> Accessed on 2-6-2017
16. Dileep KR, Raju GM, Vijaynath V, Shahina. Deaths due to fatal road traffic accidents. A Retrospective study. J Ind Acad Forensic Med 2013;35(3):236-8.

Original Research Paper

Road Safety in Mangalore – An Observation

¹Prateek Rastogi, ²Donald Xavier, ³Esha Mallik, ⁴Siddharth Shankar, ⁵MS Kotian

Abstract:

Introduction: Road traffic accidents are one of the leading causes of increased morbidity and mortality in Mangalore City. As per statistics for road traffic accidents collected from Mangalore traffic police for a period of 2 years i.e. 2015 and 2016, there were 327 fatal accidents, 2847 non-fatal accidents, 2653 vehicular accidents, 3245 cases of drunken driving and 3,88,525 cases of traffic rules violations. This alarmingly high incidence of road traffic accidents in a small coastal town motivated us to conduct this study.

Methodology: This questionnaire based study was conducted on 400 randomly picked participants including traffic police persons, commuters, and drivers (bus, auto, car, and bike). The questionnaire contained both open ended and closed ended questions. Opinions and suggestions received from the participants for various questions were compiled in MS excel sheet and were analyzed using SPSS version 17.0 programme. Institutional Ethics Committee Clearance was obtained before starting the study.

Results & Discussion: The data collected from the participants was listed in form of tables and graphs. The study showed that public is well aware of traffic rules and regulations; and the traffic police is well aware of their responsibilities. In spite of this and the fact that, Mangalore, being a modern and educated city with good infrastructure and well-informed residents, the cases of accidents and traffic violations are quite high. The results of this study list the opinions and suggestions of residents and police regarding increasing accidents and suggestions to control them. The results and suggestions obtained by this study can be used further to spread more awareness among police and public along with familiarizing them with expectations of the other stakeholders. We hope that in long run this exercise can result in increasing awareness, improving the road infrastructure of the city and thus reducing road traffic accidents.

Key Words: Road Traffic Accidents; Traffic Rules Awareness; Mangalore City.

Introduction:

Mangalore is a growing cosmopolitan city with an ever rising number of vehicles as

well as population. The city is inhabited not only by locals, but also by a large number of outside population, mainly students, owing to the presence of high-quality educational institutes and big companies in this city. In Mangalore, road traffic accidents are on the rise every day and constitute a potential cause of mortality and morbidity in the society. Owing to high purchasing power, there has been a tremendous growth of 2 and 4 wheelers in the city. Mangalore boasts of an excellent public transport system comprising of a huge fleet of buses and autos.

Till a few years back, this city was a small hamlet comprising of narrow lanes, although with times the road infrastructure has improved a lot including widening, and

Corresponding Author:

¹Professor & Head,

Department of Forensic Medicine & Toxicology,
Sikkim Manipal Inst. of Medical Sciences, Gangtok

²⁻⁴MBBS students, Kasturba Medical College,
Mangaluru, (Manipal University)

⁵Selection Grade Lecturer, Dept. of Community
Medicine, Kasturba Medical College, Mangaluru

Email: rastogiprateek@rediffmail.com

L. M. No: LM/IAFM/532

DOR: 21/08/2017 DOA: 03/03/2018

DOI: 10.5958/0974-0848.2018.00009.X

concretization of roads, but still, the growth of vehicles is much more as compared to the development of road amenities required to handle this load, resulting in traffic jams (previously unheard of in this coastal town), noise and air pollution and accidents.

In this project, an attempt has been made to understand the etiology of road traffic accidents in Mangalore. An attempt has also been made to understand the problem from the view point of various stakeholders, i.e., traffic police persons, commuters and vehicle drivers (bus, cars, bikes, and autos). The results and suggestions obtained by this study can be used to spread awareness among police and public along with familiarizing them with expectations of the other groups. This information can be spread via workshops, seminars, publications and newspaper articles. We hope that in long run this exercise will result in increasing awareness, improving the road infrastructure of the city and thus reducing road traffic accidents.

Aims and Objectives:

Aim:

Short-term - Analyze the prevalence & causation of road traffic accidents and suggestions to improve road safety in Mangalore city using inter-professional approach.

Long term - Increase awareness about road safety measures and problems faced by various stakeholders, subsequently leading to a reduction in road traffic accidents.

Objectives:

1. To identify the prevalence of road traffic accidents in Mangalore city.
2. To assess the perception of stakeholders (commuters, traffic police, and drivers) related to causation of road traffic accidents and suggestions for improving road safety in Mangalore City.
3. To suggest the interventions to reduce the mortality and occurrence of road traffic accidents in Mangalore city-based on the perception of stakeholders.

Materials & Methodology:

This descriptive cross sectional study was conducted in Mangalore City on a total sample size of 400 people, including 200

drivers (50 bus drivers, 50 auto drivers, 50 car drivers and 50 bikers), 100 commuters and 100 traffic police persons. Institutional Ethics Committee clearance was obtained. A team was formed comprising of police officials, auto and bus drivers, student volunteers, and non-teaching staff members of Kasturba Medical College, Mangalore for conducting the survey.

Epidemiological data for road traffic accidents was collected from the Traffic police stations of Mangalore City. Questionnaire based survey was done (after obtaining informed consent) for traffic police, commuters, vehicle drivers about their opinion on causes and prevention of road traffic accidents. Questionnaires were prepared in English and Kannada and were validated by peers and students. The survey team visited police stations, traffic signals, bus stops, bus stands, auto stands, hostels, and markets to interact with participants, explained them about the study and collected the data. Based on responses and suggestions statistical analysis was done using SPSS version 17.0 and results compiled in form of tables and graphs.

Results & Discussion:

As per data collected from Mangalore police commissionerate and police stations, in 2015 and 2016, 82.3% of total victims of fatal accidents were males and while the percentage was 77% in non-fatal cases (**Figure 1 & 2**). The results of previous studies show similar observations. A large number of national reports and independent studies also point out that men are killed and injured in greater numbers with the male to female ratios varying from 4:1 to 5:1.¹⁻⁵ Our study showed a ratio of 6:1 deaths in comparison with males and females. This can be accounted for the fact that a large proportion of vehicle drivers as well as pedestrians are males, as they account for more outdoor activities while females account for more indoor activity. Number of children is less as they stay in more protected environment shielded by parents. Hospital studies in Bangalore during 1993,⁶ 1998⁷ and 2005⁸ have shown that pedestrians are injured and killed to the extent of 25% - 35%. A similar pattern is also reflected in studies reported from other centers in India and

from population-based surveys.¹ In Mangalore too, the injuries and deaths of pedestrians come

to about 43.95%, about a 9% more than that of these studies.

Fig.1. Fatal accidents in 2015 & 2016 (n=327)

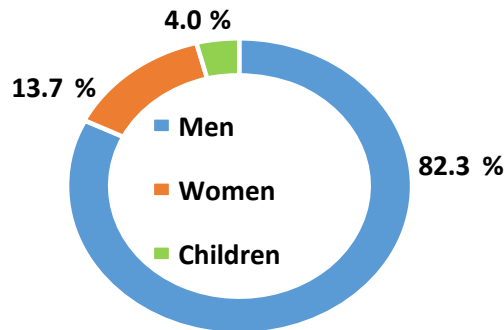
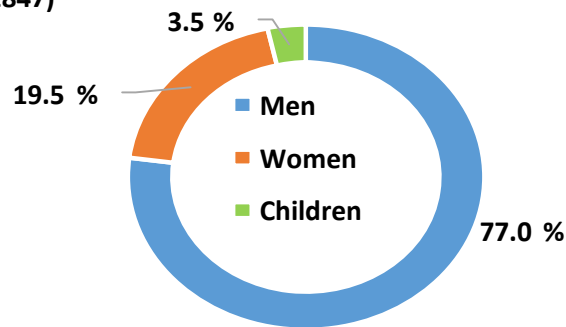


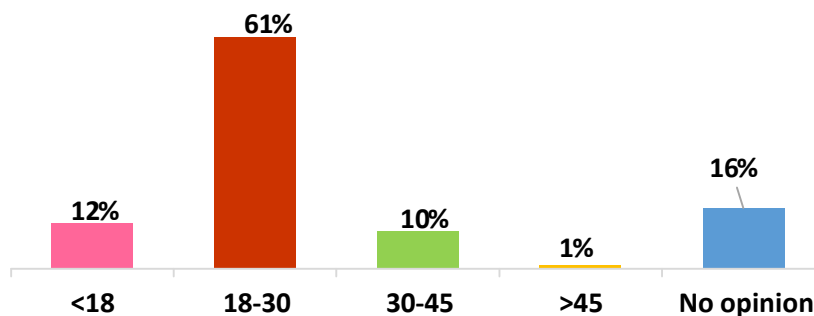
Fig.2. Non -fatal accidents in 2015 & 2016 (n=2847)

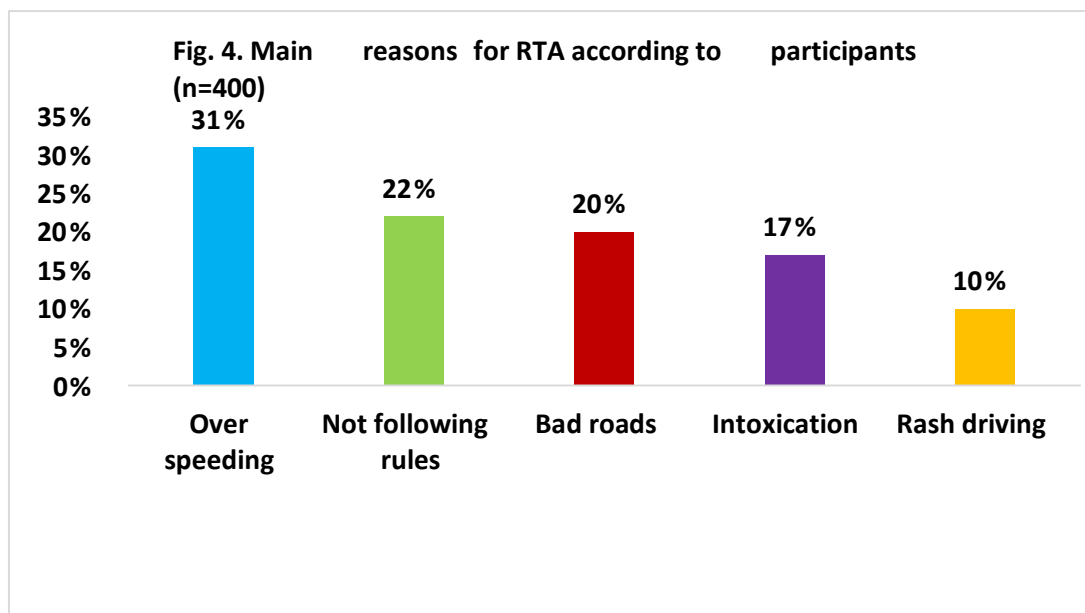


The policemen who participated in our study too believed that the age group of 18-30 years were most responsible for accidents (61%), owing to rash driving. (Figure 3) This is in concurrence with a study done in Nagpur, where majority of the victims (75%) were in the age

group 18- 37 years.⁹ Main reasons for road traffic accidents, according to participants were over speeding, 31% followed by not following rules, 22 %, bad roads, 20%, intoxication, 17% and rash driving, 10%. (Figure 4)

Fig. 3. Age groups responsible for RTA according to policemen (n=100)





Majority of participants feel that the use of indicators while driving, proper traffic signals reduces road traffic accidents. (Table 1). Surprisingly only 41% of drivers and 58% of commuters agree that increasing speed breakers can reduce road traffic accidents, where as an overwhelming majority of policemen 86 % agree to the same. 26% of computers, 56% of drivers, 10% of policemen do not agree with this notion. (Table 1) Majority of the participants; 93% of commuters, 84% of drivers, 88% of policemen feel that the existing road conditions contribute to the road traffic accidents. (Table 1)

Our study participants were of the opinion that street lights can be useful in

preventing road traffic accidents, however, there was little evidence to suggest that use of street lights would reduce accidents according to studies in Wales¹⁰ and Southampton.¹¹ There is a dearth of literature for similar studies in India.

When policemen were queried regarding road safety, a majority felt that the existing traffic rules and the powers given to them were not sufficient, 72.2% told that their current working conditions were also adding to their woes. Surprisingly, 90% felt that people were not receptive in obeying traffic rules. Most of them (78%) also felt that the presence of strictly followed Lane system will reduce the incidence of RTA's. (Table 2)

Table 1. Response of participants on questions related to road safety (commuters, n=100; policemen, n=100; drivers, n=200)

	Participants	Yes	No	Don't know
Use of indicators while driving reduces RTA	Commuters	95.0%	3.0%	2.0%
	Drivers	96.5%	2.5%	1.0%
	Policemen	99.0%	1.0%	0.0%
Proper traffic signals can reduce RTA	Commuters	96.0%	4.0%	0.0%
	Drivers	92.0%	8.0%	0.0%
	Policemen	97.0%	3.0%	0.0%
Existing road conditions contribute to RTA	Commuters	93.0%	4.0%	3.0%
	Drivers	84.0%	11.0%	5.0%
	Policemen	88.0%	10.0%	2.0%
Increasing speed breakers can reduce RTA	Commuters	58.0%	26.0%	16.0%
	Drivers	41.0%	56.0%	3.0%
	Policemen	86.0%	10.0%	4.0%

Table 2: Response of policemen on questions related to road safety (n=100)

	Yes	No	Don't Know
Are you able to accomplish traffic control under current working conditions?	27.8%	72.2%	0.0%
Do you have adequate facilities and powers to penalize traffic rule violators?	26.4%	73.6%	0.0%
Are existing traffic rules sufficient enough to control RTA's?	31.9%	68.1%	0.0%
Are people receptive in obeying traffic rules?	7.0%	90.0%	3.0%
Presence of strictly followed lane system will reduce the incidence of RTA's	78.0%	13.0%	9.0%

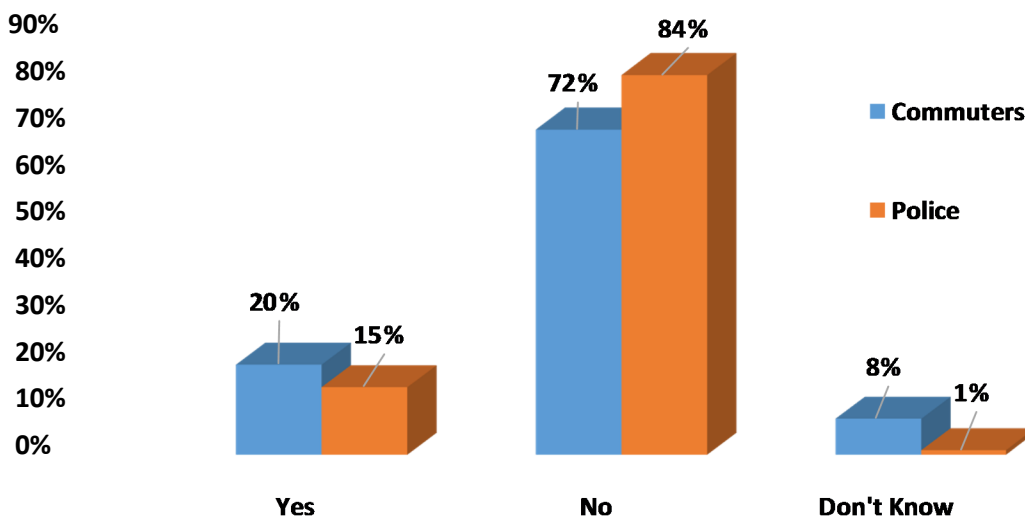
Unsurprisingly, only 20% of commuters and 15% of policemen felt that bus drivers stopped at designated stops. Overwhelming majority, 72% commuters and 84% policeman do not feel so. (**Figure 5**). When the drivers were quizzed on what they do when there was a delay to reach their destination, 46% of bikers, 47.8% of car drivers, 27.7% of the bus driver and 74% of auto drivers opted for shortcuts. Majority of the bus drivers, 40.4 %, opted over-speeding, 17% skipping stops. On the other hand, 14% of bikers and 21.7 % of car drivers opted for doing nothing. (**Figure 6**)

In a study done in Karnataka, regarding risk behaviors related to violence and injury among school-going adolescents, it was found that 27% students (total=381) had knowledge of traffic rules in detail, while 65% drove a motorized vehicle. Nearly 75% students did not use a helmet or seatbelt while driving and 17%

used a mobile phone for either talking or texting while driving.¹² The public in our study shared a similar view and felt that the use of helmets and seat belts should be promoted.

Majority, 92%, of commuters and 93% of drivers felt that proper traffic management by traffic police can reduce road traffic accidents. (**Figure 7**) Eighty two percent of commuters and 91% of drivers felt that commuters getting on and off the moving bus can lead to road traffic accidents. (**Figure 8**) Scarcily, nearly 3/4th of the drivers are not aware of permissible blood alcohol limits in India while driving. (**Figure 9**) Almost 50% of drivers felt that the traffic police were biased to rich class whereas 10.1% felt they were biased to ladies and 7.9% felt they were biased to the elderly. (**Figure 10**).

Fig. 5. Opinion of police and commuters on "Do bus drivers stop at designated stops? (Policemen, n=100; commuters n=100)



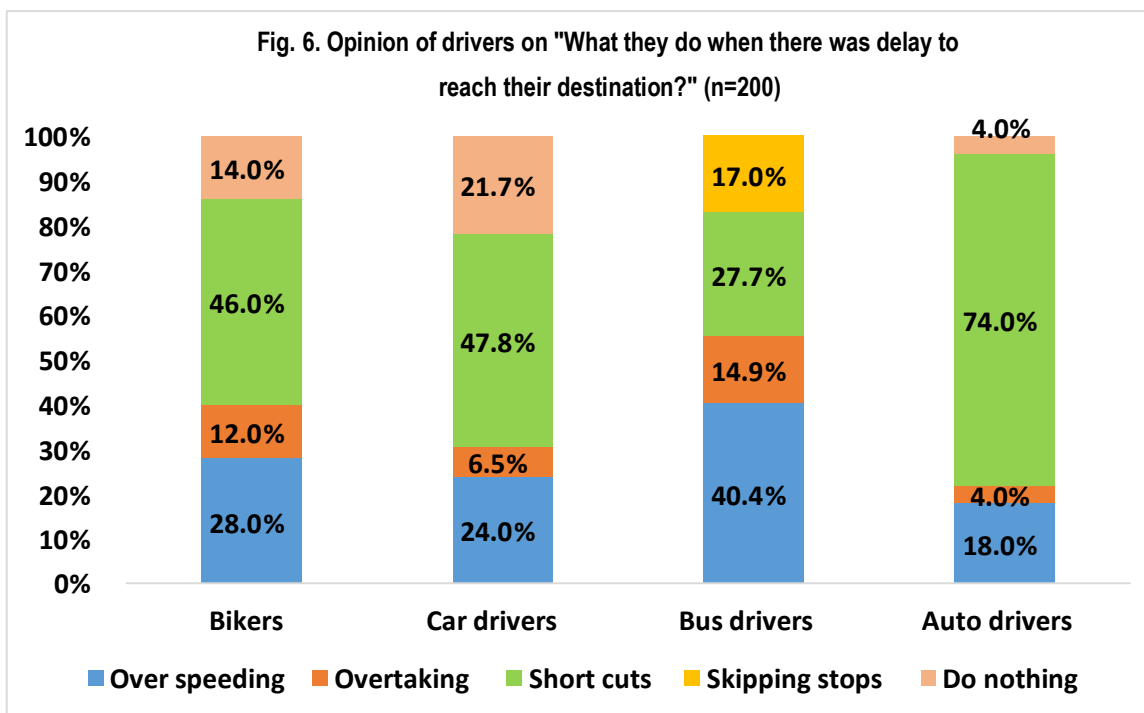


Fig.7. Opinion of commuters and drivers on "Can proper traffic management by traffic police reduce RTA's?"

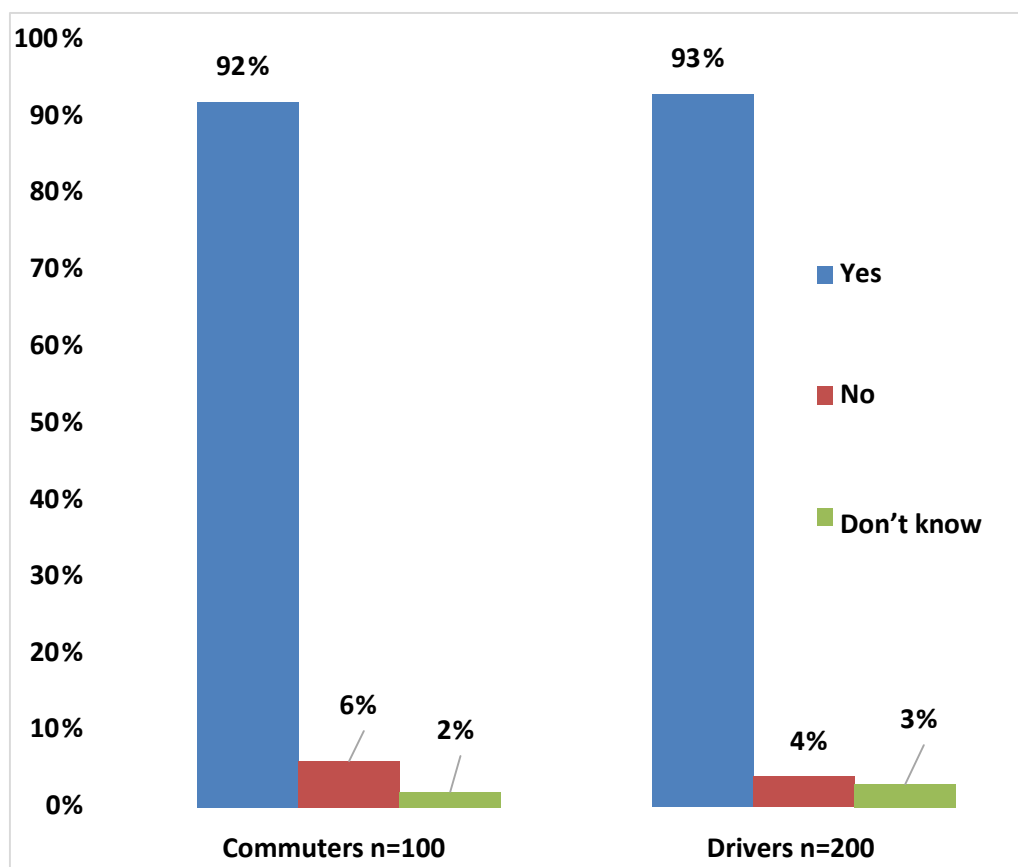


Fig.8. Opinion of commuters and drivers on “commuters getting on and off the moving bus can lead to RTA?”

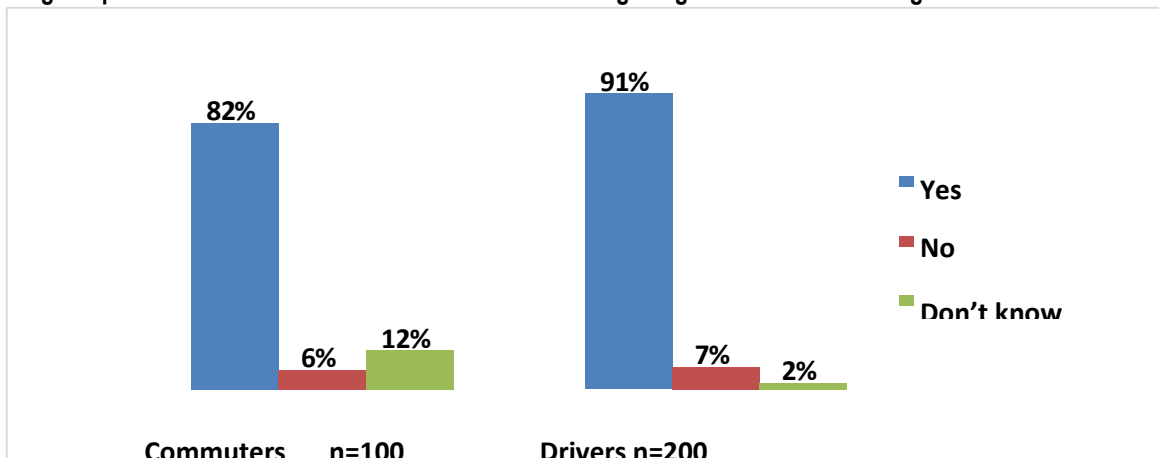


Fig. 9. Awareness among drivers about permissible blood alcohol limit in India while driving (n=200)

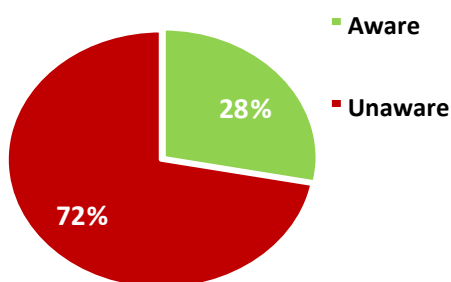
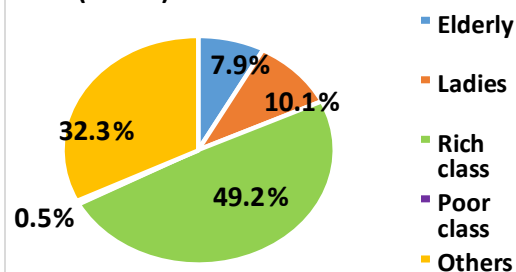


Fig.10. Opinion of drivers about bias by traffic police towards a certain class of people (n=200)



When drivers were queried on road safety, they felt that carelessness of pedestrians is a major cause of road traffic accidents. When questioned about carelessness of traffic police the response was almost equal for holding police responsible and not responsible. They also felt that presence of functioning street lights would help reduce the number of RTA, while 92% of them said that cars coming down the opposite Lane with their headlights on high beam are responsible for RTA. (Table 3)

Conclusion

There is no dearth of literature as far as road safety is concerned. This study summarizes the opinion of commuters, traffic police persons and vehicle drivers about the etiological aspects of road traffic accidents and basic awareness about traffic rules. It brings out the opinion of various stakeholders about main

reasons of road traffic accidents and how they can be reduced.

Table 3: Response of drivers on questions related to road safety (n=200)

	Yes	No	Don't Know
Carelessness by traffic police is a major cause for RTA	41.7%	48.7%	9.5%
Carelessness by pedestrians is a major cause for RTA	96.0%	4.0%	0.0%
Cars coming down the opposite lane with their head lights on high beam are a cause of RTA.	92.0%	4.0%	4.0%
Presence of functioning street lights would help reduce the number of RTA	90.9%	7.6%	1.5%

Based on suggestions and observations of participants there were few suggestions to reduce RTA

" Implement strict rules, regulate speed limit, improve road conditions, make proper footpaths, and spread awareness about road safety and traffic rules.

" Use of seat belts and safety helmets can reduce the severity of road traffic accidents.

" Use of reflectors especially on speed breakers and dividers, functioning traffic signals, the presence of traffic police and CCTV at junctions, zebra crossing for pedestrians would reduce RTA.

From this study, it can be concluded that overall the general public and drivers are aware of traffic rules and causes for road traffic accidents. It also shows that traffic police persons are aware of public needs and problems related to road accidents. Traffic police, commuters, and drivers have multiple suggestions for improving the road safety. The suggestions and opinions of stakeholders if properly disseminated and implemented can go a long way in improving the road safety.

Implications:

" Increased awareness in public and traffic police about view point of each other, related to etiology and prevention of road traffic accidents.

" Suggesting interventions to promote road safety.

" An attempt to improve the road safety.

Acknowledgements

MUFILIP(EU-FAIMER International Institute for Leadership in Interprofessional Education, Manipal University, Mangalore city police, staff, students of KMC Mangalore, drivers and commuters in Mangalore city.

Conflict of interest: None

Financial Assistance: None

References:

- Kanchan T, Kulkarni V, Bakkanavar SM, Kumar N, Unnikrishnan B. Analysis of fatal road traffic accidents in a coastal township of South India. *J Foren Legal Med* 2012;19(8):448-51.
- Bliss T, Breen J. Meeting the management challenges of the decade of action for road safety. *International Association of Traffic and Safety Sciences Research*, 2012;35(2):48-55.
- Jain A, Menezes RG, Kanchan T, Jain R. Two wheeler accidents on Indian roads . a study from Mangalore, India *J Foren Legal Med* 2009;16(3):130-3.
- National Crime Records Bureau. Accidental deaths and suicides in India. New Delhi: Ministry of Home Affairs, Government of India, 2008. [online 2008]. Available from URL: <http://ncrb.gov.in/ads2013/ADSI-2013.pdf>
- Oviedo-Trespalacios O, Scott-Parker B. The sex disparity in risky driving: A survey of Colombian young drivers. *Traffic Inj Prev*. 2018; 19(1):9-17.
- Gururaj G, Channabasavanna SM, Das BS, Kaliaperumal VG. Epidemiology of head injuries- Project report. Bangalore: NIMHANS, KSCST; 1993. Available online at: [www.nimhans.ac.in/sites/default/files/Epidemiology of Head Injuries...](http://www.nimhans.ac.in/sites/default/files/Epidemiology%20of%20Head%20Injuries...)
- Gururaj G, Reddi MN, Aeron Thomas A. Epidemiology of road traffic injuries in Bangalore. In: *Proceedings of the 5th world conference on injury prevention and control*. New Delhi: Macmillan; 2000.
- Gururaj G, Shastry KVR, Chandramouli AB, Subbakrishna DK, Kraus JF. Traumatic brain injury. Bangalore: National Institute of Mental Health and Neuro Sciences; 2005. Available online at : [www.nimhans.ac.in/sites/default/files/Traumatic Brain Injury_0.pdf](http://www.nimhans.ac.in/sites/default/files/Traumatic%20Brain%20Injury_0.pdf)
- Ganveer GB, Tiwari RR. Injury pattern among non-fatal road traffic accident cases: a cross-sectional study in Central India. *Indian J Med Sci* 2005;59(1):9-12.
- Steinbach R, Perkins C, Tompson L, Johnson S, Armstrong B, Green J, Grundy C, Wilkinson P, Edwards P. The effect of reduced street lighting on road casualties and crime in England and Wales: controlled interrupted time series analysis. *J Epidemiol Community Health* 2015;69(11):1118-24.
- Perkins C, Steinbach R, Tompson L, Green J, Johnson S, Grundy C, Wilkinson P, Edwards P. What is the effect of reduced street lighting on crime and road traffic injuries at night? A mixed-methods study. Southampton (UK): NIHR Journals Library; 2015. Available online at : <http://www.journalslibrary.nihr.ac.uk/phr/phr03110/#/abstract>
- Swain S, Mohanan P, Sanah N, Sharma V, Ghosh D. Risk behaviors related to violence and injury among school-going adolescents in Karnataka, Southern India. *Int J Adolesc Med Health*. 2014;26(4):551-8.

Original Research Paper

Maximum Cranial Circumference: A Predictor of Sexual Dimorphism of Human Skull

¹Madhusudan R. Petkar, ²Sandesh B. Datir, ³Chandeep Singh Makhani, ⁴Jamebaseer Farooqui, ⁵Rajendra S. Bangal, ⁶Kalidas D. Chavan

Abstract:

This retrospective observational study was an attempt to study the sexual dimorphism in 108 adult human skulls (58 Male and 50 Female) of known sex of population of Maharashtra, from maximum cranial circumference (MCC). MCC was measured in millimeters with the help of a thread, and was then measured on scale. The values of range, mean, standard deviation, calculated range (mean \pm 3SD), were obtained in univariate analysis. Subsequently, Demarking point (DP) and Identification point (IP) were derived. The mean and range of MCC of males (Mean - 496.91 mm, Range - 470-550 mm) was higher than that of females (Mean - 476.08 mm, Range - 442-500 mm), with significant difference. On comparing with earlier studies, the findings of the present study were found to be almost similar. The methods of demarking point and identification point were not found helpful in determining the sex of skull. Such type of studies should be carried out frequently in a given geographic area, which will help to observe the changing trends in metric measurements resulting in establishment of anthropometric standards.

Key Words: Sexual Dimorphism, Maximum Cranial Circumference, Skull, Univariate

Introduction:

Identification of a human being is one of the most challenging subjects that medico-legalists confront.

Corresponding Author:

²Associate Professor,

Dept. Forensic Medicine and Toxicology, ⁵Dean Smt. Kashibai Navale Medical College and General Hospital, Narhe, Pune.

¹Associate Professor,
Dept. Forensic Medicine and Toxicology, Dr. D. Y. Patil Medical College, Hospital & Research Centre, Pimpri, Pune.

³Associate Professor,
Dept. Forensic Medicine and Toxicology,
Army College of Medical Sciences, New Delhi

⁴Professor,
Dept. Forensic Medicine and Toxicology,
Rural Medical College, Loni

⁶Registrar,
Maharashtra University of Health Sciences, Nashik

Email ID: sandeshdatir@gmail.com.

L. M. No: 714/MAH/2009

DOR: 10/08/2017 DOA: 10/10/2017

DOI: 10.5958/0974-0848.2018.00010.6

The issue of identification arises in both civil as well as criminal cases everyday, in medico-legal practice. Deceased individuals requiring identification may include homeless individuals, undocumented immigrants, burned bodies, decomposed or skeletal remains and individuals who sustained significant facial trauma that precludes visual identification. This is common in cases of high-velocity crashes (e.g. cars, airplanes), fires, explosions, or decomposed/skeletonized remains.^{1,2}

Numerous methods exist for the identification of the living and dead, based on primary physical characters like sex, age, stature, weight, race etc. Sex identification is an initial crucial step in the revelation of the complete identity of the human skeleton as it also renders significantly clearer guidance towards age, race and stature estimation. If entire skeleton is sent for examination it becomes easy to identify sex of the individual but it becomes difficult to determine the sex of the deceased, if few bones are available and it is still more difficult when a single bone is available. Earlier traditional studies by

nonmetrical methods were centered on morphological traits. Subsequently trends changed to morphometry and statistical methods like univariate analysis, identification point, demarking point etc. The scarcity of studies on sexual dimorphism of skull has resulted in the present study, which is an attempt to study the sexual dimorphism in adult human skull from MCC and to compare with earlier studies. This will be helpful in generating data for future anthropometric and medico legal studies.³⁻⁵

Material and Methods:

The present retrospective observational study was carried out on 108 adult human skulls (58 Male and 50 Female skulls) of known sex of population of Maharashtra available in Department of Anatomy, in tertiary health care centers, during the period from August 2010 to December 2011, with prior approval from the Ethics Committee of the institution. Dry skulls of individuals of age group 18 years to 55 years of known sex, free of damage and deformity were included in the study.

MCC of each skull was measured in millimeters with the help of thread, above the level of supra-orbital ridges and on the most distant projection of occiput to zero point anteriorly i.e. Glabella. The length of the thread was then measured on scale. All the values were tabulated and analyzed statistically by routine statistical methods with SPSS software. The values of range, mean, standard deviation, calculated range (mean \pm 3SD), were obtained in univariate analysis. Subsequently Demarking point and Identification point were derived. For MCC with male range of a . b and female range of c . d, values $\frac{a+b}{2}$ and $\frac{c+d}{2}$ were the IP for females and males respectively. MCC reading less than $\frac{a+b}{2}$ was regarded as female skull and greater than $\frac{a+b}{2}$ was regarded as male skull and in case where female range was more than male then $\frac{b+c}{2}$ and $\frac{c+d}{2}$ were IP for female and male respectively. Similarly DP was calculated from calculated range i.e. Mean \pm 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. Results were

tabulated, analyzed and compared with other studies.

Results:

108 adult human skulls (58 males and 50 females) were studied in the present study. In all the skulls, MCC was measured. Data was analyzed statistically and mean, standard deviation (SD), range, calculated range (mean \pm 3SD), demarking point (DP) and identification point (IP) were obtained. Then t test was applied.

The mean MCC of male was 496.91 mm ranging between 470-550 mm. The mean MCC of female was 476.08 mm with the values ranging between 442-500 mm. The identification point of male skull was more than 500 mm and of female skull was less than 470 mm. The SD for male and female were 14.32 and 16.12 respectively. The calculated range of mean \pm 3SD in males and females was 453.94-539.89 mm and 427.71-524.45 mm respectively. The demarking point for males was more than 524.45 mm and for females it was less than 453.94 mm. (Table 1.)

Table 1: Statistical analysis of the Maximum Cranial Circumference of skull

Details of measurement (mm)	Male n=58	Female n=50
Mean	496.91	476.08
SD	14.32	16.12
Range	470-550	442-500
Identification point (IP)	>500	<470
Calculated range (mean \pm 3SD)	453.94-539.89	427.71-524.45
Demarking point (DP)	>524.45	<453.94

$t=7.11$, $p<0.0001$, highly significant, where n= number of skulls

Discussion:

The mean and range of MCC of males is higher than that of females with significant difference. On comparing with earlier studies, the findings of the present study found to be almost similar with findings of Deshmukh⁶ and Bagade.⁷ (Table 2)

It was observed that there was a lot of overlap in values of male and female skull. So the methods of DP and identification point IP were not found helpful in determining the sex of

Table 2: Comparison of Maximum Cranial Circumference

S. No	Name of workers	Male						Female						SS
		N	M	R	SD	IP	DP	N	M	R	SD	IP	DP	p
1	Keen (1950) ⁸	50	516.2	479-542	14.5	--	--	50	498.3	465-528	14.7	--	--	--
2	Bagade (1981) ⁷	70	490	458-520	15.4	--	>492	30	470.3	438-492	15.2	--	<458	<0.001
3	Hong Wei Song (1992) ⁹	30	509.1	--	21.5	--	--	30	498.8	--	22.6	--	--	>0.05
4	Deshmukh (2006) ⁶	40	496	470-529	13.3	--	>526	34	479	444-500	15.5	--	<456	<0.001
5	Shalini (2008) ¹⁰	50	550.9	--	--	--	--	50	506.94	--	--	--	--	0.000
6	Oladiipo (2010) ¹¹	500	57.49 cm	--	--	--	--	500	56.25 cm	--	--	--	--	<0.05
7	Present study	58	496.91	470-550	14.32	>500	>524.45	50	476.08	442-500	16.12	<470	<453.94	<0.0001

Where N – no. of skull, M – Mean, SD – Standard deviation, R – Range, IP- Identification point, DP – Demarking point, SS – Statistical significant

skull. The probable reasons for overlap and inability to identify the bones on application of criteria of IP and DP are as follows:

- 1) The considerable frequency of hypo masculinity in male and or hypofemininity in the female bones.
- 2) The above factor was related to genetic, nutritional, socioeconomic, and physical stress in individuals, all of which perhaps be accounted for, in the present study.¹²

Such type of studies should be carried out frequently in a given geographic area, which will help to observe the changing trends in metric measurements resulting in establishment of anthropometric standards.

Conflict of interest: None

Financial Assistance: None

References:

1. Dr. KS Narayan Reddy. The essentials of forensic medicine and toxicology. 20th edition. Hyderabad: K. Suguna Devi; 2008. pp.52.
2. Rajesh Bardale. Principles of forensic medicine and toxicology. 1st edition. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.; 2011. P.2-4.
3. O'Connor T. "Quantitative Data Analysis," MegaLinks in Criminal Justice. [Internet]. Accessed on 25 Nov2011. Available from: <http://www.drtoconnor.com/3760/3760lect07.htm>
4. Jit I, Singh S. The sexing of adult clavicles. Ind J Med Res. 1966;54:556-557. .Available from: <http://ijmr.in/CurrentTopicView.aspx?year=Ind.Jour.Med.Res.%2c54%2c6%2cJune%2c1966pp+551-571%24Original+Article>. Accessed on 25th November 2011
5. Washburn SL. Sex difference in the pubic bone. Am J Physical Anthropology. 1948;6:199-208. Available from: <http://onlinelibrary.wiley.com/doi/10.1002/ajpa.1330060210/full>. Accessed on 25 Nov2011
6. Deshmukh AG, Devershi DB. Comparison of cranial sex determination by univariate and multivariate analysis. J Anat Society of India. 2006;55(2):48-51.
7. Bagade KG. Determination of sex from axial skeleton. [Dissertation for M.S. Anatomy]. Aurangabad: Marathwada University;1981. [Central Library, Govt. Medical College, Aurangabad]

8. Keen JA. A study of the differences between male and female skulls. *American Journal of Physical Anthropology*. 1950;8(1):65-79. Available from: <http://onlinelibrary.wiley.com/doi/10.1002/ajpa.1330080113/full>. Accessed on 25 Nov2011
9. Hong Wei Song, Zi Qing Lin, Jing Tao Jia. Sex diagnosis of Chinese skulls using multiple stepwise discriminant functional analysis. *Foren Sci Int* 1992; 54:135-40.
10. Shalini Kalia Et Al. Stature estimation using odontometry and skull anthropometry. *Ind J Dent Res*, 2008;19(2):150-4.
11. Oladipo GS, Okoh PD, Hart JS. Anthropometric study of some craniofacial parameters: head circumference, nasal height, nasal width and nasal index of adult ijaws of nigeria. *Asian Journal of Medical Sciences*. 2010;2(3):111-113.
12. Padeyappanavr KV, Ameer Khusru M. Kazi, Bhusreddy PS, Kulkarni UK. Sexual dimorphism in adult human clavicles of north interior karnataka region. *J Karnataka Medico-legal Society*. 2009;18(1):3-13.

Original Research Paper

A study on the Pattern of Rape in Manipur

¹Soreingam Ragui, ²Th. Bijoy Sing

Abstract:

A retrospective study was done in the Department of Forensic Medicine, RIMS a tertiary health care teaching hospital in Imphal over a period of 7 years from 2005-2011. A gradual increasing trend was observed in the present study with maximum cases seen in 2011. Students were the most common and risky victim (51%). Summer (34%) season and afternoons (40%) were the most preferred time for such crime. In majority of the cases, the accused was known to the victim (83%) and also most of the incidents occurred in the accused's house (33%). External Injuries (11.8%) and local injuries (33.3%) were not seen in most of the cases. Hymen tear was most commonly seen in the 5, and 7^o clock position (18%).

Key Words: Rape, Injury, Hymen

Introduction:

The word 'rape' is probably derived from the Latin word rapere, which means to snatch.¹ Rape is one of the most heinous crimes ever encountered by a woman or a female child. No age is safe in respect of this offence. Rape is a legal term, the definition of which varies with countries. It is said to be the fastest growing violent crime in many parts of the world.² The law of rape has undergone transformations over the years. In India, on 2nd April 2013, the definition was revised through the Criminal Law (Amendment) Act 2013,³ which also raised the legal age of minor to eighteen. Contrary to popular belief, rape is not a rare event; it affects hundreds of thousands of people each year. It is an underreported crime, and victims of all ages do not readily identify themselves.⁴

Corresponding Author:

¹PGT,

²Professor,
Department of Forensic Medicine,
Regional Institute of Medical Sciences, Imphal

Email ID: raguisoreingam@gmail.com.
L. M. No: LM/IAFM/1003/MAN/201

DOR: 19/05/2017 DOA: 07/03/2018
DOI: 10.5958/0974-0848.2018.00011.8

This study was undertaken to analyse if there is a changing pattern of this crime, with the findings of previous workers in this area, to help in preventing this crime.

Material and Methodology:

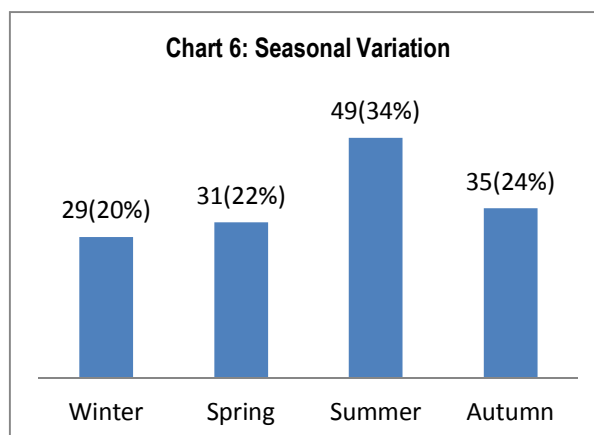
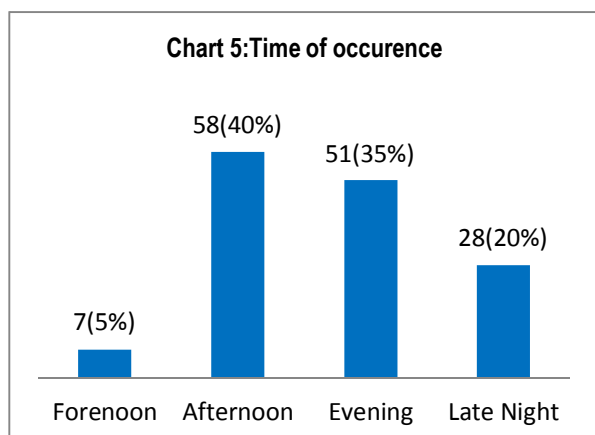
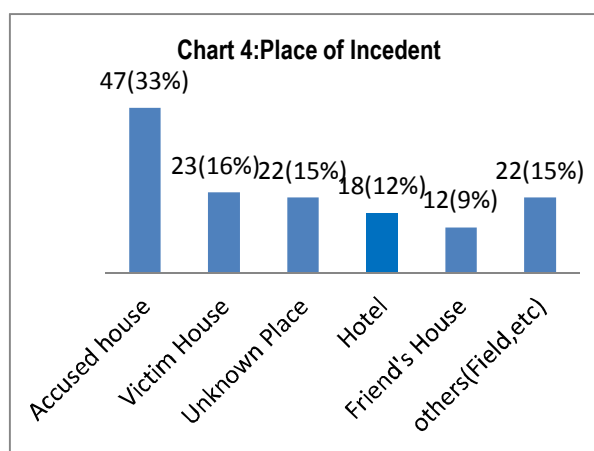
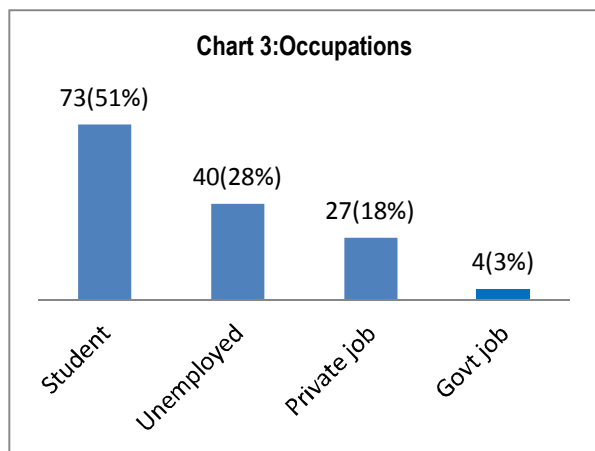
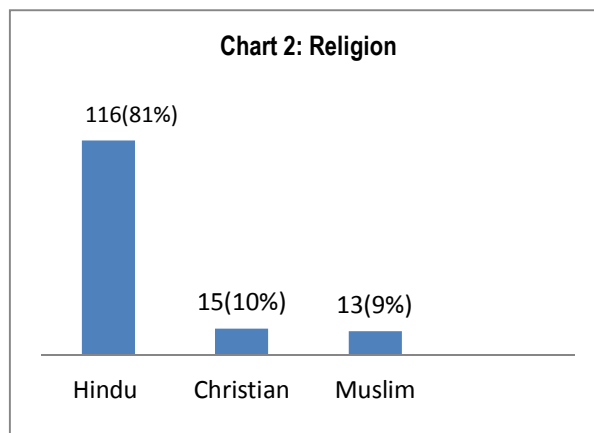
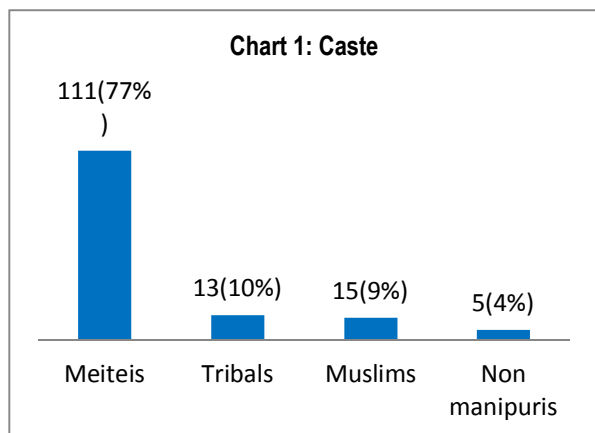
All the reported cases of sexual assaults occurring in and around Imphal were examined in the department of Forensic Medicine RIMS, a tertiary hospital in Manipur. This study includes those case brought to this institute from 2005-2011. The cases were studied to determine the incidence, distribution with respect to caste, religion, occupation, place of incident, seasonal variation, pattern of injuries etc. Permission for this study was taken from the Ethics Committee of the Institute.

Results and Observations:

Increasing trends were observed in the incidence of rape from 2006 (7.6%) to 2011 (28.5%) and the most vulnerable age group was found to be 13-20 year (47%) (**Table 1**). Maximum victims (77%) were Meiteis, with majority (81%) following Hindu religion (**Chart 1 & 2**). Most of the victims were students (51%) (**Chart 3**) and the highest number of incident occurred in the accused's house (33%) (**Chart 3 & 4**). The study showed that the incident mostly took place in the afternoon (40%) and in the summer season (34%) (**Chart 5 & 6**). It was also higher among unmarried women (87%) (**Table 2, Chart 5**).

Table 1 : Year wise distribution of cases

Age(yrs)	2005	2006	2007	2008	2009	2010	2011	Total
≤12	6	3	2	6	1	1	7	26 (18)
13-20	5	3	9	9	5	12	24	67 (47)
21-30	2	3	3	5	4	13	8	38 (26.4)
31-40	-	2	2	1	1	3	1	10 (6.9)
41-50	-	-	-	1	-	-	-	1 (0.6)
51 ≤	-	-	-	-	1	-	1	2 (1)
Total	13(9.1)	11(7.6)	16(11.1)	22(15.3)	12(8.3)	29(20.1)	41(28.5)	144(100)



In all the cases, the sexual assault took place in lying down position (97%) and in knee and elbow position (3%) (**Table 3**). The accused was known to the victim in most of the cases (83%) (**Table 4**). It was found that the victims were mostly calm during the process of examination (85%) (**Table 5**), external injuries (11.8%) (**Table 6**) and local injuries were not commonly present on the victims (33.3%) (**Table 7**). The examinations showed that old hymeneal tear (51.4%) in the 5 and 7^o o'clock position (18%) were the most common finding.

Table 2: Marital status.

Status	Number
Married	19 (13%)
unmarried	125 (87%)
Total	144 (100%)

Table 3: Position at material moment.

Position	Number
Lying	140 (97%)
Knee elbow	4 (3%)
Total	144 (100%)

Table 4: Relation with Accused

Relation	Number
known	120 (83%)
Acquainted	9 (6%)
Strangers	11 (8%)
Relatives	4 (3%)
Total	144 (100%)

Table 5: Mental status of victim

Mental status	Number
Calm	123 (85%)
Excited/Agitated	1 (0.8%)
Depressed	19 (13.4%)
Abnormal	1 (0.8%)
Total	144 (100%)

Table 6 : External Injuries

External Injuries		Numbers
Present	Abrasion	8 (5.6%)
	Bruise	8 (5.6%)
	Laceration	1 (0.6%)
Absent		127 (88.2%)
Total		144 (100%)

Table 7: Local Injuries

Local Injuries	Numbers
Post Commissure	11 (7.6%)
Fourchettes	6 (4.2%)
Labia Minora	25 (17.4%)
Labia Majora	3 (2.1%)
Anal	3 (2.1%)
Absent	96 (66.6%)
Total	144(100%)

Discussion:

Altogether, 144 cases of sexual assault victims were brought for medico-legal examination during the period of study. Rape is the least reported case in the violent crimes. This is so even in developed countries like United States. It is estimated that only 10-50 % of rapes were reported to the police.⁵ The rape cases in Manipur have shown an increasing trend in the recent years with maximum case being reported in 2011. This is mainly due to the increasing awareness in the general population leading to more case being reported (**Table 1**). No age is safe in respect to this offence.⁶ True to this statement, in our study, victims as young as 3 years and as old as 67 years were also observed. Meitei were the most commonly effected caste (77%) and Hindu religion being followed by most Meitei was the most commonly reported religion (81%).

Table 8: Hymenal tear

Hymen	Single tear					Double tear							Triple tear					Total	
Position (O'Clock)	2	3	5	6	7	3, 5	3, 7	3, 8	4, 7	5, 7	5, 9	7, 9	2, 6, 9	2, 3, 8	3, 6, 9	3, 7, 11	5, 6, 9		
Old tear	1	3	4	1	11	-	8	3	2	20	1	5	-	-	15	-	-	74 (51.4%)	
Fresh tear		2	8	5	3	3	-	-	-	9	-	-	3	1	3	1	2	40 (27.8%)	
Intact																		30 (20.8%)	
															Total	=	144(100%)		

The reason is that Meiti are the most common population living in and around Imphal and very few cases from the other districts get reported here due to the distance and lack of proper transportation. According to the census report of 2011, scheduled tribes constitute only 4.8 % and 6.3 % of the population living in Imphal East and Imphal West, respectively,⁷ this is another reason for minimum case of tribal victims. Other workers found similar finding.^{8,9}

Students were the most commonly affected victims (51%). They become an easy victim because in their quest for education, they have to go to different places like private coaching, school, college etc. in odd times, and this exposes them to more risk than others. Most of the incident took place in the residence of the accused. This is so because his residence becomes the most suitable place for him as he can take full advantage of the victim in his own place and there is less risk of getting caught.

The highest number of incidents took place during the summer season (34%). In Manipur most of the festivals are celebrated in this season, and also there is summer vacation for the students which increases the chance of more interaction, enjoyment and celebration, which many a times leads to untoward incident and crime like rape. In the afternoon, most of the guardians are out in office or for business and the children are mostly left alone at this period, this might be the reason for maximum case found in this time of the day in our study.

The most persistent finding, also observed in other studies⁸⁻¹⁰ is that, most of the accused were known to the victim. This accounted for 83% of the total cases, whereas a stranger was responsible in only 3% cases. The accused has to plan before carrying out his act and being a familiar face, gives him the advantage over the victim.

External injuries, which indicate the sign of struggle, usually were absent in most of the cases (88.2%), and likewise, local injuries were not seen in most cases too (66.6%)

Conclusion:

Rape continues to be one of the most common and serious offence against women. The increasing rate of rape is to be noted

seriously. The typical prototype injuries might not be seen in most cases. Corroborative history with proper physical examination is the only way to accurately diagnose a case of rape. The society, in general, the law enforcement agencies, in particular, should work together and with the proper precautions by the vulnerable age groups, (young females) while moving out in isolated places and also not to hook by drugs from the acquaintances or friends will only curb this serious crime.

Conflict of interest: None

Financial Assistance: None

References:

1. Nadison K. In: Jason PJ, Roger WB, Tracy SC, Carol H, Editors. Encyclopaedia of forensic and legal medicine. Oxford (UK): Elsevier Ltd; 2005. pp.91
2. Available at: <https://timesofindia.indiatimes.com/india/Rape-fastest-growing-crime-in-the-country/articleshow/17774115.cms>. Accessed on 14th April 2017.
3. Available at: [https://en.wikipedia.org/wiki/Criminal_Law_\(Amendment\)_Act,_2013](https://en.wikipedia.org/wiki/Criminal_Law_(Amendment)_Act,_2013). Accessed on 14th April 2017.
4. Robert RH, Ann WB. Practical aspect of rape investigation, a multidisciplinary approach. 3rd Ed. USA: CRC press; 2005. pp.5
5. Denny and Quadago. Human sexuality. 2nd Ed. St Louis: Mosby Year Book Inc; 1992. pp: 597
6. Mukherjee J.B. Forensic medicine and toxicology, Vol 2, 2nd Ed. India: Arnold associates; 2000. pp: 41.
7. Census 2011, Department of statistic, Government of Manipur. Available at: <https://data.gov.in/catalog/villagetown-wise-primary-census-abstract-20>. Accessed on 14th April 2017.
8. Bijoy Th, Momochand A, Fimate L. Changing pattern of of rape in Manipur. J Indian Acad For Med 2000-1;23(1-6):49-51.
9. Fimate L and Meera Th. Rape in Manipur. Int J Med Tox Leg Med 1998;1(1):49-53.
10. Bijoy Th, Lepcha OT, PradipKh. A study of child rape in Manipur. J Indian Acad For Med 2006;28(4):971-73.

Original Research Paper

Post Mortem Cooling Pattern In South India – A Basic Approach

¹Jaffar Hussain AP, ²Srijith, ³Abhijit Subhedar, ⁴Sujan Kumar Mohanty, ⁵Virendra Kumar

Abstract:

Remarkable physical change occurring in a corpse is directly related to the temperature gradient between the body and the surrounding environment. An attempt has been made by the authors to study the basic cooling pattern of human corpse during winter season (Oct 2013 to Jan 2014) of a tropical country like India. The present study includes the effect of various extrinsic and intrinsic factors on the rate of cooling and making derivative conclusions there upon.

The process of cooling was retarded in earlier stages, signifying the occurrence of temperature plateau, followed by a pattern explained by double exponential sigmoid curve. The initial rate of cooling in most of the cases was 0.5°C/hour, rising to 1°C/hour during the period of maximum cooling. The average rate of cooling/hour was estimated as 0.5°C. It has been observed that age groups & sex of the studied corpses have no influence upon the rate of cooling. The intrinsic factors like size of the body, body fats, etc. influenced the rate of cooling such that it was more in thin built subjects, average in moderately built ones and less in obese persons.

The original body temperature at the time of death decides the rate of cooling/hour in all cases.

Key Words: Core Temperature, Temperature plateau, Conduction, Convection, Radiation

Introduction:

One of the remarkable physical change that may occur in a corpse would be the heat exchange from the body to the surrounding environment, provided there might have been temperature gradient existed between the body and the environment.

The cooling of the body after death is a complex process, which does not occur at the same rate throughout the body.¹ Cooling occurs from the surface of the body to the surroundings, due to temperature difference between the body and surroundings. Core temperature is the temperature of the viscera which is higher than the surface temperature.² During life, heat is constantly transferred from one body part to other by conduction as well as convection. After death, this occurs only through conduction. Basically there are four types of heat exchange mechanisms through which heat will be lost from the body namely conduction, convection, radiation and evaporation.² Heat loss from the body parts which are in direct contact with the supporting surface occurs through conduction, whereas the body parts which are not in direct contact with the surface lose heat through convection.² Radiation is the physical process through which all bodies radiate heat. Radiation is fastest during the initial few hours, when the body is hot after death, then after body loses heat mainly by conduction. Only a small

Corresponding Author:

¹Assistant Professor

²Assistant Professor,

⁴Associate Professor,

⁵Prof. & Head,

Dept.of Forensic Medicine & Toxicology,
Meenakshi Medical College, Hospital & Research
Institute, Kanchipuram

³Professor,

Dept.of Forensic Medicine & Toxicology,
Osmania Medical College, Hyderabad

E Mail ID: jaffarhussainattarpoola@yahoo.in.

L. M. No: JIAFM/1294

DOR: 20/04/2017 DOA: 17/03/2018

DOI: 10.5958/0974-0848.2018.00012.X

fraction of heat is lost by evaporation of fluids from the body, the effect of which is incalculable. A temperature gradient is formed soon after death between the surface to the core of the body with core being warmer.³ The factors that can influence cooling pattern include ambient temperature, wind and draughts, rain, humidity and snow, body posture, body size, original body temperature, clothing, covering etc .

Aims & Objectives:

1. To study the basic cooling pattern of a human corpse, in tropical countries like India, with particular reference to the South India.
2. To study the effects of various extrinsic and intrinsic factors on the cooling pattern of a human corpse.

Materials and Methodology:

A total of 100 cases were taken to study the basic cooling pattern of the human corpse after death. All these cases were collected from the Acute Medical Care (AMC) ward of the Osmania General Hospital, Hyderabad, who were admitted and underwent treatment as MLC cases and sent to the mortuary for autopsy. This study was conducted during winter season October 2013 to January 2014. The authors personally attended the AMC ward and recorded the temperature of the AMC ward and rectal temperatures of the corpses, at the moment of death, before declaring of death by the duty doctor to the patient's attendants. From then the monitoring of the corpse was supervised by the investigators in the process of shifting from the ward to the mortuary, in order to avoid much delay in shifting the corpse by the ward attendants so that corpse may not be laid in two different room temperatures (i.e. ward and mortuary).

After admission to the mortuary, the bodies were stripped naked, placed over the mortuary table in prone position with both upper limbs lying side by the body. Thermometer (chemical), graduated from 0° to 50° C was inserted into the rectum of the corpse by keeping the buttocks wide apart, such that at least 10 cms of it from its tip should be there in the rectum. (Photo 1&2)

Photo (1): Chemical Thermometer

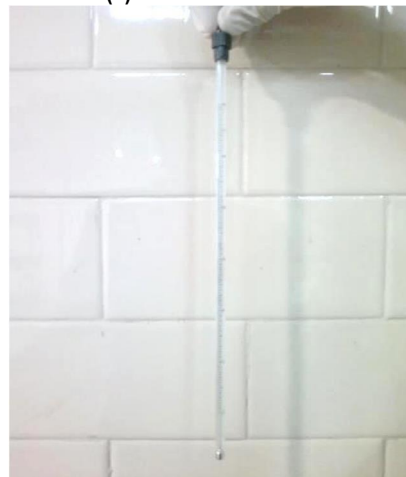


Photo (2): Recording of rectal temperature



The chemical thermometer was kept in the rectum, undisturbed, and readings were taken after 5mts interval, the time being required for its stabilization. From then serial recording of the rectal temperature readings at an hourly interval were made by the investigators without disturbing the corpse and thermometer. The initial time of recording the ambient and rectal temperatures were noted and tabulated. Likewise, serial recordings at an hourly interval of rectal and ambient temperatures were taken and tabulated.

While recording the temperature readings, the doors of the mortuary room were kept closed, in order to avoid changes in ambient temperature due to air convection currents. Exhaust fans and ceiling fans were also switched off, nearer to the corpse which affects the body temperature through radiation and convection mechanisms of heat exchange. In this way, a constant ambient temperature,

with little fluctuations was maintained throughout the process of recording.

The external factors contributing to errors in estimating the time since death like clothing, coverings (bed clothes, other fabrics) which affect the body temperature through conductive mechanism of heat exchange were removed. Readings were noted till the body attained room temperature. Informed consent was taken from the relatives for the same. Institutional Ethics Committee gave 'No Objection' certificate for the Project.

Among the 100 corpses, 50 were male and 50 female, whose age ranged from 20 -70 yrs. They were divided into thin, average, fatty built subjects, based on their body size. **Table (1) & (2)** The cause of death varied from road traffic accidents (RTA) . (60), burns (10), asphyxial deaths (10), poisoning (10) and natural deaths (10). **Fig (1)**

Table 1: Body Size among different Age groups (male)

Age groups in yrs.	Thin	Moderate	Thick	Total (n=50)
20-29	3	3	4	10
30-39	4	3	3	10
40-49	5	3	2	10
50-59	5	4	1	10
60-69	6	2	2	10
Total	23 (46%)	15 (30%)	12 (24%)	50 (100%)

Table 2: Body Size among different Age groups (female)

Age groups in yrs.	Thin	Moderate	Thick	Total (n=50)
20-29	5	4	1	10
30-39	2	5	3	10
40-49	2	4	4	10
50-59	1	3	6	10
60-69	4	4	2	10
Total	14 (28%)	20 (40%)	16 (32%)	50 (100%)

Observations:

In total, 100 cases were studied, of which 50 were male. The cause of death varied from RTA (60), Burns (10), Asphyxial deaths (10), Poisoning (10) and Natural Deaths (10). It was observed that the rate of cooling per hour varied from 0.3 . 0.6° C, the average being 0.5°C, and the time taken to reach the ambient temperature differed from body to body based upon their body size, being 18-22 hrs for thin built subjects, 22-24 hrs for average built and 24-26 hrs for obese and fatty built subjects. **(Fig 7)**

1. There was no effect of age and sex over the rate of cooling of the body in the present study. **(Fig 2 & 3)**
2. Rate of cooling was more in bodies, where the original body temperature at the time of death was high. **(Fig 4)**
3. Rate of cooling was more in thin built subjects, average in moderately built one and less in obese persons. **(Fig 5)**
4. Rate of cooling/hour was more in RTA & asphyxial deaths, moderate in poisoning and burn cases and less in natural death. **(Fig 6)**

Fig 1: Per Cent wise distribution of cases according to the cause of death

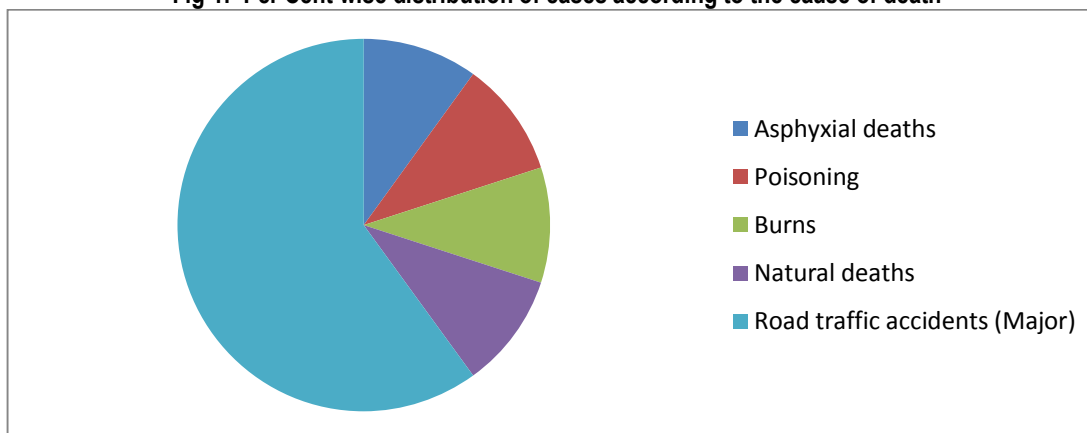


Fig 2:: Cooling Rate per hour in different Age groups (male) according to their body size

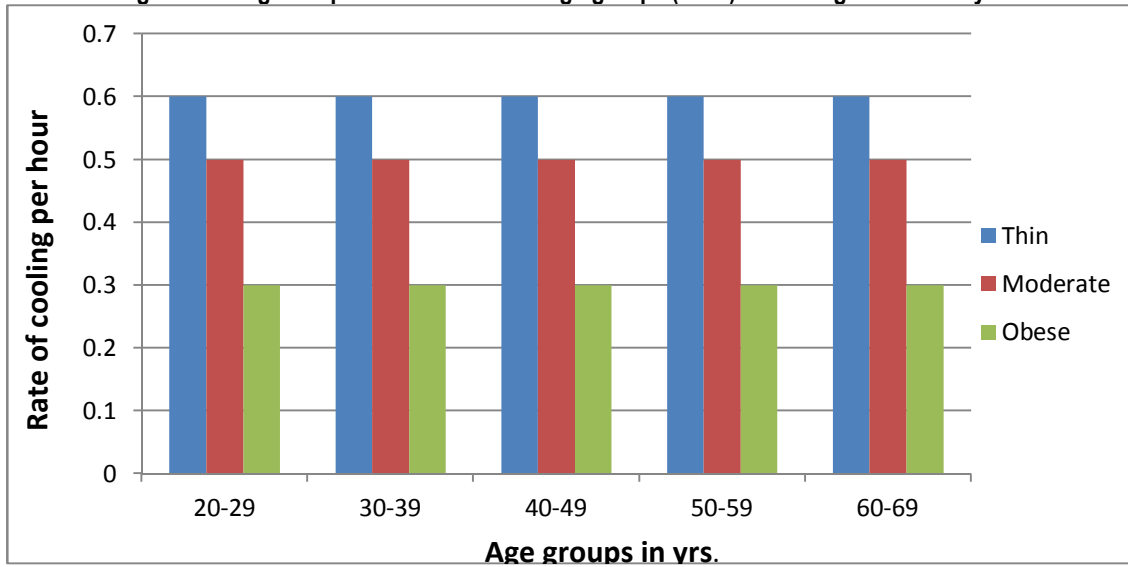


Fig 4: Cooling Rate per hour in different age groups (female) according to their body size

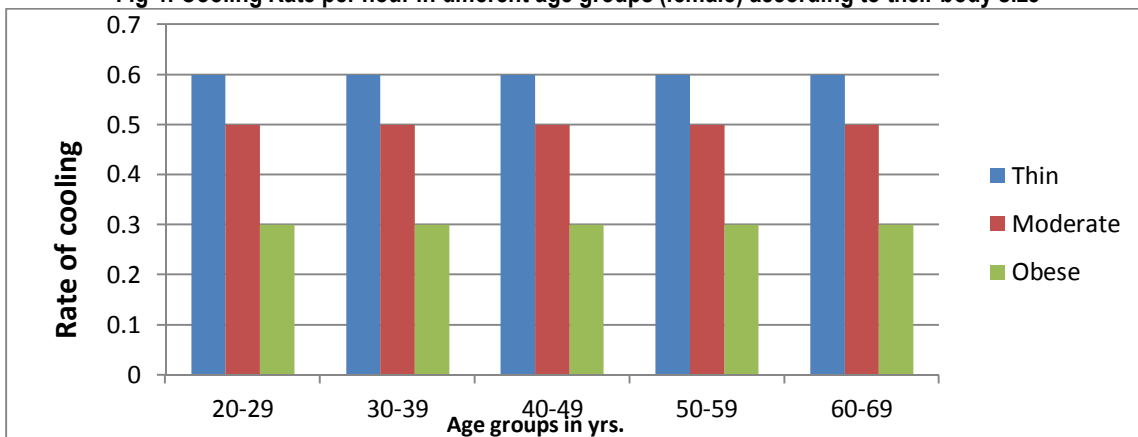


Fig 4a: Effect of original body temperature on the Rate of cooling

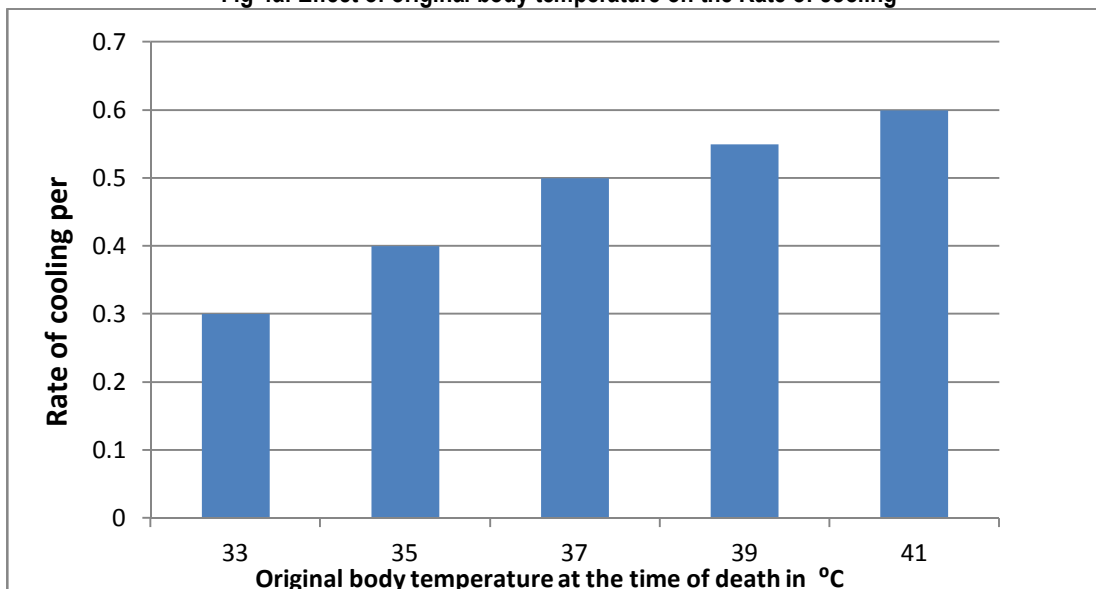


Fig 5: Effect of body size on the Rate of cooling

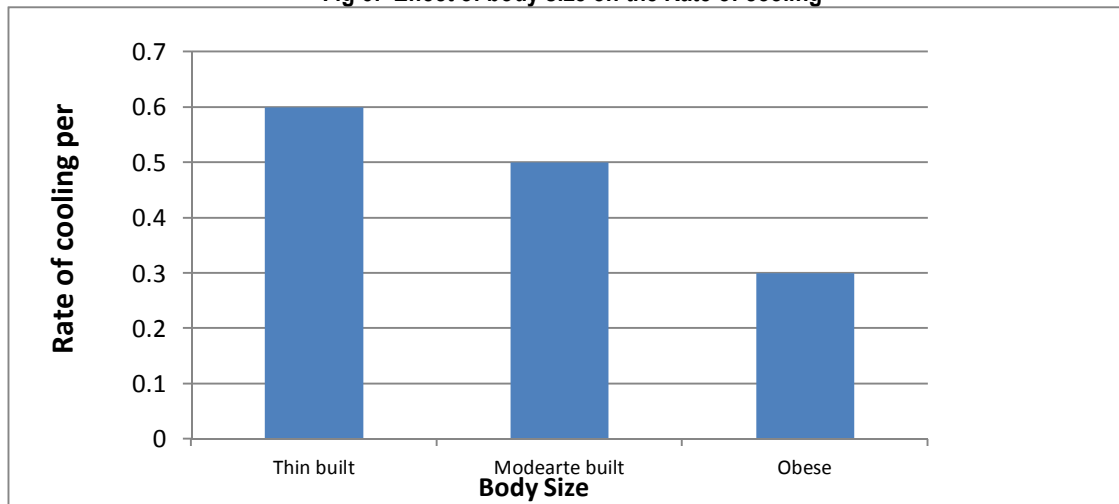


Fig 6: Effect of cause of death on the Rate of cooling

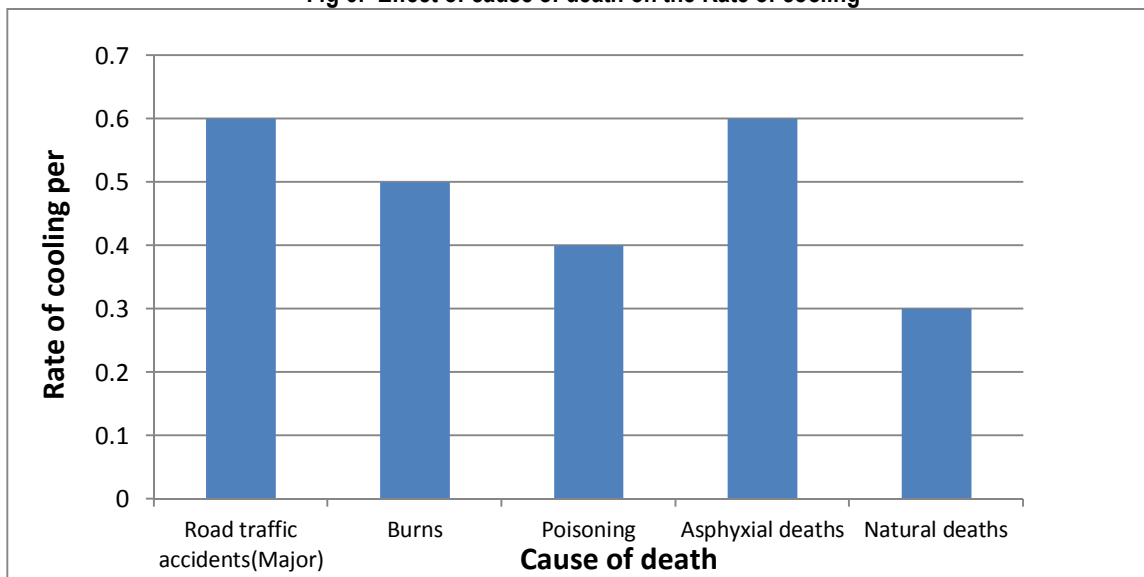
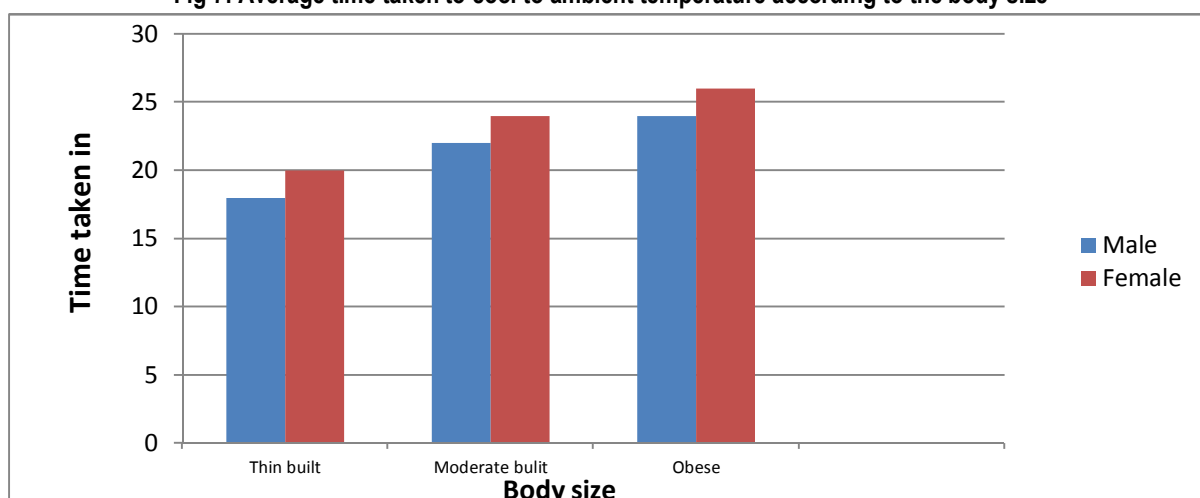


Fig 7: Average time taken to cool to ambient temperature according to the body size

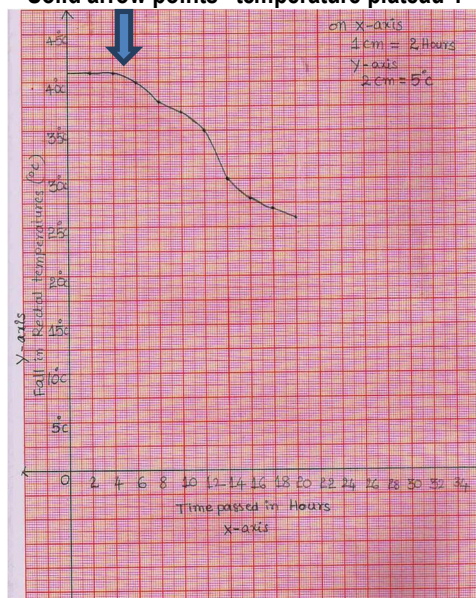


Discussion:

To study the basic cooling pattern of the human corpse, serial recordings of the rectal temperature is required. Rectal temperature represents the core temperature of the visceral organs, and is ideal for studying the cooling pattern. The process of cooling was retarded in all cases for 2 hours in earlier stages of cooling, signifying the occurrence of lag period known as temperature plateau.^{3,4}

The phenomenon of temperature plateau was explained on the basis of continuation of cellular metabolism after death, resulting in heat production for short period.^{3,4} From then on, body was cooling in a manner adequately explained by double exponential sigmoid curve.⁵ (Photo 3)

Photo (3): Cooling curve of the human body
Solid arrow points "temperature plateau".



The rate of cooling initially was 0.5°C , which reached to 1°C during the period of maximum cooling. The lowest rate of cooling was noted in bodies where the cause of death was given as natural (0.3°C); and highest in bodies where the cause of death was given as Asphyxia & RTA (0.6°C). The rate of cooling in all observed cases was 0.3°C - 0.6°C , the average rate of fall in temperature to be 0.5°C .

The factors that can introduce errors in to the calculations include ambient temperature, wind and draughts, rain, humidity and snow, body posture, body size, body fat, original body temperature, clothing, covering etc.^{6,7}

When the environmental temperature is low, as in winter, heat loss is faster & more; where as in summer, environmental temperature is even higher than that of the body, consequently heat loss from the body is almost negligible. Rate of heat loss is directly proportional to the surface area/body weight ratio.⁸ Individuals with lean body physique will cool rapidly than fatty ones.⁸ Environment influences cooling such that, bodies lying in well ventilated room will cool faster than those lying in a closed room. Age and sex of the studied groups did not affect the process of cooling. The cause of death exerts a significant influence upon the rate of cooling as rate of cooling/hour was more in RTA and asphyxia. Similarly, the original body temperature at the moment of death plays a pivotal role in the process of cooling; denoting rate of cooling per hour is more in bodies having high body temperature at the moment of death.

Conclusion:

- The initial rate of cooling was 0.5°C / hour and reached 1°C /hour during the period of maximum cooling.
- The rate of cooling varied from 0.3 - 0.6°C / hr, the average being 0.5°C / hr.
- With such a small rate of fall in temperature, it is not advisable to estimate the time since death, based on the cooling process of the body.⁸⁻¹⁰
- The average rate of fall in temperature obtained in present study was during winter season, hence the applicability of this data to the temperature based . time estimation methods is restricted to winter season only.^{9,10}
- The average time taken to reach the ambient temperature varied from 18-24 hrs, being 18-20 hrs for thin built subjects, 20-22 hrs for moderately built and 22-24 hrs for obese subjects.

Conflict of interest: None

Financial Assistance: None

References:

1. KS Narayan Reddy . The essentials of forensic medicine and toxicology. 31st Ed. Suguna Devi K, Hyderabad. pp141-2
2. Anil Aggrawal - Essentials of Forensic Medicine and Toxicology. 1st ed. Avichal Publishing Company, Delhi. 118: 1-6.
3. Nokes L, Hicks B, Knight B. The postmortem temperature plateau . fact or fiction. Med. Sci. Law 1985; 25: 263-4.
4. Available from: <http://heinonline.org/HOL/LandingPage?handle=hein.journals/mdsciw25&div=55&id=&page=> Accessed on: 2nd Feb 2017
5. Hutchins G. Body Temperature is elevated in the early post mortem period. Hum. Pathol. 1985;16:560 -1.
6. Available from: <https://www.sciencedirect.com/science/article/pii/S0046817785801040>. Accessed on: 2nd Feb 2017
7. Marshall T, Hoare F. Estimating the time of death - the rectal cooling after death and its mathematical representation./ Forensic Sci. 1962; 7: 56-81.
8. Available from: <https://ci.nii.ac.jp/naid/10024171927>. Accessed on: 2nd Feb 2017.
9. James W, Knight B. Errors in estimating time since death. Med. Sci Law 1965;5:111-16. Available from: <http://journals.sagepub.com/doi/abs/10.1177/002580246500500210?journalCode=msla>. Accessed on: 2nd Feb 2017.
10. Joseph A. Schiekele A. A General method for assessing factors controlling post mortem cooling. J Forensic Sci 1970: 15: 364 - 91.
11. Available from: <https://ci.nii.ac.jp/naid/10007369876/>. Accessed on: 2nd Feb 2017.
12. Knight B. The evolution of methods for estimating the time of death from body temperature. Forensic Sci. Int. 1988; 36: 47-55.
13. Available from: <https://secure.jbs.elsevierhealth.com/> /. Accessed on: 2nd Feb 2017.
14. Lyle H, Cleveland F. Determination of the time since death by heat loss. J. Forensic Sci. 1956, 1: 11-24.
15. Available from: <https://ci.nii.ac.jp/naid/10024171932/>. Accessed on: 2nd Feb 2017.
16. Lundquist F. Physical and chemical methods for the estimation of the time of death. Acta Med. Leg Soc 1956: 9: 205-13.
17. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/13434819>. Accessed on: 2nd Feb 2017.

Original Research Paper

Estimation of Stature from the Length of the Sternum: An Autopsy Based Study

¹Sri Jith, ²Jaffar Hussain AP, ³Virendra Kumar, ⁴Santhosh Chandrappa Siddapa, ⁵Sujan Kumar Mohanty

Abstract:

Introduction: Stature is an important parameter that aids in establishing the identity of an individual from skeletal remains. The aim of the present study was to derive a linear regression formula for estimating stature from the length of the sternum.

Materials & Methodology: The material for the present study consisted of 120 intact sterna, 65 male and 55 female, between 25 years and 60 years of age, obtained during medico legal autopsies.

Results: A linear regression formula for both sexes was derived, Stature = 117.091 + (3.41 x sternal length) for males and Stature = 115.059 + (3.27 x sternal length) for females. Standard error of estimate was 5.97cm in males and 5.26cm in females.

Conclusion: The study concluded that the length of the sternum is a reliable predictor of stature and can be used as a tool for estimation of stature when better predictors of stature are not available.

Key Words: Correlation Coefficient, Identification, Regression Equation, Stature, Sternum

Introduction:

Estimation of stature from skeletal remains is one of the prime tasks of a forensic medicine expert.¹ In cases of mass disaster, such as armed conflicts, terrorist massacres, air plane crashes, war related crimes, natural disasters, explosions, etc., when mutilated or damaged human remains consisting of only a few bones or their fragments are recovered from the site, it becomes crucial to establish the identity, particularly the stature of the missing individual.²

Such estimations are usually based on the relation between skeletal elements and stature. It is a well-known fact from many studies³⁻¹⁰ that stature bears a direct relation to the length of various body parts and bones, especially long bones, and linear regression formulas are derived to estimate the stature from the length of the bone.

However certain stature specific bones such as long bones may not be always found in every scene and in such situations, forensic experts may need to depend on bones such as sternum. The sternum has gained considerable attention with relation to sex determination,¹¹⁻²⁶ but not many studies have been conducted with respect to stature estimation. The present study was undertaken to study the correlation between stature and the length of the sternum and to make an attempt to derive a regression formula for both the male and female sexes. Studies done by other authors have either confined themselves to stature estimation in one sex, either male or female. But only a few studies such as the present one have taken both the sexes into consideration and have derived a regression equation for either sex.

Corresponding Author:

¹Assistant Professor,

²Assistant Professor,

³Professor & Head,

⁵Associate Professor,

Dept of Forensic Medicine & Toxicology,
Meenakshi Academy of Higher Education &
Research, Kanchipuram, Tamil Nadu

⁴Professor & Head,
Dept of Forensic Medicine & Toxicology,
JMM Medical College, Davangere, Karnataka

E Mail ID: srijithfun@gmail.com.

L. M. No: Not a Member.

DOR: 12/06/2017 DOA: 17/03/2018

DOI: 10.5958/0974-0848.2018.00013.1

Materials and Methodology:

Ethical approval for the study was taken from the Institutional Ethics Committee. Informed Consent was taken from the relatives of the deceased for the study.

The study was conducted on 120 intact sterna (65 males & 55 females) aged >25 years and <60 years obtained during medico-legal autopsies. It has been stated by Krogman & Iscan¹ that the bone lengthening process stops between 16 to 25 years because of epiphyseal closure, so cadavers under the age of 25 years were excluded. Fractured sternum, bodies with deformities of chest wall like pectus carinatum and pectus excavatum, observable deformities over the sternum, both congenital and acquired were excluded from the study.

The length of the cadaver or stature was measured in centimetres, using a measuring tape, from the vertex of the cranium to the base of the heel with the body being placed in a supine position on the autopsy table.

After making a standard linear midline incision, the clavicles were disarticulated at the sternoclavicular joint and the sternal margins that articulate with the first seven pairs of ribs were carefully cut at the costosternal junction. After removing the sternum from the thoracic cage, the sternum was washed, soft tissue scraped, allowed to macerate by immersing in a bucket filled with soap water for two weeks. On the third week, the sternum was placed in a bucket filled with plain water. After a total duration of three weeks the sternum were cleaned and dried at room temperature. While cleaning, repeated careful inspection was done to avoid separation of the three segments of the sternum. The following parameters were measured by using the Vernier Calipers in the following manner:

Manubrial Length: Length of manubrium measured from the suprasternal notch to the manubrium-mesosternum junction;

Mesosternal Length: Length of mesosternum measured from manubrium-mesosternum junction to mesosternum-xiphoid process junction;

Combined Length: Manubrial length + Mesosternal length

The xiphoid process was not taken into consideration in the present metric study because of high variability of its length.²⁷ Three readings each, were taken and the averages of the results were recorded in millimeters (mm). All measurements were taken keeping the bone on a flat surface in anatomical positions. The data was entered in a prestructured proforma.

The data was analyzed using SPSS version 20.0 to derive a linear regression equation for estimation of stature. Pearson's correlation coefficient was calculated to assess the correlation between stature and length of the sternum and Student t test was applied to test the significance. P value less than 0.05 was considered significant.

Results:

The stature of the male and female cadavers ranged from 150cm -182cm and 145cm -169cm, respectively.

The length of the manubrium (M1) of the male and female sterna ranged from 46mm - 54mm and 41mm - 48mm, respectively.

The length of the mesosternum (M2) of the male and female sterna ranged from 84mm - 107mm and 64mm - 94mm, respectively.

The combined lengths (M1+M2) of the male and female sterna ranged from 133mm-158mm and 105mm-145mm, respectively.

The mean length of the sterna formed 8.9% and 7.9% of the mean stature of the cadavers in males and females, respectively.

The mean values of each of the parameters along with the Standard deviation and correlation coefficient so derived, are depicted in **Table 1**.

Table 1: Statistically derived results

	Males (n=65)	CC	Females (n=55)	CC	P factor
Cadaveric stature	167.9+/-5.86	1.0	156.8+/-5.21	1.0	<0.001
M1(mm)	50.43+/-2.03	0.581	44.29+/-2.20	0.61	<0.001
M2(mm)	99.27+/-6.42	0.540	80.92+/-8.75	0.497	<0.001
M1+M2(mm)	149.7+/-8.05	0.629	125.21+/-10.74	0.598	<0.001

CC: Correlation coefficient

The derived linear regression equation for males, $Y=117.091+ (3.41 \times \text{sternal length})$, and the standard error of estimate was 5.97cms; and for females, $Y=115.059+ (3.27 \times \text{sternal length})$ and the standard error of estimate was 5.26cms. The results derived from the present study were statistically significant ($P<0.001$)

Discussion:

Researchers have continuously made an attempt to study the sternum and other long bones to estimate stature. Efforts have been made from the different elements of human skeleton since the 19th century when Pearson¹ first derived regression equations for stature estimation. All the researchers have reached a common conclusion that stature can be estimated with great accuracy even from the smallest bone, although they have encountered a small error of estimate in their studies.

In the present study, we assessed the correlation between the length of the sternum and stature in Central Karnataka population and thus derived a linear regression equation for the estimation of stature.

The mean stature in the present study was 167.9+/-5.86 in male and 156.8+/-5.21 in female cadavers, respectively. Menezes RG, et al,²⁸⁻²⁹ Nagesh & Kumar,³ Rastogi, et al,⁴ Yonguc, et al,³⁰ observed mean statures in the same range in their studies among both sexes. Nachiket, et al⁵ and Mohanty, et al⁶ confined their studies to the female population and the statures of these studies are tabulate in **Table 2**.

Table 2: Mean cadaveric stature in different studies

MEAN STATURE(+/-SD)		
Studies	Male	Female
Present study	167.9+/-5.86	156.8+/-5.21
Menezes RG et al ²⁸⁻²⁹	166.47+/-7.22	155.88+/-5.27
Nagesh&Kumar ³	166.01+/-6.90	153.51+/-5.83
Rastogi et al ⁴	171.95+/-7.05	158.57+/-5.10
Yonguc et al ³⁰	173.1+/-6.3	160.2+/-6.7
Rao et al ⁷	166.83+/-6.73	
Nachiket et al ⁵		156.7+/-6.24
Mohanty et al ⁶		156.88+/-5.83

The mean sternal length in the present study was found to be 149.7+/-8.05 and 125.21+/-10.74 in male and female sterna, respectively. The mean sternal length (M1+M2) derived studies have been compared in **Table3**.

Table 3: Mean sternal lengths in different studies

MEAN STERNAL LENGTH(M1+M2)		
Studies	Male(+/-SD)	Female(+/-SD)
Present study	149.7+/-8.05	125.21+/-10.74
Menezes RG et al ²⁸⁻²⁹	142.0+/-13.4	141.2+/-10.7
Yonguc et al ³⁰	167.3+/-12.2	144.9+/-11.0
Tumram et al ³¹	145.9+/-10.0	

The correlation coefficient of sternal length in the present study was 0.629 in males and 0.598 in females. Menezes RG, et al²⁸⁻²⁹ and Yonguc, et al³⁰ reported a correlation coefficient in the same range among both sexes. Manoharan, et al,³² Tumram, et al³¹ and Singh J, et al³³ confined their studies to the male population and reported a low correlation coefficients. Peiru & Zhiyuan³⁴ also studied the male population and derived a high correlation coefficient. (**Table 4**)

Table 4: Correlation coefficient of sternal length in different studies

CORRELATION COEFFICIENT OF STERNAL LENGTH		
Studies	Male	Female
Present study	0.629	0.598
Menezes RG et al ²⁸⁻²⁹	0.638	0.639
Yonguc et al ³⁰	0.673	0.662
Manoharan et al ³²	0.15	
Tumram et al ³¹	0.55	
Singh J et al ³³	0.318	
Peiru&Zhiyuan ³⁴	0.715	

Standard error of estimate in the present study was found to be 5.97cms and 5.26cms in males and females, respectively. Menezes, et al²⁸⁻²⁹ reported a standard error of estimate of 5.64cms and 4.11cms in males and females.

The regression equation derived for the present study was $Y=117.091+ (3.41 \times \text{sternal length})$ and $Y=115.059+ (3.27 \times \text{sternal length})$ in males and females, respectively. Regression equations derived from other studies are tabulated (**Table 5**)

REGRESSION EQUATION		
Studies	Male	Female
Present study	$117.091+(3.41 \times \text{sternal length})$	$115.059+(3.27 \times \text{sternal length})$
Menezes RG et al ²⁸⁻²⁹	$117.784+(3.42 \times \text{sternal length})$	$111.599+(3.31 \times \text{sternal length})$
Manoharan et al ³²	$117.3+(5.1 \times \text{sternal length})$	
BijoySingh & Momochand ⁵	$140.6+(2.34 \times \text{sternal length})$	
Tumram et al ³¹	$90.65+(4.8 \times \text{sternal length})$	

Conclusion:

Identification refers to establishing the identity of an individual. Identification of an individual whether living or dead is one of the most crucial tasks in medico-legal practice. Forensic investigators have an uphill task to analyse whatever skeletal remains are found and draw inferences about their identity considering all the tools of identification such as species, race, sex, age and stature of an individual.

The present study concludes that the length of the sternum is a reliable predictor of stature when long bones are not available in skeletal remains. The study confines itself to Central Karnataka population only and since there are usually high biological and inter regional variations as far as determination of individuality of a person is concerned, the authors recommend that more such studies need to be conducted on both sexes in other population groups thus deriving regression equations for the same.

Conflict of Interest: None.

Financial Assistance: None.

References:

- Krogman W, Scan M. Human skeleton in forensic medicine 2nd Ed. Springfield.1986
- Aggarwal A. Text book of Forensic Medicine and Toxicology.1st ed.Avichal Publishing Company;2014
- Nagesh KR, Kumar GP. Estimation of stature from vertebral column length in South Indians. Leg Med (Tokyo) 2006;8:269-272
- Rastogi P, Nagesh KR, Yoganarasimha K. Estimation of stature from hand dimensions of North and South Indians. Leg Med (Tokyo) 2008;10:185-189.
- Nachiket S, Sujatha N, Priya R, Raveendranath V, Rema D, Roopa R. Reliability of inter-anterior superior iliac spinous distance as compared to foot length for stature estimation in South Indians. J Forensic Leg Med 2010;17:352-354.
- Mohanty SP, Babu SS, Nair NS. The use of arm span as a predictor of height:a study of South Indian women. J Orthop Surg (Hong Kong) 2001;9:19-23.
- Rao PPJ, Sowmya J, Yoganarasimha K, Menezes RG, Kanchan T, Aswinidutt R. Estimation of stature from cranial sutures in a South Indian male population. Int J Legal Med 2009;123:271. 276
- Krishan K, Sharma A. Estimation of stature from dimensions of hands and feet in a North Indian population. J Forensic Leg Med 2007;14:327-332.
- Agnihotri AK, Purwar B, Googoolye K, Agnihotri S, Jeebun N. Estimation of stature by foot length. J Forensic Leg Med 2007;14:279-283.
- Chandran M, Kumar V. Reconstruction of femur length from its fragments in South Indian Males. J Forensic Leg Med 2012;19:132-136
- Dwight T. The sternum as an index of sex, height and age. Journal of Anatomy. 1890;24:527-535
- Wenzel J. A comparison of human and anthropoid mesosterna. Am J Phys Anthropol. 1956;14:449-463
- Ashley GT. Observation on the human sternum (abstract). Journal of Anatomy. 1951;85:412
- Ashley GT. The human sternum: The influence of sex and age on its measurements. J Forensic Medicine. 1956;3(1):p27-43
- Dahiphale VP, Baheete BH, Kamkhedkar SG. Sexing the human sternum in Marthwada region. J Anat Soc India. 2002;51(2):162-167
- Gautam RS, Shah GV, Jadav HR, Gohil BJ. The Human sternum-as an index of age and sex. J Anat Soc India. 2003;52(1):20-23
- Robert Selthofer, Vasilijie Nikolic, Tomislav Mrcela, Radivoje Radic, Igor Leksan, Igor Rudez and Kristina Selthofer. Coll Antropol. 2006(1):43-47
- Gharahdaghi J, Kiyani M, Khazali P, Sadesgh Ghoreyshi SM. A survey on the relation between sternum dimension and sex, age and body length in Iranian population. Scientific Journal of Forensic Medicine. Spring 2006;12(1);p35-39
- Hunnargi SA, Menezes RG, Kanchan T, Lobo SW, Binu VS, Uysal S, et al. Sexual dimorphism of the human sternum in a Maharastrian population: a morphometric analysis. Journal of Anatomical Society of India. 2007;10(1):6-10
- Atal DK, Murari A, Rani Y, Naik SK. Gender differentiation from sternum-a postmortem metric

- study.Int J Med Toxicol Leg Medicine.2008;11:53-58
21. Mukhopadhyay PP.Determination of sex from adult sternum by discriminant function analysis on autopsy sample of Indian Bengali population.J Indian Acad Forensic Med.2010;32(4):321-24
 22. Anupam Mahajan,Arvinder Pal Singh Batra,Baljit Singh Khurana,Sita Rani Sharma.Sex determination of Human sterna in North Indians.J Punjab Acad Forensic Med and Toxicology.2009;9(1):12-15
 23. Osunwoke EA,Gwunireama IU,Orish CN,Ordu KS,Ebowe I.A.Study of sexual dimorphism of the human sternum in the southern Nigerian population.J.Appl.Biosci.2010:1636-39
 24. Jagmahender S, Dalbir S, Pathak R. Gender determination from sternal measurements in Northwest Indian subjects. Journal indo-pacific academy of forensic odontology.2010;1:20-29
 25. Macaluso PJ.The efficacy of sternal measurements for sex estimation in South African blacks.Forensic Science International.2010;202(1-3):1-7
 26. Diana H.T and Silviya YN.Reliability of the sternal index as a sex indicator in medieval skeletal remains from Northeastern Bulgaria.J BioSci.Biotech.2014:149-152
 27. Snell RS. Clinical anatomy for medical students. 6th ed. Philadelphia: LippincottWilliams & Wilkins; 2000; p. 47. 48.
 28. Menezes RG, Kanchan T, Kumar GP, Rao PPJ, Lobo SW, Uysal S, et al. Stature estimation from the length of the sternum in South Indian males: a preliminary study. J Forensic Leg Med 2009;16:441-443.
 29. Menezes RG, Nagesh KR, Monteiro NP,Kumar GP, Kanchan T, et al. Estimation of stature from the length of the sternum in South Indian females.J Forensic Leg Med 2011;18:242-245.
 30. Goksin Nilufer Yonguc, Ayse Kurtulus, Onur Bayazit, Esat Adiguzel, Ilker Unal, Sumeyra Demir, Kemalettin Acar. Estimation of stature and sex from sternal lengths: An autopsy study. Anatomical science International. 2014/04; 90(2).
 31. Nilesh Keshav Tumram,Soniya Bhaurao Parchake,Rajesh Bardale,Pradeep Dixit.Estimation of height from the length of the sternum in an adult Indian population.Medicine,Science and the Law.2015:1-7
 32. Manoharan C,Rajesh R,Dhanalakshmi V.Morphometric study of human sternum to determine the stature in males-an autopsy study.Indian Journal of Forensic and Community Medicine,April-June 2015;2(2):91-94
 33. Singh J, Pathak RK and Chavali KH. Skeletal height estimation from regression analysis of sternal lengths in a Northwest Indian population of Chandigarh region: a postmortem study. Forensic Sci Int 2011; 20: 206:211-218.
 34. Peiru H and Zhiyuan Z. Estimation of stature from sternum of adults in North China. Acta Anthropol Sin1987; 02.
 35. Bijoy Singh TH, A Momochand. Determination of stature from the length of Mesosternum. J. of Indian Academy of Forensic medicine. 2002; 24 (4): 139-140.

Original Research Paper

Correlation of Sexual Dimorphism and Posterior Curve Length with the Help of Discriminant Function Analysis - An Autopsy Study in the Population of Delhi.

¹Rajendra Baraw, ²Monisha Pradhan, ³S. K. Khanna, ⁴Anuradha Singh

Abstract:

Background: Identification is the determination of the individuality of a person based on certain physical characteristics.¹ The sternum is one of the bones which has drawn considerable attention in this field, particularly in relation to sexual dimorphism and its application in estimation of stature.

Aim & Objectives: The purpose of this research was to evaluate the sexual dimorphism of sternum, based on measurement of posterior curve length, in fresh and dry sterna.

Materials & Methodology: The study was conducted in the mortuary of the Department of Forensic Medicine, Maulana Azad Medical College, New Delhi, on 100 cases (50 males; 50 females) in which medico-legal postmortem examination was done. Both wet as well as dried specimens of the sternum of the deceased aged above 18 years were examined for the study. Prior approval of the Institutional Ethics Committee was taken for the same.

Observations & Results: Posterior curve length of the sternum was found to be larger in males as compared to females, in both wet and dry sternum. Hence, by placing these values in the discriminant function analysis, sex can be estimated with an accuracy of about 91% and 87% for wet and dry sterna, respectively. However, these values were found to be more accurate in females in both wet and dry states; accuracy for sex determination with wet sternum was found out to be 88% for males and 94% for females, and 84% for males and 90% for females, with dry sternum.

Conclusion: Determination of sex by means of posterior curve length is a reliable indicator in both wet and dried state of the bone. The accuracy rate was high for females, both with the wet and dry specimens.

Key Words: Identification, Sexual Dimorphism, Posterior Curve Length

Introduction:

Identification is the determination of

the individuality of a person based on certain physical characteristics.¹ When a person is known by his name with complete address it may be known as complete identification. However, in certain circumstances, when only other details like age, sex etc. can be established, then it is known as partial identification. Question of identification in living persons arises in criminal cases such as in those accused of assault, murder, rape etc; in interchange of new-born babies in the hospital and in impersonation; and in civil cases like marriage, inheritance, insurance claims, disputed sex etc. identification plays an important role.² Determination of sex via examination of sexually dimorphic features has

Corresponding Author:

¹Assistant Professor,

⁴Postgraduate Student,
Department of Forensic Medicine & Toxicology,
Gandhi Medical College, Bhopal

²Assistant Professor,

³Director Professor & Head,
Department of Forensic Medicine & Toxicology,
Maulana Azad Medical College, New Delhi

Email: drrajendrabaraw@gmail.com.

L. M. No: LM/IAFM/1330/2017.

DOR: 02/06/2017 DOA: 17/03/2018

DOI: 10.5958/0974-0848.2018.00014.3

been focused primarily on the pelvic girdle, long bones, and the skull. A study by Krogman showed that he scored 100% accuracy using the whole percent skeleton, 95 percent on pelvis, 98 percent on pelvis and skull, 92 percent on long bones and 98 percent on long bones and pelvis.⁴ When pelvis and skull are not available for study, alternative methods of sex determination are required.

The human sternum consists of three parts, namely from above downward: the manubrium, the body, and the xiphoid process.⁶ With the introduction of discriminant function analysis in forensic osteological studies, even 100% sexing accuracy can be obtained from it.⁵ The present study was designed to identify these morphological features (predictors) and examine the sexual dimorphism of adult sternum in the population of Delhi, applying linear discriminant function analysis. The purpose of the current research was to evaluate the sexual dimorphism of sternum, based on posterior curved length. Since, this research provided results in the form of quantitative data it would aid in strengthening the reliability of sternum as a potential tool for sex determination.

Materials and Methodology:

The study was a descriptive cross-sectional study conducted on 100 cases (50 males; 50 females), above 18 years, brought for Medico-legal postmortem examination to the Department of Forensic Medicine, Maulana Azad Medical College, New Delhi, from Central Delhi. In each case selected for the study, after ruling out the exclusion criteria (fractured sternum, diseased/deformed or burnt sternum), consent was taken from the legal guardian of the dead body. Sex was noted. The thorax was opened using routine standard autopsy technique and sternum was taken out after sectioning it at the costochondral junction. The clavicles were disarticulated from the sternum at sternoclavicular joints. The sternal margins that articulate with the cartilages of the first seven pairs of ribs were carefully cut so that the body could be measured with precision. Direct measurements of Posterior Curved Length (PCL) of the sternum, i.e. distance between suprasternal notch and the xiphoid process; was

taken by measuring tape keeping the bone on flat surface with readings up to one mm. (Figure 1 & 2)

Fig.1- Posterior curve length of dry sternum



Fig.2- Posterior curve length of Fresh sternum



Three readings were taken and average of the results recorded. After taking direct measurements, the sterna were put in a boiling solution containing sodium chloride and detergent, and boiled carefully for 15 minutes or until the muscular coverings could be removed. After removal of muscular coverings, the sterna were cleaned and dried at room temperature. Repeat measurements were taken and tabulated. The data was summarized as mean and standard deviations. Discriminant function analysis was done to examine the dimorphism in sternum and how the variables could correctly assign the bones to the proper sex. Student's t-test used to compare the data. P value of less than 0.05 was considered significant.

Observations Derived from Sternum:

Table no. 1 shows the mean values for PCL of fresh and dry sterna of both sexes. The mean value for fresh sternum in males and females was 20.40 ± 1.13 cm & 18.26 ± 1.36 cm; and for dry sternum, 19.19 ± 1.16 cm & 17.19 ± 1.39 cm, respectively. It was observed that the mean of fresh and dry Posterior curve length, was significantly higher.

Table no-1: Descriptive statistics for fresh and dry sternum

Sex		Posterior Curve Length	Posterior Curve Length (Dry)
Male	Mean	20.4078	19.1974
	N	50	50
	Std. Dev	1.13513	1.16195
	Minimum	18.33	17.03
	Maximum	22.66	21.23
	Range	4.33	4.20
Female	Mean	18.2692	17.1954
	N	50	50
	Std. Dev	1.36755	1.39487
	Minimum	15.46	14.46
	Maximum	21.30	20.76
	Range	5.84	6.30
Total	Mean	19.3385	18.1964
	N	100	100
	Std. Dev	1.64874	1.62584
	Minimum	15.46	14.46
	Maximum	22.66	21.23
	Range	7.20	6.77

It was observed that for wet sterna, the values of PCL in males were: Mean = 20.4, S.D. = 1.13; in females: Mean = 18.26, S.D. = 1.36; $t(98) = 8.5$, $p = 0.01$. Similarly, for dry sterna, the values were: Mean = 19.19, S.D. = 1.16 for males and Mean = 17.19, S.D. = 0.70; $t(71.4) = 12.05$, $p = 0.01$. Above variables have p less than 0.05, so null hypothesis was rejected and it

was confirmed that all the three variables have significant mean difference (Table 2).

'Test of Normality' (Kolmogorov-Smirnov test)¹⁵ is done to show the normal distribution of samples taken from the same population (Table no 3), the Sig. (2-tailed) value for PCL for wet sternum (0.263) and for dry sternum PCL (0.450) is >0.05 , which establishes the fact that both male and female samples were normally distributed and taken from same population. A direct discriminant function analysis was performed using posterior curve length as variable predictors of sex for wet and dry sternum separately by SPSS software version 20.

Table 3: Showing test of Normality i.e. Kolmogrov-Smirnov test with p-value for fresh and dry sternum

		Posterior Curve Length (wet)	Posterior Curve Length (Dry)
N		100	100
Normal Parameters	Mean	19.3385	18.1964
	Std. Deviation	1.64874	1.62584
Most Extreme Differences	Absolute	.101	.086
	Positive	.095	.059
	Negative	-.101	-.086
Kolmogorov-Smirnov Z		1.006	.860
Asymp. Sig. (2-tailed)		.263	.450

Table No. 2: Independent Samples Test for fresh and dry sternum

A= Equal variable assumed B= Equal variable not assumed		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Posterior Curve Length	A	.984	.324	8.509	98	0.01	2.13	.25	1.63982	2.63
	B			8.509	94.786	0.01	2.13	.25	1.63960	2.63
Posterior Curve Length (Dry)	A	.536	.466	7.798	98	0.01	2.00200	.256	1.49251	2.511
	B			7.798	94.902	0.01	2.00200	.256	1.49230	2.511

From **table no. 4 & 5**, it is depicted that the Discriminant Function Coefficients reveal the specific relation of Posterior curve length with sex. The following discriminant function was obtained from discriminant coefficient: **DF= 0.813x - 15.99** (x = PCL of fresh sternum). Similarly, for dry sternum, the **DF= 0.882x - 15.64** (x = PCL of dry sternum) (**Table No.5 ,6**). Each subject's discriminant score would be computed by entering his or her variable values in the equation. The Cut score was zero (**Table No.4**) [Calculated from group centroid by obtaining the arithmetic mean of the values]. In cases where the DF scores was less than 0 the sternum is that of a female. For values of discriminant score above 0, the sternum is that of a male.

Table no.4, Functions at Group Centroids

Sex	Function
	1
Male	1.104
Female	-1.104

Table No.5-Discriminant Function Coefficients for fresh sternum

	Function
	1
Posterior Curve Length (Fresh)	.813
(Constant)	-15.99

Table No.6 -Discriminant Function Coefficients for dry sternum

	Function
	1
Posterior Curve Length (Dry)	.882
(Constant)	-15.644

From **Table No.7**, in case of fresh sternum in 100 sample, it was observed that 91.0% of original male and female [44 among 50 males (88%) and 47 among 50 female samples (94%)] were correctly classified by this DF score. From **Table 8**, in case of fresh sternum in 100 sample, it was observed that 87% of original male and female [42 among 50 males (84%) and 45 females from 50 (90%)] were correctly classified by this DF score.

Table no. 7 : Classification Results of Fresh sternum

		Sex	Predicted Group Membership		Total
			Male	Female	
Original	Count	Male	44	6	50
		Female	3	47	50
	%	Male	88.0	12.0	100.0
		Female	6.0	94.0	100.0
91.0% of original grouped cases correctly classified.					

Table no. 8: Classification Results of dry sternum

		Sex	Predicted Group Membership		Total
			Male	Female	
Original	Count	Male	42	08	50
		Female	5	45	50
	%	Male	84.0	16.0	100.0
		Female	10.0	90.0	100.0
87.0% of original grouped cases correctly classified.					

Discussion:

The sternum, commonly known as the ~~breastbone~~ is a flat bone that lies in the middle of the rib cage. Morphologically, the sternum is naturally curved with a convex anterior surface and a concave posterior surface.⁵ Its importance in forensic anthropology for determining the identity of human remains is well known. Many studies have derived various indices and formulae from sternum to determine the age, sex, and stature. However, there are only a handful of studies on sex determination of an individual using this bone.^{4,7-14} Most of these studies are based on measurements of length of the body and manubrium of sternum^{7,10,11,13} These studies have not specified whether the measurements were taken from the anterior or posterior surface. Also these studies have excluded the xiphoid process. There is one study which has used the posterior surface of the sternum.⁶ Two studies have included the xiphoid process in the length measurement.^{5,14}

In our study, we used the posterior surface of sternum and included the xiphoid process in the length measurement. We studied the sternum in both the wet and dry conditions and compared the findings. As our study was based on the multicultural, cosmopolitan city of Delhi, it was difficult to get race or population specific data.

Table No.9: Comparison of studies on sternum

Studies by various expert	Factor used to discriminate	Male(in cm)	Female(in cm)	Accuracy (in %)	
Jit et al (1980) ^[7]	Mean (M+B)	>14	<13.1	M-72 F-62.5	67
Gautam et al(2003) ^[8]	Mean (M+B)	14.9	12.4	-	
Osunwoke et al (2010) ^[11]	Mean (M+B)	16.46±1.99	12.33±/-1.18	M-94.11 F-69.23	81
Macaluso P.J (2010) ^[10]	Mean (M+B)	16.46±1.99	12.33±/-1.18	-	-
SirishaPuttabanthi et.al (2012) ^[13]	Mean (M+B)	13.9± 2.1	11.0±0.81	M-68.4 F-100	82
Robert Selthofer ^[14]	Total length of sternum	20.86±1.46	18.29±1.74	-	-
P.P. Mukhopadhyay(2010) ^[5]	PCL (wet)	22.4±1.01	17.92±0.98	M-100 F-100	100
Present study	PCL(wet)*	20.40±1.13	18.26±1.36	M-88 F-94	91
	PCL(dry)*	19.19 ±1.16	17.19±1.39	M-84 F-90	87

Note : (M+B)=The combined length of the manubrium and mesosternum

Most of the studies to differentiate sex from sternum were on the sternal index⁹ and combined length of manubrium and mesosternum,^{9-11,13,14} excluding the xiphoid process. Mukhopadhyay⁵ studied the length of wet sternum from posterior surface and showed that the mean posterior curve length for male and female was 22.4±1.01cm and 17.92±0.98 cm, respectively. Since, in the present study, we used both wet and dry sterna for obtaining the variables; the mean PCL of wet sternum for male and female was 20.40±1.13 cm and 18.26±1.36 cm, respectively. In the dry sternum, the mean length for male and female was 19.19±1.16 cm and 17.19±1.39 cm, respectively. The value of mean length of wet sternum was found to be 2 cm less in males and 0.34 cm greater in female, as compared to the study conducted by Mukhopadhyay.

Again, the accuracy of posterior curve length of wet sternum for present study was found to be 88% and 94% for male and female, respectively; for dry sternum it was 84% and 90% for male and female, respectively. As compared to our study, the accuracy was found to be more Mukhopadhyay, (100%) who performed it on the wet sterna of Bengali population. Also, the accuracy in sexing the sternum by Puttabanthi, et al¹³ was higher for females (100%), while it was less (68.42%) for males. On the other hand, in the study conducted by Osunwoke,¹⁷ on Nigerian population, the accuracy was more in males (94.11%) and less in females (69.23%), as compared to our study (Table No. 9).

However, the accuracy of present study is higher as compared to that conducted by Jit, et al⁷ (72% for males and 62% for females) who studied the combined length of body and manubrium as the differentiating factor.

For the posterior curve length of wet sternum, DF score was calculated as DF=0.796PCL-15.38 which has an accuracy of 91% and for that of dry sternum, DF score was DF=0.779PCL (DRY)-14.75, having an accuracy of 87% (Table No.10). In other terms, we can say that if an unknown sternum is encountered, then its sex can be estimated with about 90% accuracy by merely placing the values of PCL measurements in the discriminant function analysis equation; if the DF score < 0 then it is a female sternum and if >0 then a male sternum.

Table no. 10: DF scores for posterior curve length of fresh and dry sternum of sternum.

	DF Score	% Correctly Classified
PCL (WET)	DF= 0.813x- 15.99(x = PCL of fresh sternum)	91% (M-88; F-94%)
PCL (DRY)	DF= 0.882x- 15.64 (x = PCL of dry sternum)	87% (M-84%; F-90%)

M= male, F= Female (If DF score < 0=female and MALE=> 0).

Since, the fragmentary skeletal remains that are usually bought for anthropological examination are in the dried state, we conducted this study by measuring the parameters in both wet condition as well as after drying the sternum by means of boiling in water. In the present study, the accuracy with fresh sternum was found to be more as compared to dry sternum; the reason may be that in the fresh sterna,

junction points are held in place by soft tissues covering the junction site (manubriosternal and xiphio-steranal joints) and so the possibility of errors in measurement are few; but in dry sternum, many a times boiling (as used in this study to remove soft tissues) or decomposition may lead to loosening of the xiphoid process or manubriosternal joint from the body in non-ossified sternums.

Conclusion and Recommendations:

Based upon the observations and results of the sternal measurements, it can be concluded that mean of posterior curve length is higher among males as compared to the females. Also, sternum can be sexed with a higher accuracy rate with use of discriminant function analysis. The specimen of sternum used for measurement was both fresh and dry state i.e. processed after boiling. This process many a times leads to loosening of the xiphoid process or manubriosternal joint from the body in non-ossified sternums. To prevent such errors it is recommended that cases above 65 years of age should be considered in further studies. As India has regional population, each group needs further research which will add to the growing knowledge in physical anthropology and Forensic Medicine field.

Conflict of interest: None

Financial Assistance: None

References:

1. Sawhney CP, Ahuja RB, Goel A. Burns in India : epidemiology and problems in management. *Ind J Burns* 1993;1(1):1.
2. Reddy KSN. Thermal deaths. in: - the essentials of forensic medicine and toxicology. 18th ed. Hyderabad : K Suguna Devi.1999. p. 260-5.
3. Aggarwal BBL, Chandra J. A study of fatal cases of burns in south zone Delhi. *Punjab Medical J* 1970;20(12):451.
4. Lal P, Rahi M, Jain T, Ingle GK. Epidemiological study of burn injuries in a slum community of delhi. *Indian J of Com Med* 2006;31(2):96-100.
5. Dasari H, Kumar A, Sharma BR. Burns septicemia . the leading cause of burn mortality. *J Punjab Acad Forensic Med Toxicol* 2008;8(2):10-16.
6. Chawla R, Chanana A, Rai H, Aggarwal AD, Singh H, Sharma G. A two-year burns fatality study. *J Indian Acad Forensic Med* 2010; 32(4):292-7.
7. Buchade D, Kukde H, Dere R, Savardekar R. Pattern of burn cases brought to morgue, sion hospital, mumbai: a two year study. *J Indian Acad Forensic Med* 2011;33(4):309-10.
8. Babladi PI, Vijayanath V, Vijaymahantesh SN. Burns and burning issue in gulberga, karnataka. *Ind J For Med Toxicol* 2010;4(2):85-86.
9. Haralkar SJ, Tapare VS, Rayate M. Socio-dermographic profile of burn cases in the reproductive age group (15-45 years) admitted in shri chhatrapati shivaji maharaj general hospital, solapur. *Solapur Medical J* 2005;2(2).
10. Ghaffar UB, Hussain M, Rizvi SJ. Thermal burn: an epidemiological prospective study. *J J Indian Acad Forensic Med* 2008;30(1):10-4.
11. Pawar CK, Oberoi SS, Thind AS. Profile of burn deaths in females (between 18-45 years of age). Souvenir of 10th Annual Conference of PAFMAT 2011, Chandigarh: 26 Nov. 2011.
12. Bhagora RV, Darji JA, Panchal DN, Kalele SD, Parmar DJ. Profile of burns cases brought for post- mortem examination at mortuary of sir t. hospital, bhavnagar. *National J Integrated Research in Med* 2011;2(4):109-12.

Original Research Paper

Diatomological Mapping of Water Bodies of Indore (M.P) Region

¹Mandar Ramchandra Sane, ²Pankaj Verma, ³Rashmi Kulkarni, ⁴Pradeep Kumar Mishra, ⁵Manish Nigam, ⁶P C Sirkanungo

Abstract:

Diatoms are microscopic, eukaryotic and unicellular algae that are abundant in most aquatic habitats and are useful proxies for the ecological analysis. They are used as a tool to differentiate the ante-mortem drowning cases from post-mortem submersion. In the present study, water samples were collected from different water bodies of Indore region, Madhya Pradesh to generate the data regarding different drowning associated diatoms species found in them. Among the different diatoms genus, Navicula and Nitzschia were most common, followed by Synedra and Gamphonema. The Diatomological Mapping (D-Mapping) of water bodies might be of vital forensic importance as it can give useful lead to the forensic pathologists in solving the drowning cases, particularly when reference water sample is not available.

Key Words: Diatoms, D-mapping, Drowning, Cause of death

Introduction:

The word Diatom comes from Greek word: (dia) = through (temnein) = cut i.e. cut in half¹ In 1904, Hofmann and Roveenstoff detected diatoms from lungs and used them as evidence in solving a case of drowning mystery. Again, Gregory Popp solved a murder case of seamstress named Eva Disch who had been strangled with her own scarf² utilizing geological make-up of the soils based on diatoms.

Corresponding Author:

¹Assistant Professor,

Department of Forensic Medicine & Toxicology,
Government Medical College & Hospital, Chandigarh

²PG Resident,

³Research Associate,

⁴Professor,

⁵Professor & Head

⁶Demonstrator,

Department of Forensic Medicine & Toxicology, Sri
Aurobindo Medical College & PGI, Indore

Email ID: drmrane@gmail.com.

L. M. No: LM/ JIAFM/1343

DOR: 21/12/2017 DOA: 21/03/2018

DOI: 10.5958/0974-0848.2018.00015.5

In 1949, Tamasaka was the first to detect diatoms in bone marrow.¹ Diatoms are aquatic microscopic, eukaryotic, unicellular and photosynthetic organisms of size ranging between 5 µm. 1000 µm¹ that represent a major taxonomic division Chrysophyta, class Bacillariophyceae.³ They do not occur naturally in the body. If laboratory tests show diatoms in the body that are of the same species found in the water where the body was recovered, then it may be good evidence of drowning as the cause of death.³

In drowning related death cases, a correlation between the diatoms extracted from organs samples and the samples obtained from drowning medium have to be established.⁴ Sometimes, a case of drowning is encountered with the unclear history and circumstances, such as a drowned body may be dragged to a greater distance from the exact site of drowning due to water current, or, when significant numbers of diatom are found in the body organs but they do not match with types of diatoms from reference liquid medium.⁵ In these situations, locating the putative site of drowning becomes of vital

importance. The systematic sampling of locations where drowning deaths are frequent, allows for the creation of a predictive diatom database. Such a database is suitable for comparison with recovered tissues. D-Mapping of water bodies may help to solve the problem in such situations. This study was aimed to conduct the D-mapping of water bodies of Indore region.

Materials and Methodology

The samples were collected from water bodies from Indore district of Madhya Pradesh in 2016. Following water bodies were chosen for examination- Patalpani waterfall, Choral River, Sirpur Tank (small), Sirpur Tank (large), Choral Dam, Sanjay Jalashaya and Yashwant Sagar Dam. The basis behind choosing these water bodies was the occurrence of drowning incidences in these water bodies. Samples were collected during spring season and early summer, as favourable growth of diatoms occurs during these seasons. Fresh water sample and the stones from water with slime over it were collected in a sterile bottle without any preservative, from the selected sites.

Diatoms were extracted from water samples, by the Acid Digestion method. In about 200 ml sample, 40 ml conc. Nitric acid was added and was kept undisturbed overnight. The samples were then centrifuged at 3000 rpm for

10min. The supernatant was discarded and the residual material was further washed with distilled water to remove the acid remnants and again centrifuged at 3000 rpm for 10min. The supernatant was again discarded and the residual material was put on microscopic slides (2 for each water body) and these slides were permanently mounted with DPX solution. Slides were examined at high magnification (40X) with the help of an optical compound microscope. First hundred diatoms were randomly counted on the slide, and, percentage of each genus of diatoms was calculated. Photomicrographs were captured using a computerized camera fitted on the microscope. (Figs.1 and 2) Diatom species were identified on the basis of available literature.⁶ (Table 1)

Figure 1: Location of water bodies in Indore district (not to scale)

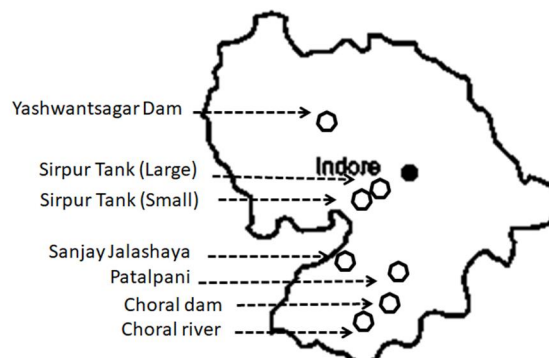


Figure 2: Microscopic view of diatoms- Cyclotella (A); Navicula (B); Cymbella (C); Synedra (D) (40X)

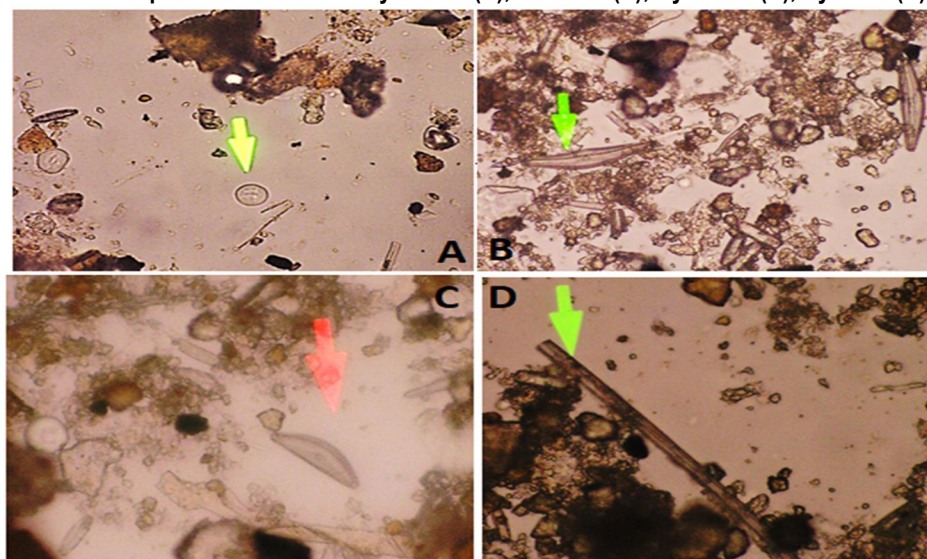


Table 1: Identification features of relevant Diatoms

No	Diatoms	Features
1	Navicula	Pinnate shaped, isopolar and have a prominent raphe and delicate rib-like structures aligned orthogonal to the raphe.
2	Anomoeoneis	Valves lanceolate to elliptical-lanceolate with broadly rounded to capitate ends. Striae distinctly punctate. Usually with hyaline areas on either side of the axial area. Distal raphe ends clearly deflected to one side.
3	Nitzschia	Linear to fusiform, sigmoid or gently arcuate shaped and raphe is found along one border of the frustule and there are usually conspicuous striae along the other border.
4	Cyclotella	Circular profile and radial spoke-like features
5	Cymbella	Biconvex surfaces and symmetry about a horizontal equator through the midpoint of the diatom
6	Gomphonema	Heteropolar apices and in some orientations have a characteristic tapering shape with prominent striae, may have a pair of apical lucencies and rectangular shape nonspecific profiles with marginal punctata.
7	Gyrosigma	Axial area is narrow and sigmoid containing a sigmoid raphe.
8	Synedra	Pinnate shaped diatom with narrow and linear valves and transverse striae.

Results

Diatoms were identified at genus level; Naviculla, Nitzschia, Gomphonema, Synedra,

Anomoeoneis, Cymbella, Cyclotella, and, Gyrosigma were the commonly observed diatoms in the water bodies. A distribution type of diatoms has shown characteristic variation among the selected sites. Most commonly found diatoms (Navicula and Nitzschia) have been observed in almost every water body but their quantity varied. Distribution of diatoms according to water bodies has been detailed in the **Table 2**, while their relative percentages are detailed in **Table 3**.

Table 2: Diatoms recovered from various water bodies of Indore region

S. no	Water Bodies	Diatoms	Most frequent
1	Patalpani	Naviculla, Nitzschia, Gomphonema, Synedra	Nitzschia
2	Choral river	Naviculla, Anomoeoneis, Nitzschia, Gomphonema, Synedra	Anomoeoneis
3	Choral dam	Naviculla, Nitzschia, Cymbella, Gomphonema, Synedra	Cymbella
4	Sirpur tank (small)	Anomoeoneis, Cymbella, Gomphonema, Synedra, Naviculla, Nitzschia	Synedra
5	Sirpur tank (large)	Naviculla, Nitzschia, Cymbella, Gomphonema, Gyrosigma	Naviculla
6	Sanjay jalashaya	Naviculla, Nitzschia, Cyclotella, Synedra	Cyclotella
7	Yashwant sagar dam	Naviculla, Nitzschia, Cyclotella, Gomphonema	Gomphonema

Table 3: Percentage wise distribution of diatoms in water bodies

Diatoms Genus	Patalpani	Choral River	Sirpur Tank (Small)	Sirpur Tank (Large)	Choral Dam	Sanjay Jalashaya	Yashwantsagar Dam
Navicula	16.67%	19%	-	51.04%	22.70%	20.60%	20.42%
Anomoeoneis	-	35%	35.80%	-	-	-	-
Nitzschia	55%	7.20%	-	9.37%	13.44%	1.90%	32.40%
Cyclotella	-	-	-	-	-	52.90%	4.22%
Cymbella	-	10.20%	2.50%	23.96%	47.90%	-	-
Gomphonema	3.33%	1.40%	24.70%	7.30%	10.08%	-	42.96%
Gyrosigma	-	-	-	8.33%	-	-	-
Synedra	25%	27.10%	37.03%	-	5.90%	25.50%	-

Discussion:

Death by drowning is defined as a death due to submersion in liquid and the mechanism in acute drowning is hypoxemia and bi-reversible cerebral anoxia.⁷ The diagnosis of drowning for bodies freshly retrieved from water is mainly based on some "drowning signs", such as the presence of fine froth at the mouth or nostrils, petechial hemorrhages, impression of ribs on lungs, oedematous lungs and some other histo-pathological findings. However, in decomposed corpses and skeletonised bodies found in water, the diagnosis of drowning is rather difficult because those "drowning signs" get destroyed.⁷ Therefore, a great number of tests have been proposed to allow a confirmation of death by drowning of a victim. Diatom test is one of these test and works as an important tool in diagnosis of death due to drowning. According to Peabody,^{8,9} diatom count can be used to discriminate between drowning and non-drowning cases. to failure to distinguish between diatoms that are present in the drowning fluid and extraneous diatoms that are present as contaminants. Source of these contaminants may be due to ingested material, or from contaminated glassware or even from cigar.⁸ Hence crux of diatom test is based on analysis and comparison with diatoms of sample water.

The species recovered from the human tissue must be represented in the flora of the site sample. D-mapping for forensic purpose has been attempted in various regions of India - including Delhi,¹⁵ Jaipur,¹⁶ Punjab,¹⁷ Haryana,^{18,19} Mumbai,²⁰ Aurangabad²¹ and Mizoram.¹ Literature lacks diatom database from Indore and surrounding region.

The diatom test has successfully been employed to diagnose death due to drowning by various research workers.¹⁰⁻¹⁴ The weakness of this test is that it can be erroneously termed positive due

The diatoms database from Indore region shows occurrence of Navicula and Nitzschia genus in most of the water bodies. However, other diatoms that were recovered were Gomphonema, Synedra, Anomoeoneis, Cymbella, Cyclotella, and, Gyrosigma. Relative proportions of these diatoms, particularly dominating diatoms in sample water, are important for diatom test. It was observed that the diatoms found in biological specimen (bone marrow/tissue) showed significant similarities, approximately in the same proportions with the diatoms present in control water sample from the site of drowning.^{12,13,22} Present study shows percentage wise occurrence of drowning associated diatoms in water bodies under study. While conducting the diatom test, interpretation must extend to analysis of relative proportion of dominating diatoms recovered from body tissues. Seasonal variation usually occurs in quantity of diatoms in a water body, however diatoms tend to show recurrence in respective water bodies with similar relative proportions among various genera.⁵ The present study is limited as it has not recorded seasonal variation in qualitative and quantitative proportions in diatoms; results can be authenticated by further update by continuous monitoring of diatom profile in water bodies.

Conclusion:

This study attempts to make a database of drowning associated diatoms of Indore region. This D-mapping gives qualitative and quantitative distributions of diatoms in different water bodies of this region. It is of vital forensic

importance as it can give useful lead to the forensic pathologists in solving the drowning cases, particularly when reference water sample is not available.

Acknowledgement:

We would like to acknowledge Anurag Sahu, Assistant Professor, Department of Forensic Science, Govt. Institute of Forensic Science, Aurangabad for his technical assistance.

Conflict of interest: None

Financial Assistance: None

References:

- Singh R, Zolawmsangi, Jasuja OP. A preliminary study on the diatom flora of various drowning sites in mizoram rivers. Anil Aggrawal's Internet Journal of Forensic Medicine and Toxicology 2016; 17(2). Available from:
- http://www.anilaggrawal.com/ij/vol_017_no_002/papers/paper002.html. Accessed: November 29, 2017
- Ruffell A & McKinley J. Forensic Geoscience: applications of geology, geomorphology and geophysics to criminal investigations. Earth-Science Reviews 2005;69(3-4): 235-47.
- Verma K. Role of diatoms in the world of forensic science. J Forensic Res 2013;4:181.
- Sankhla, Kumari MSM, Nanadan M, Kumar R. Forensic identifications of drowning death by the use of diatom analysis. Int J Dev Res 2016;6(9):9491-3.
- Singh R, Deepa, Kaur R. Diatomological mapping of water bodies e A future perspective. J Forensic Leg Med 2013;20:622-5.
- Diatoms. [Internet] Available from: <https://www.landcareresearch.co.nz/resources/identification/algae/identification-guide/identify/guide/descriptions/diatoms>. Accessed: November 29, 2017.
- DiMaio DJ, DiMaio VJM. Drowning. In: Forensic pathology. Amsterdam: Elsevier; 1989. p. 357-65.
- Peabody AJ. Diatoms and drowning - a review. Med Sci Law 1980;20(4):254-61.
- Peabody AJ. Diatoms in Forensic Science. J Forensic Science 1997;17:81-7.
- Punia RK. Diatoms: Role in drowning. J Ind Acad Forensic Med 2011;33(2):184-6.
- Malik MK, Jakhar P, Kadian A. Role of diatoms in forensic investigation: case studies from haryana. Int J Forensic Sci Pathol 2013;1(3):11-2.
- Kumar A, Malik M, Kadian A. Role of diatom test in forensic science for examination of drowning cases. Rep Opin. 2011;3(9):1-4.
- Pal SK, Sharma A, Sehgal A, Rana A. Diagnosing death with diatoms: a retrospective study of forensic cases in himachal pradesh, india. Int J Med Toxicol Forensic Med. 2017;7(2):124-37.
- Kumar A, Singh A, Joshi R, Mittal S, Tayal I. Role of study of diatoms in forensic investigations . two year retrospective study. J Ind Acad Forensic Med 2016;38(3):321
- Mishra MK, Kumar S. Study of diatom flora for the site identification of yamuna river at Delhi. International Journal of Development Research 2017;7(7): 14103-8.
- Singh R, Singh R, Singh R, Thakar MK. Diatomological studies from three water bodies of Jaipur. Indian Internet J Forensic Med Toxicol 2006;4(3): 1-11.8
- Thakar, Mukesh Kumar Singh R. Diatomological mapping of water bodies for the diagnosis of drowning cases. J Forensic Leg Med 2010;17:18-25.
- Saini P, Kushwaha KPS. Morphological study of diatoms in 24 different water bodies of Haryana, India. Anil Aggrawal's Internet Journal of Forensic Medicine and Toxicology Available from:
- http://www.anilaggrawal.com/ij/vol_017_no_001/papers/paper002.html. Accessed: November 29, 2017.
- Saini E, Khanagwal VP, Singh R. A systematic data basing of diatoms from different geographical localities and sites of Haryana for advancing validation of forensic diatomology. Data in Brief 2017;10:63-8.
- Rana D, Bhandari D. Isolation and characterisation of diatoms from waterbodies of Mumbai. Int J Cur Res Rev. 2016;8(17):13-21.
- Sahu A, Najmi AH. Identification of aquatic sites of Aurangabad district of Maharashtra by diatoms (phytoplankton). Natl J Extensive Edu & Interdisciplinary Research. 2013;1(11):37-40.
- Ludes B, Quantin S, Coste M, Mangin P. Application of simple enzymatic digestion methods for diatom detection in the diagnosis of drowning in putrefied corpses by diatom analysis. Int J Leg Med 1994;107:37-41.

Original Research Paper

Awareness, Attitude and Approach of Rural Public to Snakes & Snake Bites

¹Chidananda PS, ²Lohith Kumar R, ³Raksha R, ⁴Abhishek Yadav

Abstract:

Background: In most cases, fatality from snake bites occur either due to delay in reaching the health centre or approaching a quack, who often resorts to use of unscientific methods. Efforts have been seldom made to evaluate the awareness of the people about venomous snakes, first aid and superstitions.

Materials & Methodology: A cross-sectional study using a semi-structured questionnaire was conducted on people from five villages, with an aim to know the ability of the public to recognize the eight commonly encountered snakes in our region. The awareness about proper first aid management and the attitude of the people towards traditional and modern therapy was also studied.

Results: Common Cobra and Vine Snake was identified by 98% and 94% of the individuals, respectively. Maximum difficulty was with identifying Cat snake, Russell viper and Common krait. 2/3rd of the non-venomous snakes were recognized as venomous. Methods they employed when bitten by a snake included tying a tight tourniquet above the level of bite, putting incisions and taking to a traditional therapist.

Conclusion: Preventive measures, though felt needed, were not used by majority of the subjects. There is a dire need for organizing education programmes to make the public aware regarding the identification of snakes, snake-bite management at the field, etc.

Key Words: Snake Bite, Antivenom, Snake Recognition, First Aid

Introduction:

Treatment of snakebite is primarily aimed at neutralizing the venom with specific antivenin and this can be achieved only if the victim approaches a medical centre at the appropriate time.

Corresponding Author:

²Assistant Professor

¹Associate Professor

Dept. of Forensic Medicine & Toxicology,
Shimoga Institute of Medical Sciences, Shivamogga.

³Medical Graduate,
Shimoga Institute of Medical Sciences, Shivamogga.

⁴Assistant Professor,
Department of Forensic Medicine & Toxicology,
AIIMS, New Delhi

Email ID: lohithkumar1612@gmail.com.

L. M. No: LM/JIAFM/DEL/840

DOR: 23/06/2017 DOA: 21/03/2018

DOI: 10.5958/0974-0848.2018.00016.7

India is thought to have more snakebite cases than any other country and the rural public (farmers) are the commonest victims.¹ There is a strong association between snakebite-induced mortality with poverty, choosing of untrained village based traditional therapists and delay at arrival to medical centres.^{1,2} People choose quacks, either because of lack of knowledge, or due to poor transportation. Even if they approach a medical centre, they may not have identified the snake, putting the physicians under pressure to rely purely on signs of envenomation.

Snakebite first-aid education to well read farmers, local healers, health workers and NGOs in rural parts of Nepal has shown reduction in dependency on traditional healers from 56% to 22% and attracted people towards invaluable pressure immobilization technique and antivenom therapy.³ Our centre is located in the midst of a forest, surrounded by many villages and tribes, where high instances of snakebite are encountered. Current available data is solely

based on under reported hospital statistics^{1,3,4} and less effort has been made to evaluate awareness about venomous snakes, first aid and superstitions.

Materials and Methodology:

A cross-sectional study was carried out on people residing in five villages, where in information was collected by interviews with the subjects using a *Semi-structured Questionnaire under three sections*

Section 1: Socio-demographic data.

Section 2: Identification of Snakes - By showing photographs of commonly encountered four venomous and four non-venomous snakes in our region i.e., Common cobra, Common Krait, Russell viper, Saw scaled viper and Vine snake, Buff striped keel back, Rat Snake and Cat snake, respectively.

Section 3: Attitude and Approach of public towards snake bites.

Inclusion criteria:

1. General public aged above 18years and below 60years, willing to participate.

Exclusion criteria:

- Persons having medical knowledge .
Medical and Paramedics.
- Non residents of that village.

Sample size: A total of 100 people were interviewed, of which 20 participants were considered from each village with representative samples from both the sexes.

Observations:

Among the 100 subjects, 31% were in the age group of 21-30yrs, with 67% males. 31% had education till 5th standard, 35% were agriculturists, and 26% were self employed, including laborers in farming fields. The socio-demographic profile is shown in **Table No.1**.

Table 1: Shows the socio-demographic profile of the study population.

Demographic Profile of the Sample in Percentage		
Age (In Yrs)	18-20yr	8
	21-30yr	31
	31-40yr	17
	41-50yr	26
	51-60yr	18

Gender	Male	67
	Female	33
Occupation	Agriculturist	35
	Quarry	0
	Government employee	6
	Non-government employee	11
	Self employed	26
	Unemployed	0
	Others	22
Education	Primary (till class 5)	31
	Secondary (till class 10)	27
	Higher secondary (till class 12 or equivalent)	11
	Graduation	9
	Post graduation studies	0
	Informal education	0
	Diploma	1
	Illiterate	21
Marital Status	Single	17
	Married	83
	Divorced	0
	Widowed	0
	Separated	0
Religion	Hindu	87
	Christianity	1
	Muslim	12
	Others	0
Cumulative Monthly Household Income	<Rs. 1, 000/	4
	Rs. 1, 000 – 5,000/	58
	Rs. 5,001- 10,000/	25
	Rs. 10,001- 50,000/	11
	> Rs. 50,000	2
No. of Dependent Family Members	≤ 2	9
	3	15
	4	25
	5	19
	≥ 6	32
Place of Sleep		
Outdoor	On ground	0
	Cot	0
Indoor	On floor	73
	Cot	27
Total		100

Table No. 2: Shows the ability of the study population to identify snake by looking at the relevant snake Photographs.

Photographs Of Snake Shown	Snakes Identified as (In Percentage)											Total
	CC	CK	RSV	SSV	VS	CS	RS	BSKB	OV	ONV	Not able to identify	
Common Cobra	98	0	0	0	0	0	0	0	1	0	1	100
Common Krait	11	6	6	3	0	0	9	0	50	2	13	100
Russell Viper	15	45	0	3	0	0	1	0	26	0	10	100
Saw Scaled viper	16	1	11	14	1	0	1	1	38	1	16	100
Sub-Total Venomous	140	52	17	20	1	0	11	1	115	3	40	400
Vine Snake	1	0	0	0	94	0	1	0	2	1	1	100
Cat Snake	28	0	6	0	0	0	2	0	29	9	26	100
Rat Snake	21	0	0	0	0	0	45	0	18	2	14	100
Buff striped Keel back	17	0	1	0	0	0	20	10	15	13	24	100
Sub Total Non-Venomous	67	0	7	0	94	0	68	10	64	25	65	400
Total	207	52	24	20	95	0	79	11	179	28	105	800

Abbreviations used: CC: Common Cobra, CK: Common Krait, RSV: Russell Viper, SSV: Saw Scaled Viper, VS: Vine Snake, CS: Cat Snake, RS: Rat Snake, BSKB: Buff Striped Keel Back, OV: Other venomous, ONV: Other Non-Venomous.

One of the important objectives of the study was to find out the ability of the subjects to identify commonly encountered snakes. They did not have any difficulty in recognizing common cobra and Vine snake, with 98% properly identifying common cobra and 94% identifying Vine Snake. Difficulties arose in recognizing other snakes. Maximum difficulty was with cat snake, Russell viper and common krait. Cat snake and Russell viper were identified by none and common krait by only 6% of the population. Saw scaled viper was variedly identified. Subjects did not have difficulty in recognizing venomous snakes. They had difficulty in identifying non-venomous snakes, and 2/3rd of non-venomous snake were recognized as venomous (**Table No. 2**).

For the objective of determining attitude and approach towards snakes and snakebites, few predicted and some unexpected responses were seen. Major reasons behind worshipping snakes were due to religious belief of considering them as Gods (70%), to some extent to the fear of bite/ curse for not worshipping (8%), few said they love (1%) and some don't worship (20%). The sample group perceived multiple causes for a snake to bite, which included accidental (94%), lack of protective mechanism (91%) and punishment for the sins committed (33%). Methods employed when bitten by a snake included, tying a tight

tourniquet above the level of bite (88%), putting incisions at the site (37%), and taking to a traditional therapist (67%), immobilize and/or take to hospital (73%).

For the hypothetical queries regarding the steps to be employed at the time of bite, different steps were followed - correct immobilization of the bitten part (67%), Reassurance (96%), Tying tight tourniquet (93%), Incision & suction (81%), Application of plant extracts (30%), Snake stones (17%) and Heat/ vacuum (4%).

The means of transport that can be employed to transfer the patient were, a two wheeler (94%), bullock cart (87%), wait for an ambulance or a four wheeler (89%) in the absence of two wheeler, make him to walk (3%) or run (4%) to the hospital.

Very few preventive measures were employed in the form of use of gum boots (13%), wearing thick gloves (12%), and tilling machines (10%) and their need was not felt by more than ½ of the population. However the application of preventive measures which might reduce snake-human contact chance was being followed by majority at their residence (**Table No. 3**).

Table No. 3: Shows the preventive measures employed and or felt essential for snakebite in percentage.

and of not essential for employees in percentage.			
Preventive measures	Not Employed but felt		Employed
	Needed	Not Needed	
At work place			
Use of gum boots	29	58	13
Wearing thick gloves	29	59	12
Tilling with machines	23	67	10
At the residence			
Keeping premises garbage free	0	1	99
Keeping premises free of rodents	0	1	99
Not sleeping on floor	6	87	7
Sleeping with curtains	4	93	3

Discussion:

In our study, majority of the sample group were poor⁵ male adults (as per the poverty definition of World Bank), who depended on agriculture for their livelihood. Snakebite incidence in similar type of population is reported from various countries and the reasons for higher incidence among them are: bold & aggressive attitude of male adults, occupational exposure as farmers/ herdsman, life styles & working habits like sleeping on the floor and outside the house, inability to access affordable, effective treatment centre due to poverty or non-availability, at the crucial hour, etc.^{1,6-11} The subjects interviewed in our study have been identified as the risk group for snake bites.

The subjects did not have any difficulty in recognizing common cobra and Vine snake, but Cat snake and Russell viper were identified by none and common krait by only 6% of the population. Saw scaled viper was variedly identified.

According to Joseph JK, et al,¹² even the dead snakes brought to the hospital are misidentified; for example hump-nosed viper as saw scaled viper, resulting in receipt of ineffective treatment. The subjects in our study did not have difficulty in recognizing venomous snakes though they had difficulty in identifying 2/3rd of the non-venomous ones. A similar

problem was reported by Shetty AK,⁸ where in, 37.5% of the victims bitten by non-venomous snake were brought to the tertiary care centre as poisonous snake bites.

One more finding which needs mention here is that, ½ of our subjects identified Russell viper as common krait and this might be attributed to the use of confusing terminology by the local public for these two snakes, as Kolakamandalaq and Kadambalaq respectively. Unless the victim or the bystander visualizes and recognizes the snake, it becomes very difficult for the physician to treat the case, based on the symptomatology alone. This is further compounded by absence of antivenom for all the 52 varieties of poisonous snakes in India.

Major reasons behind worshipping snakes here were due to religious beliefs (70%), and majority feel presence of multiple causes for a snake to bite - including accidental (94%), absence of protective mechanism (91%) and punishment for the sins committed (33%). Though people are ready to come-out of superstitions, but the movies and television serials portraying snakes taking revenge, traditional methods, use of thaitha etc, at times force them to believe.

Methods commonly employed, when bitten by a snake included tying a tight tourniquet (88%), putting incisions at the site (37%), taking to a traditional therapist (67%), immobilize and/or taking to hospital (73%). It can be seen that, the rural public still follow the outdated, discontinued, scientifically proven ineffective and dangerous methods of first aid. Similar findings are reported by studies of other workers,^{1,7,13-20} wherein people approached a traditional healer within 25 minutes of snake bite and who employed outdated first aid methods and gave false assurance to the victims. This indicates that people are convinced that tying a tourniquet is important, however, they prefer both traditional and modern methods of treatment in almost equal ratio. However such higher rate of use of unscientific methods is not seen in the developed world which report negligible mortality from snake-bite.²

Preventive measures were not frequently employed among our sample population and were even felt as not needed, at work place. This is in contrast to the West,²

where they take most of the safety precautions. Though this is linked to poverty, as per Harrison,² we perceive it other way, as majority employed safety means at residence suggesting their callous attitude towards their lives and concern for the safety of their family.

Conclusion:

There was generalized lack of awareness in the sample group regarding various aspects of snake bite, most importantly preventive measures. The at-risk areas and population should be identified by the government agencies and an implementation plan should be made for enhancing awareness about preventive measures and field management of Snake-bite by using locally available materials. Mass media, Gram Panchayats, NGOs etc can be used to educate the public for this purpose.

Acknowledgement:

We are thankful to Indian Council of Medical Research for assisting and encouraging STS project.

Conflict of Interest: None.

Ethical Clearance: Institutional Ethics Committee approval obtained prior to the study.

Source of Funding: We thank ICMR for giving scholarship to graduate for doing this study under ICMR-STs Projects.

References:

- Mohapatra B, Warrell DA, Suraweera W, Bhatia P, Dhinra N, Jotkar RM, et.al. Snakebite mortality in India: A National Representative Mortality survey. *PLoS Negl Trop Dis*. 2011;5(4): e1018. Doi:10.1371/journal.pntd.0001018. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/21532748>. Accessed on 22/07/2012.
- Harrison RA, Hargreaves A, Wagstaff SC, Faragher B, Laloo DG; Snake Envenoming: A Disease of Poverty. *PLoS Negl Trop Dis*. 2009; 3(12); e569. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/20027216>. Accessed on 26/08/2012.
- Pandey DP; Snakebite First-aid education and its impact in rural Madi valley, Central-South lowland Nepal; Physician Byte. Available from: http://www.physicianbyte.com/snaCon_SnakebiteFirst-AidEducationAndItsImpact_%20DebPrasadPandey.aspx. Accessed on 18/09/2012.
- Sharma SK, Chappuis F, Jha N, Bovier PA, Loutan L, Koirala S. Impact of snake bites and determinants of fatal outcomes in southeastern Nepal. *Am J Trop Med Hyg*. 2004;71(2);234-8.
- World Bank, 1990, World Development Report. Oxford University Press. Available from: http://www-wds.worldbank.org/external/default/main?pagePK=64193027&piPK=64187937&theSitePK=523679&menuPK=64187510&searchMe%20nuPK=64187511&siteName=WDS&entityID=000178830_98101903345649. Accessed on 26/08/2012.
- Meenatchisundaram S, Michael. A. Snake bite and therapeutic measures: Indian scenario. *Ind J Sci Technol* 2009;2(10);69-73.
- Reddy BN, Magesh B, Singh RK, Pallavi M, Reddy NN. Factors affecting the snake bite and health seeking behaviour of snake bitten individuals of madurai district, tamilnadu. *Nat J Res Com Med* 2012;1(2);86-9.
- Shetty AK, Jirli PS. Incidence of Snake Bites in Belgaum. *J Indian Acad Forensic Med* 32(2);139-41.
- Fadare JO, Afolabi OA. Management of snake bite in resource-challenged setting: A review of 18 months experience in a Nigerian hospital. *J Clin Med Res*. 2012;4(3);39-43.
- Cesaretti Y, Ozkan O. Snakebites in Turkey; epidemiology and clinical aspects between the years 1995 and 2004. *J Venom Anim Toxins incl Trop Dis* 2010;16(4);579-86.
- Brunda G, Sashidhar RB. Epidemiological profile of snake-bite cases from Andhra Pradesh using immunoanalytical approach. *Indian J Med Res* 2007;125;661-68.
- Joseph JK, Simpson ID, Menon NC, Jose MP, Kulkarni KJ, Raghavendra GB et al. First authenticated cases of life-threatening envenoming by the hump-nosed pit viper (*Hypnale hypnale*) in India. *Trans R Soc Trop Med Hyg* 2007;101;85-90.
- Sawai Y. Study on deaths due to snakebite in anuradhapura district, sri lanka. *The Snake*; 1984; 16;7-15. Available from:

14. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2811174>. Accessed on 26/08/2012.
15. Harris JB, Faiz MA, Rahman MR, Jalil MA, Ahsan MF, Theakston RD, et al. Snakebite in Chittagong Division, Bangladesh: study of bitten patients who developed no signs of systemic envenoming. *Trans R Soc Trop Med Hyg.* 2010;104(5);320-7. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/20096910>. Accessed on 14/07/2012.
16. Bawaskar HS, Bawaskar PH. Profile of snakebite envenoming in western Maharashtra, India. *Trans R Soc Trop Med Hyg* 2002;96;79-84.
17. Hati AK, Mandal M, De MK, Mukherjee H, Hati RN. Epidemiology of snakebite in the district of Burdwan, west Bengal. *J Indian Med Assoc.* 1992;90;145-7. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/1522302>. Accessed on 16/08/2012.
18. Sharma SK, Koirala S, Dahal G, Sah C. Clinico-epidemiological features of snakebite: a study from eastern Nepal. *Trop Doct.* 2004;34;20-2.
19. Chauhan S. Pre-hospital treatment of snakebite envenomation in patients presented at a tertiary care hospital in northwestern India. *J Venom Anim Toxins incl Trop Dis* 2006;11;275-82.
20. Bhat RN. Viperine snake bite poisoning in Jammu. *J Indian Med Assoc.* 1974;63:383-392. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/4452795>. Accessed on 06/07/2012.
21. Watt G, Padre L, Tuazon ML, Theakston RD, Laughlin LW. Tourniquet application after cobra bite: delay in the onset of neurotoxicity and the dangers of sudden release. *Am J Trop Med & Hyg.* 1988;38:618-22.

Original Research Paper

Medicolegal Cases for Bone Examination: 11-Year Retrospective Study

¹H. V. Ambade, ²A. P. Kasote, ³M. P. Fulpatil, ⁴M. M. Meshram**Abstract:**

The skeleton or bones recovered by the police are sent to the Department of Anatomy for medico-legal examination in our institute. Even in mutilated bodies, charred bodies and certain decomposed or non-decomposed bodies where identity and cause of death is disputed, bone or piece of bone is sent for anatomical opinion after preliminary postmortem examination to rule out the doubts. Hence, it is attempted to review all medico-legal cases for bone examination carried out in the Department of Anatomy during the study period of 11 years to determine its characteristic pattern.

In the present study, of the total 256 medico-legal cases for bone examination, 91% were of human origin. Almost 50% of the medico-legal cases were recovered from the forest, barren land or farm; and 11.7% cases were exhumed for bone examination. The bone examination was carried out without any preliminary postmortem examination in 45.7% cases. Almost 60% of the medico-legal cases were usually in the form of skeletal remains, either dry/ wet bone or bone pieces. The opinion about age and gender was confirmed after bone examination in 88.7% and 78.8% cases, respectively.

Key Words: Bone Examination; Anatomical Opinion; Medico-legal Cases; Pattern

Introduction:

Recovered human remains that are buried or badly decomposed or skeletonised are a challenge for the doctor to give opinion about the questions asked by the investigating officer with respect to identification and cause of death of the deceased. When the skeletal remains are found, the question that comes in the mind of investigating officer is where to send these remains.¹ The investigating officer usually directs such cases to the department of Forensic

Medicine for various queries like cause of death, age sex, etc. After preliminary postmortem examination, the skeletal remains are then referred to the Anatomy expert for bone examination. In some states, the bone examination is carried out by the Forensic Department.

In Maharashtra, the department of Anatomy of Government Medical Colleges, as shown in **Table no. 1**

The questions usually asked by the investigation officer are:¹

1. Are the bones human?
2. If human, do they belong to one individual or more?
3. Sex of the person
4. What was the age of the person at the time of death?
5. If there are injuries on the bones, then whether they were antemortem or postmortem injuries.

Sometimes questions are asked which are not related to anatomist:

1. Whether the bones belong to the person in the photograph?
2. Opinion regarding the poison
3. Blood grouping of the individual
4. DNA fingerprinting for identification

Corresponding Author:

¹Assistant Professor,

²Professor,

³Professor and Head,

Department of Anatomy, Government Medical College, Nagpur.

⁴Professor and Head,
Department of Anatomy,
Government Medical College,
Chandrapur. Maharashtra, India.

E-Mail Address: hemachimne@gmail.com

L. M. No: Not a Member

DOR: 06/06/2017 DOA: 19/03/2018

DOI: 10.5958/0974-0848.2018.00017.9

5. Superimposition of skull

Against this background, the present study is carried out to determine the pattern of medico-legal cases for bone examination by anatomy expert.

Table no. 1, is authorized to carry out medico-legal examination of bones from a designated area.^{1,2}

Table 1: Authorized department of Anatomy for bone examination in Maharashtra^{1,2}		
Sr No	Name of the colleges (Govt = Government)	Name of the district
1	Grant Medical College, Mumbai	Mumbai, Thane, Nashik, Raigad
2	BJ Medical College, Pune	Pune, Satara, Ahmednagar
3	Govt Medical College, Solapur	Solapur, Osmanabad, Latur
4	Govt Medical College, Miraj	Sangli, Kolhapur, Ratnagiri, Sindhudurg
5	SRTR Medical College, Ambajogai	Beed, Purbhani
6	Govt Medical College, Aurangabad	Aurangabad, Buldhana, Jalna, Akola, Nanded
7	Govt Medical College, Nagpur	Nagpur, Amravati, Yavatmal, Chandrapur, Gadchiroli, Bhandara, Wardha
8	BH Govt Medical College, Dhule	Dhule, Jalgaon

Materials and Methodology:

The present study is an observational cross sectional study which includes all medico-legal cases received in the Anatomy Department of Government Medical College, Nagpur. This is an authorized medical centre where medico-legal cases were received, not only across the district but also from the neighboring districts of the Vidarbha region of Maharashtra for bone examination in disputed cases, or to confirm the identity of the deceased. The study was conducted during the period January 2004 to December 2014. The accompanying police papers provided

much of the information regarding age, sex, address, date of missing, condition of body, place of retrieval and manner of death along with the history. After maceration, bone examination was done for reconstructive identification in the form of age, sex, stature, injury, etc also provides confirmative information. With this background, the present study was conducted to determine the pattern of medico-legal cases brought for anatomical bone examination after reviewing the medico-legal record of the Anatomy department.

Results:

During the 11- year period from 2004 to 2014, a total of 256 medico-legal cases were examined in this center. As per **Fig 1**, the average number of medico-legal cases per year was 23.3, with range 17 to 38. Maximum medicolegal cases were recorded in the year 2006 and least number was recorded in the year 2013.

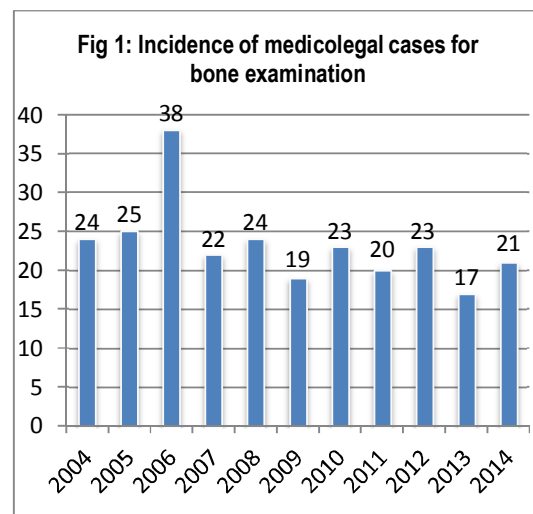


Fig 2 shows the distribution of source of medico-legal cases, whether human or animal, after considering both police information and the bone examination. Of the total 256 medico-legal cases, 91% cases were of human origin and 1.6% cases were of animal origin. The source was not known in 7.42% cases.

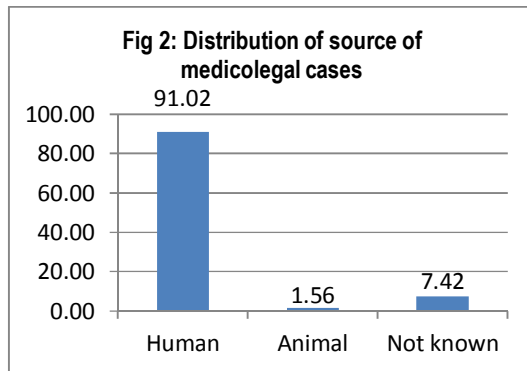


Table 2 shows the distribution as per the area, from which these medico-legal cases were received for bone examination. Maximum cases were received from Nagpur district seen in 23.8% cases. This was followed by Chandrapur district in 19.1%, Bhandara district in 12.9% and Yavatmal district in 11.7% cases.

Table 2: Area-wise distribution of medicolegal cases

Area (District)	Number	%
Amravati	28	10.94
Bhandara	33	12.89
Buldhana	1	0.39
Chandrapur	49	19.14
Gadchiroli	18	7.03
Gondia	23	8.98
Nagpur	61	23.83
Wardha	12	4.69
Washim	1	0.39
Yavatmal	30	11.72
Total	256	100.00

Table 3 shows the distribution of claimed and unclaimed medico-legal cases. The body was claimed in 55.9% cases by the relatives of the deceased, when recovered by the police. The body was identified by relatives either from the clothes or belonging or due to the confession of the crime by the accused. The claimed body was identified in 52.7% and remained unidentified in only 3.1% cases, after anatomical examination. However, it remained unidentified even after anatomical examination and police investigation in 28.5% cases

Table 3: Distribution of claimed and unclaimed cases

Identity	Claimed	%	Unclaimed	%
Identified	135	52.73	70	27.34
Unidentified	8	3.13	73	28.52
Total	143	55.86	113	44.14

As per **Table 4**, most number of medico-legal cases was recovered by the

police from the forest area in 24.6% cases, followed by barren land in 12.9% cases and farms in 12.5% cases. In 8.6% medico-legal cases, the body was recovered from the place of residence either from home, ashram, hospital, railway station, etc. In 7.8% cases, the body was found in canal. Bodies were also recovered from lake, river and well in 15.2% cases.

Table 4: Distribution of location of body recovered by police

Location	Number	%
Forest	63	24.61
Barren land	33	12.89
Farm	32	12.50
Resident place*	22	8.59
Road side	11	4.30
Railway track	5	1.95
Canal	20	7.81
Lake	10	3.91
River	17	6.64
Well	12	4.69
Crematorium	7	2.73
Graveyard	8	3.13
Septic tank	4	1.56
Vehicle, Railway Wagon	4	1.56
other	4	1.56
Water tank	2	0.78
Valley	2	0.78
Total	256	100.00

(*home=16, ashram=1, behind dargah=3, Hospital=1, railway station=1)

Table 5 shows distribution of source of retrieval of body received for anatomical examination. Usually the body was retrieved from open or land surface in 55.9% cases. It was retrieved from water sources in 25.4% cases and from below the land while digging or exhumation in 14.06% cases. Two cases were retrieved from the valley and 10 cases were found in the container or bag or vehicle.

Table 5: Distribution of source of retrieval of body

Source	Number	%
Open (land surface)	143	55.86
Burial (below land)	36	14.06
Water	65	25.39
Valley	2	0.78
Container/ vehicle	10	3.91
Total	256	100.00

As shown in **Table 6**, the medico-legal cases were received directly without autopsy for bone examination in 45.7% cases and were received after autopsy in 54.3% cases. The body was exhumed for bone examination in 11.7% cases.

Table 6: Distribution of medicolegal cases brought directly or after postmortem

Examination	Number	%
Direct without PM*	117	45.70
Indirect after PM**	139	54.30
Total	256	100.00

* Exhumed in 14 cases, ** Exhumed in 16 cases

Table 7 shows the distributions of medico-legal cases depending on the status of body whether complete, partial, skeleton or skeletonised remains. The body was complete in 21.1% cases, partial in 9.8% and only a part of the body was available in 8.6% cases. Complete skeleton was received in 11.7% cases, but the skeletal remains in the form of dry or wet bone or separated bones were received in 41% cases. In 7.8% cases, only pieces of bone were available for anatomical examination.

Table 7: Distribution of medicolegal cases depending on status of body

Status of body	Number	%
Complete	54	21.09
Partial	25	9.77
Part of body	22	8.59
Skeleton body	30	11.72
Skeleton remains -bone	105	41.02
Bone pieces	20	7.81
Total	256	100.00

(Partial= more than half of the body; part of the body= only some body parts like head, limbs, etc)

Skeleton body= almost complete skeleton; skeletal remains= one or few separated bones)

Table 8 shows the distribution of medico-legal cases depending on the condition of the body received for the anatomical examination. The body was decomposed in 30.1% cases, partial skeletonised in 17.2%, burnt in 7%, normal in 2.3% and infested by animals in 8.2% cases. Dry bones were recovered by police in 9.8%, and wet in 41% cases for anatomical examination. Piece of bones were only present in 2.3% cases and burnt bone pieces were available in 5.5% cases for anatomical examination.

Table 8: Distribution of medicolegal cases depending on the condition of body (n=256)

Condition of body	Number	%
Normal (NAD)	6	2.34
Burnt/ charred	18	7.03
Decomposed	77	30.08
Skeletonised	44	17.19
Excavenging by animal	21	8.20
Dry bone(s)	25	9.77
Wet bone(s)	105	41.02
Bone piece(s)	6	2.34
Burnt bone piece(s)	14	5.47

(Normal= Non-decomposed and complete)

Table 9 shows the distribution of manner of death on the basis of police investigation and anatomical examination. In medico-legal cases for bone examination, homicide was the commonest manner of death, seen in 28.9% cases, followed by the suicide in 7.8%, accident in 6.3% and natural in 2.3% cases. Attack by wild animals was noted in 1.2% and concealment of birth of fetus in 1.2% cases. In 52.3% cases, the manner of death was not known even after police investigation.

Table 9: Distribution of manner of death in medicolegal cases

Manner of death	Number	%
Suicidal	20	7.81
Homicidal	74	28.91
Accidental	16	6.25
Natural	6	2.34
Attack by wild animal	3	1.17
Concealment of birth	3	1.17
Not known	134	52.34
Total	256	100.00

Of the total 256 cases, determination of sex was not asked of the anatomy expert in 44 cases. Thus, as per **Table 10**, of the remaining 212 medico-legal cases, the sex was confirmed as either male or female in 78.8% cases from bone examination and not known in 19.3% cases. But, in 4 cases, the bones turned out to be of animal origin.

Table 10: Distribution of age and sex opinion from bone examination

Gender (n=212)	Number	%
Male	129	60.85
Female	38	17.92
Not known	41	19.34

Similarly, the opinion about age was not asked in 26 cases. Thus, out of the remaining cases, the opinion regarding age from bone examination was given in 88.7% and could not be given/ possible in 9.6% cases.

Discussion:

Medico-legal case is a case where the investigation is carried out by various investigating agencies. Bone examination is a special type of investigation done either in the department of Anatomy or Forensic Medicine for different purposes. Reconstructive identification can be possible from bone examination in the form of age, sex, stature, race, etc. In some cases, the identification can be possible by means of superimposition method and reconstruction of facial features from the skull bone. As per the directions of Supreme Court of India in decomposed dead body, the matter should be referred to Anatomy expert, especially when the bones of dead body have fallen out and are separate. It is incumbent upon the doctor to have referred the matter to anatomy expert, and failure of which is a serious lacuna to the prosecution case.^{3,4}

In the present study, 23.3 medico-legal cases per year were examined in the department of Anatomy for bone examination with peak incidence seen in the year 2006. The body was claimed in 55.86% cases and unclaimed in 44.14% when recovered by the police. Almost 50% medicolegal cases were recovered by police from the forest, barren land and farm. The body was usually retrieved from the open land surface followed by water surface. The medicolegal cases were received indirectly after postmortem examination in 54.3% cases. This is partially due to the fact that police usually takes such medicolegal cases for the postmortem examination and then forwarded to the anatomy department by the autopsy surgeon for bone examination, particularly in the partial body, skeletonised body and mutilated body. The medicolegal cases were usually received in the form of skeletal remains, either bone or bones in 41.02% cases. The complete skeleton was present in 11.72% and bone pieces in 7.81% cases. Thus, the bones were available in

almost 60% medicolegal cases for anatomical opinion.

The bones were predominantly of human source with only 1.56% cases were of animal source. The source was not known even after bone examination in 7.72% cases due to small insufficient and charred bone pieces available for the opinion. The manner of death was not known in more than 50% cases probably due to loss of circumstantial evidence, non-availability of complete body, and the body remained unidentified even after police investigation. But, the opinion regarding age and gender was confirmed in 88.7% and 78.8% respectively from bone examination.

Conclusions:

1. Bone examination is a special type of investigation carried out in disputed cases or to confirm the identity of the deceased.
2. The medicolegal cases were unclaimed in 44.1% and remained unidentified in 28.5% cases even after police investigation. Almost 50% of the medico-legal cases were recovered from forest, barren land and farm. It was received directly without any preliminary postmortem examination in 45.7% cases. Almost 60% of the cases were usually in the form of skeletal remains, either dry/ wet bone or bone pieces.
3. The cases were predominantly of human source with only 1.6% cases of animal source. The opinion regarding age and sex was given after bone examination in 88.7% and 78.8% cases respectively.

Conflict of Interest: None

Financial Assistance: None

References:

1. Pawar SD, Dhapate SS. Examination of recovered human remains: Role of anatomist. J Medicolegal Asso Maharashtra 2003;14:8-9.
2. Government Resolution No. CRA-697 dated 6 Feb 1998, Home department, Government of Maharashtra regarding authorization of centers for bone examination.
3. AIR 1975 SC 258: 1975 Cri LJ 282, State of Punjab v Bhajansingh . Supreme Court, India.
4. Bhanwar Singh v State of Rajasthan, 1988 Cri LJ 1054 . Rajasthan High Court, India.

Review Research Paper

History of Forensic Medicine of India with Reference to Crime and Punishments during British Period (1757 To 1947)

¹A.M.M.Patnaik, ²M. Jagadeesh Naik, ³Ch. Lakshmi Kumar

Abstract:

The British political ascendancy in India began after the battle of Plassey in 1757 and ended in 1947. During their rule (1757 to 1947), Forensic medicine was an evolving subject in India. Most Indians were poor, illiterate, and orthodox, with low morals that breed - need, greed, lust, rage and revenge. Such a society, though timid and gentle in appearance outwardly, was ripe for committing crimes - of passion, theft, robbery and religious. Perjury, impersonation, extreme forms of torture, child stealing for prostitution, child killing for their ornaments, murder of women and elderly men, assassination, arson, adultery, rape, unnatural sex offences and criminal abortion were the leading crimes of the day. The means availed by the delinquent included drugging, poisoning, strangulation and use of sword. Deception tactics, concealing bodies, disposal of bodies by burning, throwing into water bodies etc. were employed to avoid detection. This rich haul of intricate crimes and the punitive actions of the British including evolution of forensic medicine is the subject of our learning. This history is divided into two periods: 1. 1757 to 1857 AD (Company rule)

2. 1858 to 1947AD (Crown rule)

Key Words: Nizamat Adalats, Regulatory Acts, Assessors

Introduction:

History of Forensic Medicine was introduced in the curricula of some Indian universities recently at the undergraduate level. Keeping this in mind, an endeavor has been made into enlarging the scope of evolution of Forensic Medicine during British rule (1757-1947). The history would be described as per the headings mentioned below:

The Geo-political conditions of India in the 19th century.

(Map-A) & (Map - B) show the extent

of territories of the East India Company in 1805 & 1857, respectively. The British Crown took over governance of India in 1857.

Judicial Machinery:¹ The criminal justice system was taken over by the English servants of the company in 1790. As per the Judicial reforms of 1793, district criminal courts (Nizamat Adalats with collector as head, regional Nizamat Adalats, the equivalents of high courts (courts of circuit appeal) were established at Mushirabad, Decca, Patna, Allahabad, Agra, Lahore, Madras and Bombay. The Sadar Nizamat Adalat at Calcutta functioned like a superior court. Supreme courts were established in Madras in 1801 and in Bombay in 1823. The provincial courts of appeal and courts of circuit were abolished in 1830 & 1843, respectively.

Indians were entrusted with only magisterial duties in the rural areas, due to their untrustworthiness. Initially, the kazis and the pundits assisted in the delivery of justice in the district courts. Later English Sessions Judges tried the cases with the help of Indian assessors. The trial was with the help of jurors in High courts.

Corresponding Author:

¹Professor,

²Associate Professor,

³Professor & Principal,

Department of Forensic Medicine MIMS Medical College, Nellimarla (Vizianagaram) A.P.

Email: forensicpatnaik.a@gmail.com.

L. M. No: Not a Member

DOR: 27/02/2017 DOA: 21/03/2018

DOI: 10.5958/0974-0848.2018.00018.0

After 1857:

The British government replicated British laws in India, after 1857. The Indian Penal Code 1860, The Criminal Procedure Code 1861 and The Indian Evidence Act 1872, drafted by Macaulay, the law member of the Governor General's council in 1837; were enacted after some modifications and considerable delay on 06/10/1860.²

The courts of magistrates 1st class, 2nd class and 3rd class, in mofussil towns, Sessions courts at district level and High courts at state level were established. The High courts were established at Calcutta, Allahabad, Lucknow, Patna, Lahore, Bombay and Madras. The courts of Coroners were established at Bombay and Calcutta under the Coroner's act of 1871.³ All civil and criminal cases had to be appealed at the judicial commission of the Privy Council at London, which was constituted by an act of British parliament in 1833 to hear appeals from overseas British territories.

Historical Punishments:

(A) Transportation for life, in which a convicted prisoner was sent to a penal colony overseas. The cellular jail in Andaman and Nicobar, established in 1870, served as a penal colony. Several freedom fighters languished and died unsung in this savage jail. This was abolished after attaining independence.

(B) Whipping⁴: All females and all males above 45 years of age were exempt from whipping; which was abolished by an Act of Parliament of India in 1954.

Relevant Historical Acts:

1. Regulation Act VIII of 1799: Willful murder by poisoning would attract death penalty as per this regulation and life imprisonment, if no death occurred; due to high ratio of homicidal poisoning cases as narrated by Mathiharan.⁵
2. The Opium Act of 1857 regulated cultivation and manufacture of opium poppy under government monopoly.⁶
3. The Lunatic Asylums Act of 1858 regulated restraint of insane to the mental asylums with separate hospitals for the Europeans and Indians.⁷

4. The Coroners Act of 1871 introduced Coroner's system at Calcutta and Bombay. Coroners were also operating in the presidency towns during company rule.
5. The Ilbert Bill of 1883⁸ gave powers to the Indian judges to try and examine European accused and victims in cases like rape, assault etc. It came into force in 1884.
6. The Indian Lunacy Act of 1912⁹ replaced the Lunatic Asylums Act of 1858. For the first time in 1922, the words mentally ill and mental hospitals were used instead of insane, lunatic and lunatic asylum.
7. The Poisons Act of 1904 & 1919¹⁰: For the first time these two Acts were enacted to restrict sale, importation, possession of poisons etc.
 - a. The Medical Degrees Act of 1916: the first of its kind regulated the Western medical degrees granted by medical colleges in India and provided safe guards in eliminating unqualified persons from practicing allopathic medicine.
 - b. The Workmen's Compensation Act of 1923: is a social security Act meant for the disabled workers of the factories at work place.
 - c. The Indian Medical Council Act: was passed by Indian Legislative assembly in 1933.
 - d. The Drugs and Cosmetics Act, 1940 and Rules of 1945. Regulated import of drugs into India and manufacture, distribution and sale of drugs.

The Police system:

The Inspector General of Police and the Superintendent of Police at the state and district levels was exclusively European. The sub inspector of police and the constables at the Thana level were Indians. At the village level, the home guards and mohuriars were to report crimes and apprehend suspects. The darogah, in all suspected cases of death, would conduct an inquest and forward the dead body along with the report to the nearest sub-divisional magistrate, who would quickly assess the report and would forward the dead body along with his own report to the Civil

Surgeon for a post-mortem examination. In advanced decomposition conditions, the body might not be forwarded by the police officer if weather and distances did not favor. This procedure was done away during the Crown rule and the police officer would directly send the dead body to the Civil Surgeon. The same procedure was followed for live victims of poisoning and serious injury¹¹.

The Medico-legal System¹²:

The British introduced a system of civil surgeons at the district level, trained in western medicine, to the I.M.S (Indian Medical Service) cadre, who were posted both to the army and the civil stations. These were to be men of ability and character and were to be intolerant to any degree of abuse. They were selected through a highly competitive examination held at London. The civil surgeons had the option to reject internal examination of the dead bodies if the bodies were in an advanced state of decomposition. After the 1840s, Indian Medical Diploma holders posted as sub assistant surgeons, also opined on medico-legal cases. The professor of forensic medicine worked as police surgeon and Coroner in presidency towns. The civil surgeons post-independence lacked this sort of training and the system collapsed in due course of time.

Evolution of Medical Jurisprudence in India¹³:

The National Medical College at Calcutta was started in 1835. The L.M.S course was upgraded to M.B course in 1907. Medical jurisprudence was included in part two of M.B course. Dr. F. J. Mouat taught medical jurisprudence in the initial years. In 1842, Dr. O'Shaughnessy, Chemical Examiner to the Government, issued clear guidelines for transmission of viscera placed in properly corked and sealed glass bottles over which the private seal of the surgeon or the magistrate was affixed and then put inside tin boxes. The Civil Surgeons, assistant surgeons and sub-assistant surgeons, were all conducting chemical examination of the stomach contents, vomitus and other incriminating material; at the civil stations.

In 1843, Dr. Mouat, Chemical Examiner, obtained vegetable and mineral poisons; from various locations of the country. He analyzed the poisons and categorized them as follows:

Category1. Arsenic, Aconite, Nux Vomica, Opium, Lall Chitra, Oleander; all deadly poisons were preferred for homicidal and suicidal purposes.

Category2. Datura and Ganjah which cause intoxication and insensibility were extensively used for facilitating robberies.

Category3. Lall Chitra was the traditional abortionist's choice.

Category4. Copper Sulphate, Arsenic, Snake poison, Bis Baree were medicines in the native doctor's kit.

The first professor of medical jurisprudence was Dr. Woodford (1850-60). Dr. Norman Chevers, serving as secretary to medical board to the government, published *A Manual of Medical Jurisprudence Including History of Crime in India* in 1856. He was also the principal of Calcutta Medical College from 1861-1876. He strongly advocated the use of photography at the crime scene, though photography was cumbersome in those days.

Dr S. C. Mackenzie,¹⁴ professor of medical jurisprudence, (1879-1894) did pioneering work on changes in dead bodies like rigor mortis, greenish discoloration, maggots, evolution of gases, onset of adipocerosus etc, for calculating time since death. 305 cases of drowning were analyzed by Mackenzie to know the causes of death. J. C. S. Vaughan, John Moses, A. Porter, D. G. Rai, Collis Barry were the reputed medico-legists of that period.

Dactylography introduced by Sir William Herschel in 1858 to prevent impersonation in civil life; was a revolutionary contribution to the field of legal medicine.¹⁵ Edward Richard Henry, I.G. of Police, Bengal, abandoned anthropometry for Dactylography in 1897, which was adopted by the Government of India in 1897 and Scotland Yard in 1901.

The Scenario at Bombay¹⁶:

The Grant Medical College was started at the jeejeebhoy Jasmhed jee hospitals in the year 1845. Dr. Colls started teaching medical jurisprudence in 1849. Dr.

L.A. Waddell conducted a large series of experiments for producing an anti toxin against snake bite on the lines of anthrax vaccine, in 1888. Unfortunately, his experiments were halted due to want of patronage by the Government. In 1901, the anti venom discovered by Dr. M. Calmette and Prof. Fraser, was supplied to Indian civil and military stations.

The Scenario at Madras¹⁷:

The Madras Medical College was started as a medical school in the year 1835. Dr John Urquhart (1825-1892), was assigned the duties of the Coroner and Professor of Medical Jurisprudence at Madras Medical college in 1857, during the company rule. Major Vangeysel, in 1900, reported a high ratio of homicidal poisoning cases for the years 1897, 98 & 99, which was more than the figures available for England. The most common poison used was white arsenic. Further, Lt. Col. Newcomb, Principal, Madras Medical College and Chemical Examiner, corroborated this fact after studying 300 poisoning cases in 1934.¹⁸

The Scenario in the first half of 20th century:

More medical schools were established and some of them upgraded to medical colleges. The I.M.S; so far the exclusive domain of the British, was opened to the Indians. Indian civil surgeons in good numbers started conducting autopsies.¹⁹ A new Indian star and a pioneer, J. P. Modi (1875 - 1954), proved himself as a competent medical jurist and showed the path for independent India. ~~%~~Medical Jurisprudence and Toxicology+edited by Modi, was published in 1920 and the 25th edition in 2016.

Some Medieval Crimes Prevalent During the Period:

1) **Large scale concealment of bodies after murder:** In those days, with dense forest cover available all over India; the bodies of murdered victims were being concealed in jungles, in the sandy beds of rivers or were thrown into water bodies to conceal the crime. To detect the bodies, search parties methodically proceeded by

digging in the houses, searching in garbage heaps, etc and often they succeeded.

- 2) **Torture:** Varieties of torture were practiced by parents, school masters, husbands, police, and rulers on children, pupils, wives, prisoners and tenants, respectively; including application of heat, suspending persons, application of irritants, introduction of solid bodies into vagina, rectum etc; torture by compression, binding in painful positions, releasing stinging or gnawing creatures on the person, sticking pins or thorns under the nails, submerging under water, filling the mouth with pebbles, mud and sand and striking the chin upwards, pulling the hair on both sides, beating the ankle and other joints with a soft mallet, closing the nostrils till the victim was half suffocated, etc.
- 3) **The curse of human sacrifice:** Human sacrifice aimed at appeasing Gods, for success of individuals, communities and rajas was a common practice in many parts of the country.
- 4) **Rape and unnatural sexual offences:** These heinous crimes were as common as today's figures. Eunuchs in some North Indian cities were practicing sodomy as a means of livelihood.
- 5) **Cases of fatal injuries on first intercourse,** due to the custom of child marriages, deaths were frequently reported as healthy adult grooms tried to have forcible intercourse with their child wives.
- 6) **Rampant criminal abortions, concealing birth and abandonment of children:** The custom of child marriages resulted in large number of child widows due to low life expectancy of males. This unpleasant social situation led to large number of illegal pregnancies in grown up widows; besides unmarried and married women, whose husbands were away, were also victims of this scourge. The hard choice for such hapless victims was crude criminal abortions resulting in large number of maternal deaths. Where ever abortions failed or pregnancies resulted in

live births; the births were concealed by abandoning or killing the new born.

- 7) **Female Infanticide**: In many villages of Benares district, there were no girls. In Mianpur, in eleven villages, the girl child population was zero and in 30 villages, 37 girls were accounted for 329 boys. The situation in other places in India was similar. After a stringent legislation by the government in 1870, the figures gradually improved. The practice of female feticide is rampant even in the present day.
- 8) **Juggernaut**²⁰: The annual Cart Festival of Lord Jagannath at Puri (Odisha); drawn on an enormous wooden cart, under whose wheels devotees threw themselves to be crushed to attain moksha (salvation).
- 9) **Sati**²¹: In this medieval Hindu practice, a widow would forcibly be immolated by fire on the funeral pyre of her husband, by the relatives. This practice was outlawed by Lord Dalhousie in 1829. Estimated five to six hundred instances were occurring in British India annually in the 19th century.
- 10) **Thuggi**²²: Thugs (phasighars) were a secret sect of an organized gang of professional robbers and murderers, who roamed in groups across the Indian subcontinent; accompanying and befriending unsuspecting travelers. They robbed and killed the travelers at opportunist moments, by manual strangulation (phasi) undertaken with a large hand kerchief or a noose, by a group of 3 thugs. According to British Historian Mike Dash, 50,000 people were killed in 150 years. The thugs were crushed by Lord William Bentinck and his chief, Captain Sleeman, in the 1820s.
- 11) **Pindaries**²³: They consisted of roughly 30,000 horsemen, who operated in the Central and South India. These Pindaries were making forays into the villages - killing people, burning houses, molesting females and plundering households in British Territories. In 1818, an army of 1, 20,000 soldiers encircled them and delivered a crushing blow after which the Pindaries disappeared from India.
- 12) **Commonly used poisons of the period**: Datura, cannabis, Nux Vomica, opium, bish boree, Arsenic, mercury, copper

sulphate etc. were extensively used for suicidal, homicidal purposes and for procuring criminal abortion. These poisons were available in the bazaars of India without any restriction. Arsenic eating, like opium and tobacco was practiced by some communities to increase physical stamina etc.

In 1899, two cases of arsenic being sent by post for homicidal purpose were recorded. Cattle poisoning, for their hides, was a big racket involving well organized gangs with the suppliers, middle men and executioners involved in the crime. Arsenic Suis were used for poisoning cattle. These hides were exported to Britain, France and America in large quantities for profit. During this century Datura was extensively used for road side robberies. Cases of running amok were also reported after opium eating.

Lathyrus sativus (kesar dal) poisoning in central India:

In 1833, Colonel Sleeman reported large number of cases of paralysis of lower limbs in people below 30 years of age due to consumption of kesar dal as staple. Once affected; there was no recovery. Fortunately, no new cases were reported since 1834. Cattle fed on kesar dal did not suffer from paralysis.

Causes of accidental deaths:

Drowning, snake bite, mauling by wild animals, constituted bulk of the cases in those days.

Means of suicidal deaths:

Hanging in rural and poisoning, hanging, drowning in urban areas, were the methods adapted.

- 13) **Treatment of snake bite**: It included free excision of 2" square to be carried out till the depth of the fangs; soft parts to be excised down to the bone if the bite was on the extremity. Fingers and toes were to be amputated, if the bite was on the fingers or toes. Reliance was placed on early free excision. The treatment included administration of stimulants, application of poultice, ammonia to smell, artificial respiration etc.

Some Sensational & Celebrity Cases:

1. **Determination of identity of a detained person by police**²⁴:

Dr. Norman Chevers Principal of Calcutta Medical College, in 1872, was asked by Government of India to proceed to Cawnpore (Kanpur) to determine the identity of a person detained by police. The Government suspected the detainee to be the legendary Maratha prince Nana Sahib, who actively fought British during the first war of independence, in 1857. He was wanted for war crimes and went underground after the mutiny. As per the citation in the obituary of Norman Chevers, (1886) he had satisfactorily conducted the case, for which he received commendation from Government of India. It was however not clear whether the detained person was the great Maratha prince or not.

2. **The celebrity case of Baroda**²⁵:

Arsenic was detected in the sherbet offered to British resident, Col. Phayre, by a peon of the Residency, with the alleged complicity of the Gaikwad of Baroda, in 1874. Since the issue directly challenged the British paramountcy; a court of inquiry consisting of three high level Indian members and three high level British members was ordered by the Governor-General of India. The committee gave a fractured verdict. The case eventually went for trial to the Bombay High Court, where the Gaikwad successfully defended the case. Nothing happened to the British resident after taking a couple of gulps of sherbet. In all probability, the Gaikwad was framed by the British resident.

3. **Establishing identity with the help of thumb print in a murder case**:

The case of one Kangali Charan, arrested for the murder of a tea garden manager in 1889, was determined by finger prints, much before finger prints were approved as evidence by Government.

4. **The sensational Fulham case and exhumation**²⁶:

Modi reported a notable case of exhumation on the body of the late Mr. Fulham, conducted at Agra. Orders for exhumation were issued by the district magistrate of Agra on 6-12-1912. This case is a role model for generations of medical officers to follow the rules on exhumation. Arsenic was

detected in the long bones of late Fulham 14 months after death.

Conclusion:

Offences against persons and mindsets of criminals have changed little in the 200 years since British started medico-legal institutions in India. The teaching of Forensic Medicine remains the same since 1840. Offences like Sati, Thuggi, Juggernaut, road side drugging, human sacrifice, Homicidal poisoning, old methods of torture, attended crimes due to run amok by opium chewing have all but disappeared. These are for us, ~~historical~~ historical crimes+now.

The prestigious Indian Medical Service was abolished during Second World War. The British who ruled India for nearly 200 years, altogether left India after 1947, but the institutions they created have survived and flourished.

Conflict of Interest: None

Financial Assistance: None

References:

1. Available from: https://www.academia.edu/5106252/judicial_system_of_east_india_company. Accessed on: 10-02-2017.
2. Mittal S, Mittal S, Mittal MS. Evolution of forensic medicine in india, J Ind Acad Forensic Med 2007;29(4):90-4.
3. Available from: <https://indiankanoon.org/doc/792853/>. Accessed on 10-02-2017.
4. Available from: <http://hansard.millbanksystems.com/commons/1880/jun/28/india-punishment-of-flogging>. Accessed on 10-02-2017.
5. Karunakaran M. Origin and development of forensic medicine in india; Am J Forensic Med Pathol 2005;26(3):254-60.
6. Available from: Cbn.nic.in/html/opium_history/html. Accessed on 22-1-2017.
7. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3705679/>. Accessed on 22-1-2017
8. Available from: <https://www.britannica.com/event/Ilbert-Bill>. Accessed on 22-1-2017
9. Available from: http://www.rfhha.org/images/pdf/Hospital_Laws/Indian_lunacy_act_1912.pdf Accessed on 22-1-2017
10. Modi JP. Modi's medical jurisprudence & toxicology, 16th Ed. 1967. Eds Modi NJ, N M

- Tripathy pvt. Ltd. page no: 451(3); 428; 447(5); 429(4); 455, 456 & 457.
11. A Manual of medical jurisprudence for Bengal and North western provinces by Norman Chevers, M.D, Published by: F. Carbery, Bengal Military Orphan Press . 1856; page no: 198,199;14, 15 & 16; 190; 187-189; 69; 24,25; 44 . 63; 200 . 234; 237 . 246; 460 . 468; 479 . 484; 489 . 493;
 12. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2068793/>. Accessed on 10-02-2017.
 13. Available from: http://www.histopathology-india.net/history_of_medicine.htm. Accessed on 10-02-2017.
 14. Lyon IB. Medical Jurisprudence for India. 3rd Ed. 1904; Eds Waddell LA. Thacker Spink & Co., Ltd., page: 70, 71 & 200,201; 303; 488-522; 639-640; 51, 52, 53; 131,132.
 15. Subrahmanyam BV. Modi's Medical Jurisprudence & Toxicology, 22nd edition . 2004. LexisNexis Butterworths, New Delhi; P.P:28 . 1.
 16. Available from: https://en.wikipedia.org/wiki/Grant_Medical_College_and_Sir_Jamshedjee_Jeejeebhoy_Group_of_Hospitals. Accessed on 10-02-2017.
 17. Available from: <https://findagrave.com/cgi-bin/fg.cgi?page=gr&GRid=133030338>. Accessed on 10-02-2017.
 18. Kannan K, Mathiharan K. Modi's Medical Jurisprudence & Toxicology, 24th Ed. 2012. LexisNexis Butterworths Wadhwa, Nagpur; P.P: 8-2, 9-6&10-2, 4.
 19. Available from: https://en.wikipedia.org/wiki/Indian_Medical_Service. Accessed on 20-03-2018.
 20. Available from: <http://www.dictionary.com/browse/juggernaut>. Accessed on 13-02-2017.
 21. Available from: org.wiki/sati-practice, www.dictionary.com. Accessed on 13-02-2017.
 22. Available from: <https://en.wikipedia.org/wiki/thugge>, accessed on 13-02-2017.
 23. Available from: <https://en.wikipedia.org/wiki/pindari>, www.dictionary.com, Accessed on 13-02-2017.
 24. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2257808/?page=1> the BMJ, vol. 2. No: 1355, Dec 18, 1886, page 1245. Accessed on 20-06-2016.
 25. Available from: http://bombayhighcourt.nic.in/libweb/historicalcases/cases/Trial_Of_Malharrao_Gaikwad1875.html. Accessed on 15-02-2017.
 26. Available from: <http://trove.nla.gov.au/list?id=42937>, Accessed on 15-02-2017.

Case Report

Atypical Missile Wound From an Improvised Firecracker Buster Pipe: A Case Report

¹Narendra Kumar, ²Hemant Kukde, ³Ramesh Savardekar

Abstract:

Dead body of a 17 year old boy was brought for medico-legal autopsy with a history of collapse and sudden death while bursting a jute twine (sutli) bomb contained in an iron pipe during a religious procession. Upon noticing an apparent stab injury on chest, a case of homicide was registered by the police. During autopsy, a penetrating wound, with irregular margins was noted on right side of chest and a circular metal plate was found embedded in right lung and right atrium of heart with a huge hemothorax. The metal plate corresponded to the back end of the iron pipe that housed the bomb while bursting. It was concluded that the wound was an accidental missile wound caused by bomb blast within the pipe. Such atypical missile wounds are not frequently reported, highlighting the fatal potential of such commonly used firecrackers and is of concern to the autopsy surgeon as the injury mimics a stab wound.

Key Words: Autopsy, Missile, Fatal, Stab Wound, Foreign Body, Firecracker, Iron Pipe, Forensic Pathology

Introduction:

Bursting of firecrackers is very common in India during festivals, while rejoicing victories or in religious processions. Minor accidental burns while bursting fireworks are often reported, however they are seldom fatal. Jute twine bomb (locally called sutli bomb) (**Fig. 1**) is an Indian firecracker popular during the festival of Diwali and other celebrations. It creates a huge sound while bursting and is the noisiest firecracker, exceeding the permissible sound barrier of 145 decibels (dB). Efforts are being made by many NGOs to ban the sale and use of this bomb.

We report a fatal case, where a 17 year old boy died while bursting a jute twine bomb contained in an iron pipe (**Fig. 2**) during a religious procession.

The case highlights the fatal nature of such bomb when used in a container like pipe. The wounds from such injuries are of particular concern to the forensic pathologist as they closely mimic stab wounds and at times may resemble atypical gunshot wounds.

Fig 1. Showing Jute Twine bomb



Figure 2: Iron pipe used for bursting bomb



Corresponding Author:

¹Assistant Professor,

²Associate professor,

³Professor & Head,

Dept. Forensic Medicine & Toxicology,
Lokmanya Tilak Municipal Medical College &
General Hospital, Sion, Mumbai

E Mail ID: naren2014@gmail.com.

L. M. No: Not a Member

DOR: 04/07/2017 DOA: 04/01/2018

DOI: 10.5958/0974-0848.2018.00019.2

Case summary:

A dead body of a 17 years male was brought for medico-legal autopsy with alleged history of homicide. On perusal of inquest papers and enquiring with the investigating officer it was revealed that the deceased was a participant of a religious procession and was bursting jute twine bombs housed in an improvised iron pipe. During the ongoing procession he had burst multiple bombs of the similar make. While doing so he suddenly collapsed and became unresponsive. He was rushed to a nearby hospital, where he was declared brought dead. The investigating officer, upon noticing a stab wound on the chest, registered a case of homicide against an unknown assailant.

At autopsy, the deceased was thin built with generalised & well marked rigor mortis. A penetrating wound was noted on the right side of middle 1/3rd chest extending up to midline, situated 4 cm medial to right nipple of size 4.5 cm x 2.5 cm, cavity deep, margins abraded and contused (**Fig. 3**). No other injury was present on the body at the time of examination.

Fig. 3 Showing penetrating wound on chest



penetrating wound on right side of chest

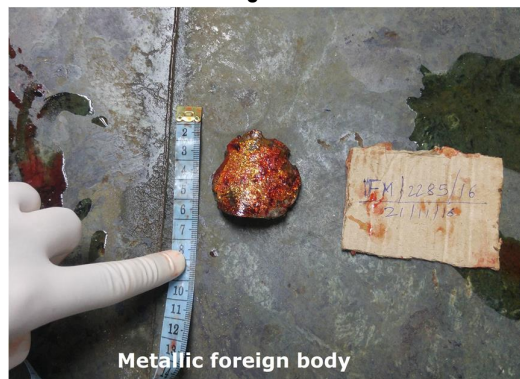
On internal examination, the right 5th rib was fractured, with irregular margins. Extravasation of blood was present in the surrounding tissues (**Fig. 4**). About 1 litre blood and blood clots were present in thoracic cavity. A slightly deformed circular metallic foreign body measuring 4cm x 4cm x 0.1cm and weighing 9 gram, was present embedded in the lower lobe of right lung and right atrium of heart (**Fig. 5 & 6**). Right lung was partially collapsed. All other visceral organs were pale. Stomach contained about 500cc partially digested food without any abnormal odor. It was concluded that the injury is accidental and cause of death was ascertained as %Shock and

hemorrhage following penetrating chest trauma+.

Figure 4

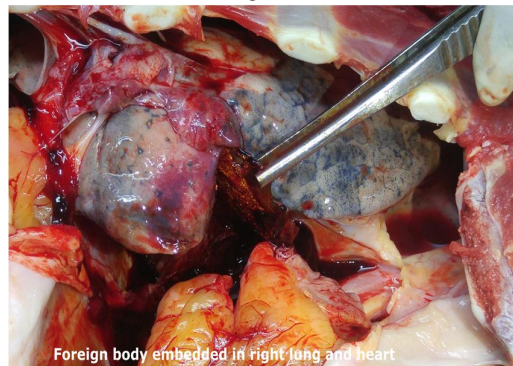


Figure 5



Metallic foreign body

Figure 6



Foreign body embedded in right lung and heart

Discussion:

Chemical explosives are grouped as High-order or Low-order explosives. High-order explosives such as trinitrotoluene (TNT), semtex, nitro-glycerine and dynamite produce a supersonic wave of overpressure in air. Low-order explosives such as gunpowder or petroleum-based devices produce a subsonic blast and, although they may produce

secondary missiles and cause burns, they are unlikely to produce primary blast injury.¹

Firecrackers are usually made up of gun powder, which contains charcoal, sulphur and potassium nitrate. Flash powder is used as an explosive component of firecrackers, which is a chemical mixture consisting of potassium perchlorate and finely powdered aluminium. Firecrackers are grouped under low-order explosives which burn at a steady speed and can be detonated under extreme circumstances.²

Detonations which occur within a confined space or which are confined by a restrictive container tend to result in enhanced energy release when the container ruptures under the pressure of the explosive reaction. Secondary blast injury is due to the effect of projectiles activated and set in motion by the blast being dispersed at speed with high kinetic energy. In order to produce damage, this kinetic energy of the projectiles has to be absorbed by the target tissues, where it is dissipated as heat, noise and mechanical disruption.³ Projectiles can be derived from the container of the explosive, or from parts of a vehicle or other items in the vicinity of the explosion.

The iron pipe used in this case was a 2 feet long hollow pipe with the rear end closed by a circular disc. Metallic handles, one on each side, were attached to the pipe by welding (**Fig. 6**). Jute twine bomb is busted by housing it at the open front end of the pipe. Upon busting, the jute twine bomb in this pipe, the sound created is of higher intensity with a long flash of light as compared to busting it in open. The busting of the jute twine bomb (low order explosive) contained in this improvised assembly resulted in an increased pressure within the iron pipe and by the virtue of which its rear end got detached. The detached rear end acted as a high speed projectile entering the thoracic cavity. Though the circular metal object weighed only 9 grams, the velocity

attained due to blast pressure was enough to penetrate the body tissues. The rear end of the main pipe in the present case was missing and corresponded with the circular metallic body found in the thoracic cavity.

Fatal wounds from high velocity projectile are not uncommon and reported by several authors. In one such case, a mechanic sustained penetrating mandibular injury, from the handle of a sledgehammer when the inner tube of a military truck tyre burst during repositioning.⁴ In another case,⁵ a deceased sustained cavity deep lacerations on the trunk, when the pressure valve of an oxygen cylinder acted as a missile due to bursting of the cylinder. Interpretation of wound and comparing the foreign body with the alleged weapon/object in such a case is pivotal for determining the manner of death as the injury mimics homicidal stab wound.

Conflict of Interest: None

Funding: Nil

References:

1. Centers for Disease Control and Prevention. Explosions and blast injuries: A primer for clinicians. Department of Health and Human Services USA. [Online] 2003 Available from: URL: <http://www.bt.cdc.gov/masstrauma/explosions>. cited 2005 June 2.
2. Wallace GL. Blast injury basics: a guide for the medical speech-language pathologist. ASHA Leader 2006;11:26-8.
3. Saukko P, Knight B. Knight's forensic pathology. 3rd ed. London: Arnold; 2004. p. 245-77.
4. Gilbert Lau. An unusual case of pneumatically-induced facial and cervical injuries: a case report. Forensic Sci Int 1995;73:131-8.
5. Millo T, Sharma P. Penetrating missile injury by sudden oxygen release from compressed oxygen cylinder: a case report J Indian Acad Forensic Med 2013;35(4):392-97.

Case Report

Sodomy – ‘The Sin of Sodom’: A Report on Five Cases

¹John Deb Barma, ²Memchoubi Ph, ³Th Meera Devi

Abstract:

Sodomy or the sin of Sodom is anal intercourse between two males or between a male and a female. It is the commonest of the unnatural sexual offences. A report on five cases involving five minor boys, who were forced into anal sex (sodomy) by three youths in their late teens in a remote area of a North-Eastern State of India is reported. Considering the nature of such a crime and to emphasize the fact that no age is safe and young boys can also be victims of such type of unnatural sexual offences, this paper has been presented.

Key Words: Unnatural Sex, Sodomy, Minor Boys

Introduction:

Sodomy is anal intercourse between two males, or between a male and female. This used to be practiced in a town called Sodom.¹ This sexual practice prevails all over the world without any age limitations, involving adults, children and old subjects. Old and children usually act as passive agents. Sodomy is popularly referred to as paederasty with a child acting as passive agent who is known as catamite and with old people serving as passive agent as gerontophilia. In many cases, sodomy may have minor degree psychological aberration. In vast majority of cases, possibly it is a compulsive or easy outlet of sexual desire. In male homosexuality, sodomy is the most popular and widely practised method.² In this paper, a report on cases of sodomy involving five minor boys in the remote area of North-Eastern State of Manipur is presented.

Case Report:

On 28th December 2015, in a remote village of Manipur, while playing in a playground, five boys (all under 10 years) were called out one by one by three youths (in their late teens) from the neighbourhood. The boys were made to bend forward after pulling down their pants and were forced into anal intercourse. They were threatened not to reveal the matter. However, the mother of one of the victims became suspicious when the child complained of pain during defecation that night. The matter was reported to police after about 5 days and the boys were brought for examination 7 days after the incident.

On examination, in three of the child victims who were aged 7, 9 and 9 years respectively, there were findings in the form of healing abrasions at the anal margins in case of the 7 and 9 year old boys at 12 o'clock position (**fig 1 & fig 2**) and in case of the other 9 year old boy, it was observed at 10 o'clock position (**fig 3**). However, in the remaining cases of two boys aged 7 years, no such findings were observed, even though they gave a similar history.

Corresponding Author:

¹P.G Trainee,

²Associate Professor,

³Professor,

Department of Forensic Medicine & Toxicology,
Regional Institute of Medical Sciences, Imphal,
Manipur

E mail:- drjohndebbarma@gmail.com.

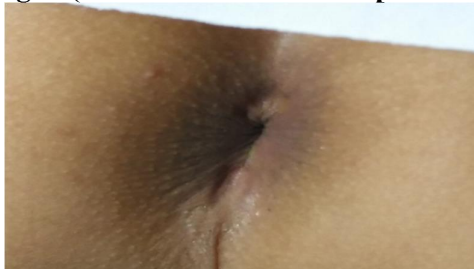
L. M. No: Not a member

DOR: 12/04/2017 DOA: 04/01/2018

DOI: 10.5958/0974-0848.2018.00020.9

Fig. 1 (Abrasion at 12 o'clock position)



Fig. 2 (Abrasion at 12 o'clock position)**Fig. 3 (Abrasion at 10 o'clock position)**

Discussion:

The abnormal sexual act of sodomy is practised all over the world. In India, such a carnal intercourse against the order of nature+ is punishable with life imprisonment u/s 377 IPC.³ According to NCRB (National Crime Reports Bureau) reports 2015, over 60% of the cases registered u/s 377 IPC were child victims.⁴ The cases reported here may be just the tip of the iceberg for such a heinous crime in this part of the country. Workers like Sharma, et al⁵ and Sarkar et al⁶ observed that maximum cases of sodomy was observed in the age group of 6-10 years. Hagraas et al⁷ also found the mean age group of sexually abused male children to be 9.7 yrs.

The prevalence of such a crime amongst young children could be due to factors such as innocence of these children and the inability to physically resist or defend themselves, etc. In such a crime, to punish the culprits, timely examination of the victim is important for documentation of injuries and signs of anal penetration. In our case, the victims came 7 days after the incident, the reason being threat by the assailants. Similar delay was observed in studies conducted by Sarkar et al⁸ where sexually assaulted victims came after 5-7days of incident reason being threat, embarrassment, shame and feeling of guilt. Most of the sodomy assailants were

neighbours, in a study by Neelam et al (72.7%).⁹ Bhowmik et al¹⁰ also observed that 45.5% of the sodomy cases were committed by assailants known to the victims. Similarly, in our cases, the assailants were neighbours of the boys, and this goes against the myth *%strangers usually commit sexual violence+*.

Conclusion

All over the world it is presumed that females are more vulnerable to sexual crimes. However, it is evident from this report of five cases that young boys are also equally susceptible to this heinous crime. Our findings also contradict the myth - *%strangers usually commit sexual violence+*. For prevention of such crimes, children should be educated about good touch and bad touch.

References:

1. Reddy KSN, Murty OP. The essentials of forensic medicine and toxicology. 33rd ed. New Delhi: Jaypee Brothers Medical Publishers; 2014.p.411-436.
2. Nandy A. Principles of forensic medicine including toxicology. 3rd ed. Kolkata: New central Book Agency (P) Ltd; 2010.p.687-720.
3. Sodomy law. 2011;[18 screens]. Available at: https://en.wikipedia.org/wiki/Sodomy_law. Accessed July 30, 2017.
4. Deeptiman Tiwary. Children victims in 60 percent cases under Section 377: NCRB data. 2016;[12 screens]. Available at: <http://indianexpress.com/article/india/india-news-india/rape-section-377-indian-penal-code-ncrb-date-pocso-children-rape-3033639/>. Accessed July 30, 2017.
5. Sharma DC, Oberoi SS, Bhullar DS. Magnitude of sodomy from chemical analysis in Punjab State. J Punjab Acad Forensic Med Toxicol 2008;8(1):6-11.
6. Sarkar SC, Lalwani S, Rautji R, Bharadwaj DN, Dogra TD. A study on victims of sexual offences in south Delhi. J Fam Welfare 2005;51(1):60-66.
7. Hagraas AM, Moustafa SM, Barakat HN, El-Elmi AH. Medico legal evaluation of child sexual abuse over a six year period from 2004 to 2009 in the Suez Canal area, Egypt. Egyptian Journal of Forensic sciences 2011;1:58-66.
8. Sarkar S, Murty OP, Bhardwaj DN, Sharma RK, Dogra T.D. Prospective study of victims and offenders of sexual offences. Mal J Path Sci 2008;3(2):7-44.

Case Report

An Interesting Case of Accidental Smothering in an Unusual Place

¹Abhishek Yadav, ²Mahesh Kumar, ³Antara Debbarma, ⁴Sudhir Kumar Gupta

Abstract:

Smothering is an asphyxial death which occurs from the mechanical occlusion of the external respiratory orifices and is generally considered to be homicidal, but care should also be taken to prevent the misdiagnosis of homicidal smothering. Accidental smothering occurs when a person accidentally falls into a large quantity of semisolid or finely divided material which may pass down in the respiratory passages. We report of case of a female child whose death was suspected to be a case of homicidal smothering but later after crime scene visit and corroborating the autopsy findings with the detailed investigation, the child was found to be accidentally smothered. The authors want to emphasize the importance of correlating and interpreting the autopsy findings with the history, examination of scene of crime, circumstantial evidence and investigative findings, so as to lead the death investigation to reach a logical conclusion.

Key Words: Accidental Smothering, Asphyxia, Homicide, Death Investigation

Introduction:

Smothering is an asphyxial death which occurs from the mechanical occlusion of the external respiratory orifices.¹ It is commonly done by hand, soft pillow, fabric in homicides and making the diagnosis is a challenging task for an autopsy surgeon. Similarly care should be taken to prevent the misdiagnosis of homicidal smothering in an accidental case as it may lead to the miscarriage of justice and may destroy the life of an individual who is wrongly made accused in that case. We report a case of a female child who went missing from her home and was found dead. Initially the death of the child was suspected to be a case of homicidal smothering but later after crime scene visit and corroborating the autopsy findings with the detailed investigation, the child was found to be smothered accidentally.

Corresponding Author:

¹Assistant Professor,

²Assistant Professor, ³Senior resident,

⁴Professor & Head,
Department of Forensic Medicine and Toxicology,
AIIMS, New Delhi

E-mail ID: drayad_in@yahoo.com.

L. M. No: No 987/DEL/12

DOR: 05/062017 DOA: 07/01/2018

DOI: 10.5958/0974-0848.2018.00021.0

Case Report:

The deceased was a six years old female who went missing in a afternoon from her home. Her family used to live on a first floor rental accommodation and the ground floor was occupied by the landlord family. A hue and cry was raised, police was also informed. The search continued till the morning when a septic tank on the ground floor of the house was opened and the body of the child was found lying in prone position. The body was brought to Department of Forensic Medicine, All India Institute of Medical Sciences (AIIMS) for postmortem examination.

Autopsy Findings:

The body was of a female child with length 113 cm. Soiling of clothes was present with mud, vegetative matter and water. Clothes were not torn and intact. Rigor mortis was present all over the body. Soddening of palms and soles are present (**Image-1**). Bluish discoloration of palms and soles were present. Dirt and mud particles were found over the body. Mucous was seen coming out of the nostrils. Blush discoloration of nail beds present. Anal, vaginal and rest of the normal orifices were normal.

Image-1: Soddening of Soles and Palms**Image-2: Bluish Color Contusion With Lacerated Wound**

The following external injuries were present on the body:

1. Lacerated wound 0.3 x 0.2 x 0.5 cm was present on the inner aspect of lower lip, surrounded by a bluish colored contusion of size 1 cm (**Image-2**).
2. Lacerated wound 0.3 x 0.2 x 0.2 cm was present over the frenulum of upper lip, surrounded by a bluish colored contusion of size 1 cm.
3. Loosening of right upper central incisor teeth were present, surrounded by a hematoma around the margins.
4. Grazed abrasion of size 4 x 3 cm, reddish in color, was present on the left forehead region, with a vertical orientation just below anterior hairline (**Image-3**).

Image-3: Grazed Abrasion over Forehead

Brain was edematous and congested. Mucous mixed dirty colored fluid was present only up to the level of trachea. Petechial hemorrhages present over both pleural surfaces over the middle lobe region. Lungs were congested. Petechial hemorrhages were present over lungs and left ventricular surface of the heart. Stomach contained about 200 ml of semi digested fluid material. Visceral organs were congested.

Discussion:

The presence of classical signs like cyanosis, petechiae hemorrhages, edema and congestion of the viscera indicated the mode of death to be asphyxia.²⁻⁶ The torn frenulum and injuries on the inner side of lips raised the suspicion of antemortem smothering⁶ and the same was conveyed to the Investigating Officer (IO). Police further investigated the matter and the autopsy surgeons also visited the crime scene. On detailed investigation, it was revealed that on that unfortunate afternoon, the child was playing after having her lunch on the first floor of the house while her mother was sleeping, which can be corroborated with the presence of semi digested fluid material in her stomach. Around the same time, there was a sewer vacuum truck cleaning out the contents of a septic tank which was located just before the first step of the staircase between the two floors (**Image-4,5**). They left after completing their jobs and after about half an hour the house owner who used to live on the ground floor saw that the cover of the septic tank was opened and he closed the lid. His wife and son were also present in the house at that time. Soon after the girl was found missing, police was informed, the search continued till next morning when her body was found in the septic tank.

Image-4: Opening Of Septic Tank With Hard Rough Stone Edges

Image-5: Position Of Septic Tank Just Below The Staircase



The police did not find any involvement or motive of the family members of the landlord family in the death of the child. After considering all the circumstantial evidences, investigative and autopsy findings, it was concluded that the girl came down the stairs and fell in the open septic tank. The external injuries sustained by the girl corroborated with the hard stone edges of the tank. The child got accidentally smothered by the sludge present in the septic tank as evident by the external examination of the body and the clothing. Accidental smothering occurs when a person accidentally fall into a large quantity of semisolid or finely divided material like mud, ashes grain, sand, coal dust etc. and it may also pass down in the respiratory passages.² Few cases of such accidental deaths have also been reported previously.^{7,8} The similar circumstances have been noticed in the present case where the child fell in the septic tank and got smothered by the contents of the tank.

Conclusion:

The manner in the equivocal asphyxial deaths is distinguished by a fine line. The autopsy surgeon should also correlate and interpret his findings with the history,

examination of scene of crime, circumstantial evidence and investigative findings, so that all aspects of a death investigation could be corroborated to reach a logical conclusion.

Funding: Nil.

Conflict of Interest: None.

References:

1. Saukko P, Knight B. Forensic pathology. 4th Ed. Boca raton: CRC Press: 2016. Chapter-14: Suffocation and asphyxia. p. 346.
2. Reddy KSN. The essentials of forensic medicine and toxicology. 25th Ed. Hyderabad: K Suguna Devi; 2006. Chapter 14; Mechanical Asphyxia: p 297-331.
3. Mahanta P. Modern textbook of forensic medicine & toxicology. New Delhi: Jaypee Brothesr: 2014. Chapter 17; Asphyxial deaths: p 340-360.
4. Aggarwal A. Textbook of forensic medicine and toxicology. New Delhi: Avichal Publishing Company; 2014. Chapter-19; Asphyxia: p 366-392.
5. Pillay VV. Textbook of forensic medicine and toxicology. 17th Ed. Hyderabad: Paras Medical Publisher; 2016. Chapter 14; Mechanical Asphyxia: p 296-325.
6. Vij K. Textbook of forensic medicine and toxicology: principles and practice. 6th ed. New Delhi: Elsevier India Pvt Ltd; 2014. Chapter-6; Asphyxial Deaths: p110-111.
7. Kettner M, Ramsthaler F, Horlebein B, Schmidt PH. Fatal outcome of a sand aspiration. Int J Legal Med. 2008;122(6): 499-502. doi:10.1007/s00414-008-0252-4
8. Singh G, ChedupLepcha, Sarma PC. Fatal accidental smothering: a case report. J Punjab Acad Forensic Med Toxicol 2011; 11(1): 42-42.

Case Report

Drug-Induced Aplastic Anemia – A Forensic Overview and Review of Literature

¹Gerard Pradeep Devnath, ²Siddhartha Das, ³Rakhee Kar, ⁴Rajesh Nachiappa Ganesh

Abstract:

Background: Survivors of road traffic accidents often suffer from sequelae of the initial incident. Some of these sequelae are complications of the surgery, side effects of the drugs, and psychological events.

Case presentation: A case of a road traffic accident survivor is discussed, who succumbed to drug-induced aplastic anemia. The aplastic anemia resulted from unmonitored administration of phenytoin and NSAIDs, on which he was put on to combat the onset of neurological complications. We highlight the lethal hematological complication, aplastic anemia, caused by phenytoin and NSAIDs.

Conclusion: The role of a Forensic Medicine specialist in such type of brought dead cases, where history of the case is unavailable at the time of autopsy, is discussed here. As aplastic anemia is a pathological condition, such cases are rarely subjected to forensic autopsy and hence this topic is not commonly dealt with in Forensic Medicine based literature. Hence the authors are presenting this brought dead case and have also briefly reviewed the literature available on aplastic anemia.

Key Words: Road Traffic Accident; Phenytoin; Non-Steroidal Anti-Inflammatory Drugs; Aplastic Anemia; Brought Dead Case

Background:

Incidences of road traffic accidents (RTA) are rising in India, accounting for 1,41,526 deaths in 2014.¹ Causes of death in RTA are mainly due to head injury and its complications. Individuals who survive from head injuries, especially skull fractures, following RTAs may suffer from sequels such as traumatic epilepsy and CNS infections.² Treating these sequels expose the patients to drugs and its complication.

Anti-epileptic drugs such as phenytoin are commonly used for treatment of seizures, and complications associated with it are varied. Hematological complication following phenytoin use ranges from neutropenia, leukopenia, red cell aplasia, agranulocytosis and thrombocytopenia.³ Instances of severe and potentially lethal bone marrow depression and agranulocytosis, which are treatable, have also been reported.⁴

Case Presentation:

The deceased was received dead at our hospital with a history of chest pain and breathlessness. An external autopsy examination was unremarkable except for severe pallor. Internally, petechial haemorrhages were present in the inter-lobar fissures of both the lungs. The heart weighed 400 gm. Epicardial petechial hemorrhages were present over the anterior and posterior wall of the right atrium, and papillary muscle hemorrhage of the left ventricle was also noted (**Figure 1 A & B**). The liver weighed 1400 gm and was pale. Both the kidneys were pale and multiple petechial hemorrhages were noted on

Corresponding Author:

¹Senior Resident,

Dept. of Forensic Medicine & Toxicology,
JIPMER, Karaikal

²Additional Professor,
Dept. of Forensic Medicine & Toxicology,
JIPMER, Puducherry

^{3,4} Additional Professor
Department of Pathology, JIPMER, Puducherry

Email ID: drgerardfm@gmail.com
L. M. No: Not A Member.

DOR: 17/08/2017 DOA: 09/01/2018
DOI: 10.5958/0974-0848.2018.00022.2

their surface (**Figure 2A**). The brain was intact and pale. A yellowish discolouration of size 5x3 cm was present on the base of the frontal lobe (**Figure 2B**), suggestive of a previous injury. Viscera were collected for chemical analysis and representative sections of liver, spleen, kidney, heart and part of frontal lobe and cerebellum were sent for histopathological examination.

Figure 1 A

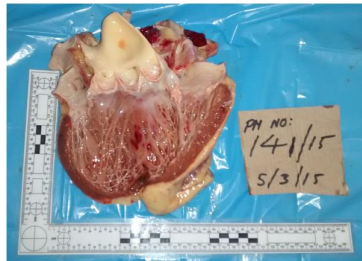


Figure 1 B

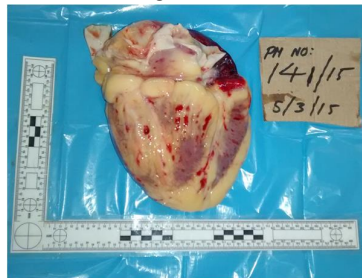


Figure 2 A



Figure 2 B



As the histopathology and viscera reports were awaited, the patient case records were reviewed, which revealed a history of RTA about one year back. He was given symptomatic treatment and kept under

observation for a week and then discharged. After three weeks, he was readmitted to the hospital with high-grade continuous fever associated with chills and rigor and headache of 4 days duration. MRI of the brain showed a pneumoencephalos in the left frontal lobe region, measuring about 5.8 cm x 3.6 cm; multiple fractures of the frontal bone and cibriform plate with bilateral CSF rhinorrhoea. All biochemical and hematological investigations were within normal limits except for WBC count which was 1200/mm³, which came back to normal range following treatment. Patient was diagnosed as a case of meningitis following traumatic CSF rhinorrhoea. CSF rhinorrhoea was surgically treated outside our hospital. The patient was put on phenytoin (100 mg, thrice daily), post operatively. During the treatment, he frequently used to take NSAIDs to combat headache without the knowledge of the treating physician. After about nine months of starting phenytoin, patient developed bleeding from the gums for which he was readmitted and evaluated. His hematological evaluation showed the following (Hb . 5.9 gm%, reticulocyte count . 0.2%, WBC count . 1400/mm³, neutrophil . 6%, lymphocyte . 94%, absolute neutrophil count . 90/mm³, platelet count . 4000/mm³). Blood culture was found positive for *E. coli* infection. The cause of anemia was extensively worked out. Bone marrow aspirate showed hypocellular particles with diluted trails. Bone marrow biopsy was adequate and with overall cellularity of 5-10 % showing interstitial prominence of mature lymphocytes, plasma cells and few histiocytes along with formation of few lymphoid nodules (**Figure 3, 4**). On immunohistochemistry with CD79a and CD3, the lymphoid nodules were positive for both B and T lymphocytes, respectively, indicating their reactive nature (**Figure 5, 6**). Normal trilineage hematopoiesis was markedly suppressed. These features were consistent with aplastic anaemia (AA). Once the diagnosis was confirmed, the patient was planned for bone marrow transplantation (BMT) and was discharged and told to revisit the hospital on a specified date. However one week after this, he suddenly developed breathlessness and was received dead in our hospital. Viscera analysis report tested positive

for phenytoin. Histopathology report revealed hemorrhage in all tissues. Based on the post-mortem findings, histopathology and viscera report, and reviewing hospital case sheet records the cause of death was opined as AA and complications, arising there off.

Figure 3

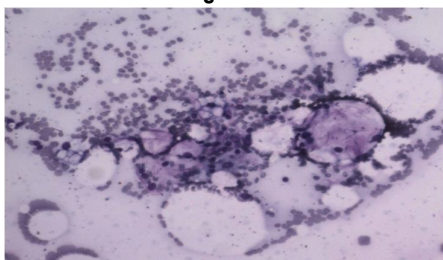


Figure 4

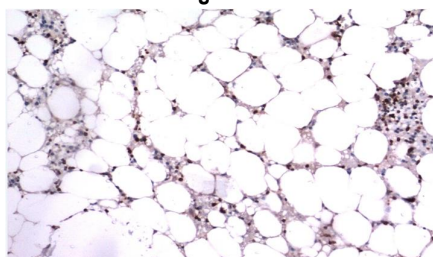


Figure 5

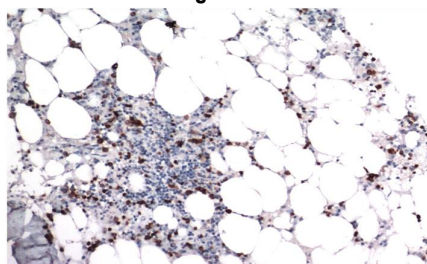


Figure 6



Discussion & Review:

Incidence:

AA is a hematopoietic stem-cell disorder which is characterized by pancytopenia of the peripheral blood and bone marrow hypocellularity.⁵ It may be classified as acquired and inherited. A low incidence of the disease has been reported from the United Kingdom,⁶ France,⁷ Brazil,⁸ Israel and some European countries.⁹ However, some of the

older studies have reported higher incidences.¹⁰⁻¹² Also, its incidence has shown geographic variation, as it was found to be higher in the Asians. The prevalence reported from Japan, China and Bangkok was 31-48 per million, 19-21 per million and 3.7 per million respectively.¹³ Two epidemiological studies carried out in Asia and Europe using the same methodology, observed the incidence to be 2-3 times higher in Asia compared to the West.¹³ This variability in incidence rates may be attributed to the differences in exposure to environmental factors like chemicals, drugs, viruses, genetic background, diagnostic criteria, and study designs.⁹

Etiology:

The etiology of acquired AA is thought to be both an extrinsic immune-mediated suppression of marrow progenitors, and an intrinsic abnormality of stem cells.^{14,15} Though laboratory and clinical findings suggest an immunological etiopathogenesis, majority of cases are idiopathic in origin.^{7,16,17} Among other etiological factors are exposure to ionizing radiations, chemicals, drugs and some viruses.¹⁸⁻²¹ As per one study, 74% of the cases were idiopathic, 13% associated with drug toxicity and 5% to hepatitis.⁷ Other studies reported 2-5%, and 4-10% of cases to be associated with hepatitis.^{7,18,22} The drugs which are found to be associated with increased incidence of AA are aminosalicylates, antibacterial drugs, antidepressants, antiepileptics, antirheumatic drugs, non-opioid analgesics, NSAIDs, thyroid inhibitors and ulcer-healing drugs.^{15,23} A population-based case-control study of AA in Thailand found drugs to be the most commonly implicated cause, but they explained only 5% of newly diagnosed cases.²⁴ The relationship between phenytoin and AA is well documented.^{5,25,26}

Pathophysiology:

Most cases of drug-induced AA lead to an idiosyncratic immune response directed against hematopoietic stem cells. It is important to note that when drugs are responsible for causing AA, stopping the putative drug does not usually lead to hematopoietic recovery unlike in agranulocytosis and drug-induced

thrombocytopenia.¹⁵ The antiepileptic drugs phenytoin or carbamazepine undergo oxidative metabolism to form the potentially toxic arene oxide metabolites.²⁶ If not detoxified, arene oxide metabolites can bind covalently to cell macromolecules and cause genetic mutations and cytotoxic damage, and by acting as haptens lead to secondary immune reactions.^{26,27} The cellular enzymes, epoxide hydrolases are essential for detoxification of arene oxides and their defect may lead to an accumulation of reactive metabolites. An analysis of several families indicates an obvious defect in detoxification capabilities in cells from patients and that the parents' lymphocytes show an intermediate defect.²⁸ Idiosyncratic drug reactions may occur in some individuals either from their increased production and/or decreased detoxification. Those patients who have an inherited defect in phenytoin arene oxide detoxification are more susceptible to phenytoin hepatotoxicity.²⁶

In one case, in vitro studies demonstrated a phenytoin-dependent antigranulocyte antibody directly implicating phenytoin for the leukopenia. Moreover, an extremely high titre of platelet-associated IgG and autoantibodies directed against the patient's red cells, granulocytes and lymphocytes were also demonstrated. In vitro marrow culture studies failed to detect cellular or humoral inhibitors and were suggestive of a stem cell defect.²⁹ Phenytoin affects the following cells of erythropoiesis such as CFU-S (colony forming unit-stem cell), committed stem cell like CFU-G (Colony forming units-Granulocytes), CFU-E (Colony forming units-Erythrocytes) and BFU-E (Burst forming unit-Erythroid).³⁰ Phenytoin is metabolized by cytochrome P450 enzyme CYP2C9 (90%) and CYP2C19 (10%). Its metabolic rate varies according to ethnicity, race and in the Tamil population, the frequency of CYP2C9 alleles viz. CYP2C9*1, CYP2C9*2, CYP2C9*3 has been established. It has a narrow therapeutic index and zero order (nonlinear) pharmacokinetics, and hence may reach high level in an individual possessing mutant alleles (CYP2C9*2 and CYP2C9*3). This results in precipitation of adverse effects at the conventional dosages.³¹ In the present case also, we presume an idiosyncratic immune

reaction directed against the patient's hematopoietic stem cells. Considering his Tamil ethnicity, presence of a mutant allele also cannot be ruled out.

Clinical Features:

The presenting symptoms of AA generally reflect the underlying anemia, neutropenia or thrombocytopenia. Bleeding secondary to thrombocytopenia is common. It typically presents as bruising usually over the dependent surfaces and petechiae, in the form of bleeding gums, and epistaxis.^{14,15} Menstruating women commonly have heavy menstrual flow or menorrhagia. Patients also present with nonspecific symptoms of fatigue, lack of energy, shortness of breath, or even angina secondary to anemia. Neutropenia manifests as frequent and persistent minor infections or as sudden onset of chills, fever and prostration. Splenomegaly is typically absent and reticulocytopenia is the rule.^{14,15} In our case there was no splenomegaly and the reticulocyte count was only 0.2%. Bleeding manifestations brings the patient to the doctors which initially may be in the form of excessive bruising or a petechial rash but commonly presents with bleeding from the gums or nose.^{32,33} In this case the presenting complaint was bleeding from the gums. He also gave a history of easy fatigue while doing routine household work.

Diagnosis:

Definitive diagnosis of AA can be made by bone marrow biopsy and histopathologic examination.³⁴ A bone marrow aspirate to assess cell morphology, and a bone marrow biopsy and histopathologic examination to assess cellularity and architecture are required for diagnosis.^{15,34} Biopsy point counting i.e., determination of numbers of cells in small grids is the most accurate method of determining cellularity, but visual estimation is more frequently used. The biopsy usually shows almost complete replacement of the marrow with fat.¹⁵ A reduction in the number of hematopoietic stem/progenitor cells is a universal laboratory finding. CD34+ cells, assayable hematopoietic progenitors, and long-term culture initiating cells are also strikingly reduced.^{35,36} Once the diagnosis of AA is established it is important to establish its spectrum based on the peripheral

pancytopenia. This includes nonsevere AA (NSAA), severe AA (SAA) and very severe AA (VSAA). SAA (bone marrow cellularity <25%, Two of three peripheral blood criteria: absolute neutrophil count <500/mm³, platelet count <20,000/mm³ & reticulocyte count <60,000/mm³ or <1% corrected reticulocyte count). VSAA (same as SAA with absolute neutrophil count <200/mm³). NSAA (bone marrow cellularity <25% & peripheral blood cytopenias do not fulfil criteria for SAA).^{15,37} Accordingly this case fell into the category of VSAA. Despite the precision of its diagnostic criteria, AA has always been a diagnosis of exclusion.³⁸

Treatment:

Most cases of AA occur due to immunologic destruction of hematopoietic cells. Hence these patients respond well to immunosuppressive therapies like antithymocyte globulin (ATG) and cyclosporine CSA).³⁹ Allogeneic BMT from an HLA-matched sibling donor is the treatment of choice for young patients with SAA. Immunosuppressive therapy with ATG/CSA is used in older patients and those who lack a matched sibling donor. Although single-agent ATG and single-agent CSA⁴⁰ are capable of inducing remissions in acquired AA; the combination ATG/CSA leads to a higher response rate and a greater likelihood of no BMT.^{41,42} The response rates to ATG/CSA range between 60% and 80%, with 5-year survival rates comparable to BMT.⁴³ However, in contrast to BMT, most patients are not cured of their disease. Most patients respond within 6 to 12 weeks after receiving ATG/CSA. ATG is usually given over 4 days but CSA must be continued for at least 6 to 12 months before tapering the drug. High-dose cyclophosphamide without BMT has been used to treat patients who lack a suitable donor.¹⁵ It is proposed that immunosuppressive therapies work by suppressing or killing autoreactive T-cell clones.¹⁴ Montane et al. observed a better survival in patients treated with BMT as compared to androgens.⁹ BMT is the treatment of choice in those with a suitable donor and provides a 5-year survival of more than 75%.¹⁴

Fatality:

The most frequent cause of death from AA is sepsis caused by bacteria or fungus (especially aspergillus). In the instant case, the patient suffered from E.coli infection which was successfully treated. However he succumbed to CVS complication. The 2-year mortality rate with supportive care alone for patients with SAA or VSAA approaches 80%.⁴⁴ In one prospective study, the fatality rate was estimated to be 34% and 39% at one and two years respectively.⁷ Some of the earlier studies like IAAAS (49% at 2 years)⁴⁵, Clausen (74% at 4 years)⁴⁶, Gale (80% between 1 and 2 years after diagnosis)⁴⁷ have reported a higher fatality rate. One study observed the survival rate to be 73% at 3 months, 57% at 2 and 5 years after diagnosis, and 51% at 15 years.⁹

Conclusion:

Drug-induced AA is an uncommon scenario. In this case, though usual dose of phenytoin was administered, but owing to its narrow therapeutic index and ability to cause idiosyncratic suppression of hematopoietic stem cells proved fatal for the patient. Unmonitored intake of NSAIDs compounded the risk. Hence approaching the patients who are under these drugs with anticipation towards their lethal hematological complication would be prudent on the part of a physician. In such cases, a forensic pathologist should take a proper history and go through the patient case records wherever available and corroborate the same with the autopsy findings, viscera, histopathology and biopsy report. This case adds to the already available knowledge of AA that is present in literature.

Conflict of Interest: None.

Financial Assistance: None.

References:

1. National Crime Records Bureau. Accidental deaths and suicides in India 2014. New Delhi: Ministry of Home Affairs. Govt. of India; 2015. Available from: <http://ncrb.gov.in/StatPublications/ADSI/ADSI2014/ADSI2014.asp>. Accessed on 2nd August 2017.
2. Saukko P, Knight B. Head and spinal injuries. In: Saukko P, Knight B, Editors. Knights forensic pathology, London: Arnold; 2004, p.174. 221.

3. McNamara JO. Pharmacotherapy of the epilepsies. In: Brutton LL, Lazo SJ, Parker LK, Editors. Goodman & Gilman's, the pharmacological basis of therapeutics, New York: McGraw Hill; 2005, p. 501. 26.
4. Rawanduzay A, Sarkis A, Rovit RL. Severe phenytoin-induced bone marrow depression and agranulocytosis treated with human recombinant granulocyte-macrophage colony-stimulating factor. *J Neurosurg* 1993;79:121-4.
5. Handoko KB, Souverein PC, van Staa TP, Meyboom RHB, Leufkens HGM, Egberts TCG, et al. Risk of aplastic anemia in patients using antiepileptic drugs. *Epilepsia* 2006;47:1232-6.
6. Cartwright RA, McKinney PA, Williams L, Miller JG, Evans DI, Bentley DP, et al. Aplastic anaemia incidence in parts of the United Kingdom in 1985. *Leuk Res* 1988;12:459-63.
7. Mary JY, Baumelou M, Guiguet M, The French Cooperative Group for Epidemiological Study of Aplastic Anemia. Epidemiology of aplastic anemia in France: a prospective multicentric study. *Blood* 1990;75:1646-53.
8. Maluf EM, Pasquini R, Eluf JN, Kelly J, Kaufman DW. Aplastic anemia in Brazil: incidence and risk factors. *Am J Hematol* 2002;71:268-74.
9. Montane E, Ibanez L, Vidal X, Ballarin E, Puig R, Garcia N, et al. Epidemiology of aplastic anemia: a prospective multicenter study. *Haematologica* 2008;93:518-23.
10. Bottiger LE, Westerholm B. Aplastic anaemia: I. Incidence and aetiology. *Acta Med Scand* 1972;192:315-8.
11. Davies SM, Walker DJ. Aplastic anaemia in the northern region 1971-1978 and follow-up of long term survivors. *Clin Lab Haematol* 1986;8:307-13.
12. Szklo M, Sensenbrenner L, Markowitz J, Weida S, Warm S, Linet M. Incidence of aplastic anemia in metropolitan Baltimore: a population based study. *Blood* 1985;66:115-9.
13. Issaragrisil S, Sriratanasatavorn C, Pankijagum A, Vannasaeng S, Porapakkham Y, Leaverton PE, et al. Incidence of aplastic anemia in Bangkok. *Blood* 1991;77:2166-8.
14. Kumar V, Abbas AK, Aster JC. Red blood cell and bleeding disorders. In: Kumar V, Abbas AK, Aster JC, editors. Robbins and Cotran Pathologic Basis of Disease, Philadelphia: Elsevier Saunders; 2015, p. 629-67.
15. Brodsky RA. Acquired aplastic anemia. In: Greer JP, Arber DA, Glader B, List AF, editors. Wintrobe's clinical hematology, Philadelphia: Lippincott Williams Wilkins; 2014, p. 965-74.
16. Young NS. Acquired aplastic anemia. *Ann Intern Med* 2002;136:534-46.
17. Wallerstein RO, Condit PK, Kasper CK, Brown JW, Morrison FR. Statewide study of chloramphenicol therapy and fatal aplastic anemia. *JAMA* 1969;208:2045-50.
18. Brown KE, Tisdale J, Barrett AJ, Dunbar CE, Young NS. Hepatitis-associated aplastic anemia. *N Engl J Med* 1997;336:1059-64.
19. Young NS. Aplastic anemia. *Lancet* 1995;346:228-32.
20. Young NS, Calado R, Scheinberg P. Current concepts in the pathophysiology and treatment of aplastic anemia. *Blood* 2006;108:2509-19.
21. Brodsky RA, Jones RJ. Aplastic anaemia. *Lancet* 2005;365:1647-56.
22. Young NS, Issaragrisil S, Chieh CW, Takaku F. Aplastic anaemia in the Orient. *Br J Haematol* 1986;62:1-6.
23. van Staa TP, Boulton F, Cooper C, Hagenbeek A, Inskip H, Leufkens HGM. Neutropenia and agranulocytosis in England and Wales: incidence and risk factors. *Am J Hematol* 2003;72:248-54.
24. Issaragrisil S, Kaufman DW, Anderson T, Chansung K, Thamprasit T, J Sirijirachai, et al. Low drug attributability of aplastic anemia in Thailand. *Blood* 1997;89:4034-9.
25. Blackburn SC, Oliart AD, Garcia RLA, Perez GS. Antiepileptics and blood dyscrasias: a cohort study. *Pharmacotherapy* 1998;18:1277-83.
26. Gerson WT, Fine DG, Spielberg SP, Sensenbrenner LL. Anticonvulsant induced aplastic anemia: increased susceptibility to toxic drug metabolites in vitro. *Blood* 1983;61:889-93.
27. Dosch HM, Jason J, Gelfand EW. Transient antibody deficiency and abnormal T suppressor cells induced by phenytoin. *N Eng J Med* 1982;306:406-9.
28. Shear NH, Spielberg SP. Anticonvulsant hypersensitivity syndrome in vitro assessment of risk. *J Clin Invest* 1988;82:1826-32.
29. Schweiger FJ, Kelton JG, Messner H, Klein M, Berger S, McIlroy WJ, et al. Anticonvulsant-induced marrow suppression and immune

- thrombocytopenia. *Acta Haematol* 1988;80:54-8.
30. Bloom JC, Schade AE, Brandt JT. Toxic responses of the blood. In: Klaassen CD, editor. *Casarett and Doull's Toxicology: The basic science of poisons*, New York: McGraw Hill; 2013, p. 527-58.
31. Ramasamy K, Narayan SK, Shashindran C, Adithan C. Severe phenytoin toxicity in a CYP2C9*3*3 homozygous mutant from India. *Neurol India* 2007;55:408-9.
32. Malik S, Sarwar I, Mehmood T, Naz F. Aetiological considerations of acquired aplastic anaemia. *J Ayub Med Coll Abbottabad* 2009;21:127-30.
33. Clausen N, Kreuger A, Salmi T, Storm-Mathisen I, Johannesson G. Severe aplastic anaemia in the Nordic countries: a population based study of incidence, presentation, course, and outcome. *Arch Dis Child* 1996;74:319-22.
34. Milosevic R, Jankovic G, Antonijevic N, Jovanovic V, Babic D, Colovic M. Histopathologic characteristics of bone marrow in patients with aplastic anemia. *Srp Arh Celok Lek* 2000;128:200-4.
35. Bacigalupo A, Figari O, Tong J, Piaggio G, Miceli S, Frassoni F, et al. Long-term marrow culture in patients with aplastic anemia compared with marrow transplant recipients and normal controls. *Exp Hematol* 1992;20:425-30.
36. Schrezenmeier H, Jenal M, Herrmann F, Heimpel H, Raghavachar A. Quantitative analysis of cobblestone area-forming cells in bone marrow of patients with aplastic anemia by limiting dilution assay. *Blood* 1996;88:4474-80.
37. Young NS. Aplastic anemia, myelodysplasia and related bone marrow failure syndromes. In: Longo DL, Fauci AS, Kasper DL, et al. editors. *Harrison's principle of internal medicine*, New York: McGraw Hill; 2012, p. 887-97.
38. Guinan EC. Diagnosis and management of aplastic anemia. *Hematology Am Soc Hematol Educ Program*. 2011;2011:76-81.
39. Young NS, Kaufman DW. The epidemiology of acquired aplastic anemia. *Haematologica* 2008;93:489-92.
40. Maschan A, Bogatcheva N, Kryjanovskii O, Shneider M, Litvinov D, Mitushkina T, et al. Results at a single centre of immunosuppression with cyclosporine A in 66 children with aplastic anaemia. *Br J Haematol* 1999;106:967-70.
41. Frickhofen N, Kaltwasser JP, Schrezenmeier H, Raghavachar A, Vogt HG, Herrmann F, et al. Treatment of aplastic anemia with antilymphocyte globulin and methylprednisolone with or without cyclosporine. *N Engl J Med* 1991;324:1297-304.
42. Marsh J, Schrezenmeier H, Marin P, Ilhan O, Ljungman P, McCann S, et al. Prospective randomized multicenter study comparing cyclosporin alone versus the combination of antithymocyte globulin and cyclosporin for treatment of patients with nonsevere aplastic anemia: a report from the European Blood and Marrow Transplant (EBMT) Severe Aplastic Anaemia Working Party. *Blood* 1999;93:2191-5.
43. Bacigalupo A, Broccia G, Corda G, Arcese W, Carotenuto M, Gallamini A, et al. Antilymphocyte globulin, cyclosporin, and granulocyte colony-stimulating factor in patients with acquired severe aplastic anemia (SAA): A pilot study of the EMBT SAA Working Party. *Blood* 1995;85:1348-53.
44. Camitta BM, Thomas ED, Nathan DG, Gale RP, Kopecky KJ, Rapoport JM, et al. A prospective study of androgens and bone marrow transplantation for treatment of severe aplastic anemia. *Blood* 1979;53:504-14.
45. International Agranulocytosis and Aplastic Anemia Study. Incidence of aplastic anemia: The relevance of diagnostic criteria. *Blood* 1987;70:1718-21.
46. Clausen N. A population study of severe aplastic anemia in children. Incidence, etiology and course. *Acta Paediatr Scand* 1986;75:58-63.
47. Gale RP, Champlin RE, Feig SA, Fitch JM. Aplastic anemia: biology and treatment. *Ann Intern Med* 1981;95:477-94.

Letter to Editor

Dear Sir,

Through this letter, I would like to highlight the growing trend of uploading 'prank' videos in the social media as well as video sharing websites.

Pranks: Practical Joke, Profession or Path to Prison?

Prank simply means a practical joke or mischievous conduct. According to Cambridge dictionary, 'prank' means a trick that is intended to be funny but not to cause harm or damage.¹ But, can it be called *'just a prank'*, when someone receives physical intrusion in addition to embarrassment? Obviously not! Viewers enjoy the scene at the cost of a victim who receives mental and/or physical intrusion. It is not unknown that social media does not run for the sole purpose of entertainment but also run for a business; commercialization of the social media promulgates such trends as the prankster (who plays prank) receives fun, fame as well as funds.

One of the most famous practical joking traditions still vibrant in many countries is April Fools' Day, celebrations of which date back to the ancient Roman times.² Also few shows on television, previously made to entertain the people, were broadcasting prank acts with lighter level of joking or pranking. Most of the acts were limited to make the participants foolish or surprised, without involving any physical intrusion. For example, a man was standing in a public place as to look like a statue and surprised the people passing by.

However, in the era of unstoppable usage of social media, the level of pranks goes higher and higher. It cannot be called *'just a prank'* when someone suffers from multiple injuries. The scene of a prank may look laughable when prankster in a get up of a terrorist throws a suspected bag in public and runs away; which is obviously followed by panic and/or stampede due to sympathetic response of fight or flight. Neither can it be *'just a prank'* when victim is to be kidnapped by the pranksters.

Many such types of videos are available on video sharing websites under the

heading of 'pranks' which includes not only mental humiliation and embarrassment, but also physical harms. In some videos, the prankster as a hairstylist, plays a prank on the customer by snatching his hair, bending his head violently and massaging the hair in a way that provoke the customer to react violently in return.³ Few more among the endless list of prank videos are comprised of ghost pranks, thief pranks, killer pranks, kidnapping pranks etc.

Question arises at this point that why such type of prank videos are uploaded in hundreds every day? One of the reasons behind this is the professionalism of the internet based earning. The more you upload videos with questionable content, the more you will attract viewers and the more you will earn from the commercially developed system. Most of the pranksters have already started earning through uploading prank videos and some of them made this as their profession. Since decades, it has been observed that human tendency towards earning is to keep the efforts as less as possible to earn as much as possible. However, the famous dictum 'No gain without pain' applies here also but, at the cost of pain which is perceived by the victims of prank and the gain generated for the pranksters instead. Basically, Internet provides platforms and promotes such concepts. When going through the famous websites, one can find millions of makers as well as millions of viewers who enjoy making and viewing prank videos respectively. Nevertheless, the term 'business' comes with the inherent part called 'competition' which ultimately results in propagation of the idea. Most professions admit that benefits of social media must be balanced against its potential to negatively influence professional lives and the public trust.⁴

In a different context, when a researcher is required to provide 'participant information sheet' and 'consent form' in interview based research study how can these types of pranks be excluded from the list of ethics in human experimentation? Pranks cannot be considered as social experiments in a lighter way when it involves making fun of

people by physical-mental intrusion (that too without taking consent!!). In western countries, apart from injuries, sometimes deaths were also reported while pranking.^{5,6}

In addition to breach of privacy, many prank acts fall under the definitions of offences prescribed under Indian Laws along with the punishments. But, in absence of filing complaints most of the prank acts go unnoticed and unreported. The Indian Penal Code defines injury, public nuisance, hurt, intentional insult with intent to provoke breach of the peace, etc. under multiple sections that are applicable depending on the individual act of prank.⁷ It is high time for our country to consider the pranks in terms of defining boundaries and prescribe specific legislations to at least halt the progress of the people who are doing this for the sake of business.

Conclusion:

It's pretty easy to hoax or prank the people. More or less, all want to be deceived, but only up to a certain point. Some hoaxes are for fun and pleasant but, others are malicious and unpleasant.⁸ It is high time for the policy makers to understand the earnestness of the current trends towards pranking the people and to make aware the community about their personal rights, delay in which can result in something more serious. *"Irony is, the pranks are always funniest and most effective when there are people who find them neither funny nor effective."*⁹

References:

1. Cambridge Dictionary. Meaning of 'prank' in the English Dictionary. Available from: <https://dictionary.cambridge.org/dictionary/english/prank>. Accessed 18 March 2018.
2. Brzozowska D. Book review: Marsh, Moira (2015). Practically Joking. Logan: Utah State University Press. 195 pp. The European Journal of Humour Research. 2016;4(2):87-9
3. Saloon pranks in India. Available from: https://www.youtube.com/results?search_query=saloon+pranks+in+india. Accessed 18 March 2018.
4. Woodley C, Silvestri M. The internet is forever: Youthful indiscretions & ill-conceived pranks reveal the need for effective social media policies in academia. In ICICTE Conference. Crete, Greece 2013. Available from:
5. <http://www.icicte.org/Proceedings2013/Papers%202013/06-2-Woodley.pdf>. Accessed 19 March 2018
6. Toby Meyjes. Best man dies after being thrown into water during stag do prank Available from:
7. <http://metro.co.uk/2016/12/14/best-man-dies-after-being-thrown-into-water-during-stag-do-prank-6323764/>. Accessed 20 March 2018
8. Kristine Phillips. An 11-year-old boy killed himself after his girlfriend faked her death. She's now facing charges. Available from: https://www.washingtonpost.com/news/education/wp/2017/04/09/an-11-year-old-boy-killed-himself-after-his-girlfriend-faked-her-death-shes-now-facing-charges/?utm_term=.4a9ad612663f. Accessed 20 March 2018
9. Ss. 44, 268, 290, 319, 321, 323, 504, 506 & 509, The Indian Penal Code, 1860.
10. Carroll R. Pranks, Frauds, and Hoaxes from Around the World. Skeptical Inquirer. 2004;28(4):41-6
11. McIntyre Iain. How to Make Trouble and Influence People: Pranks, Protests, Graffiti & Political Mischief-Making from Across Australia. : PM Press; 2013. Available from: https://books.google.co.in/books/about/How_to_Make_Trouble_and_Influence_People.html?id=yaVuAAAAQBAJ&redir_esc=y. Accessed 19 March 2018

Dr. Sunil M. Doshi,

Associate professor,
Department of Forensic medicine & Toxicology,
Smt. B. K. Shah Medical Institute and Research Center, Sumandeep Vidyapeeth University, Vadodara, Gujarat.

Email: drsunil2347@gmail.com



Prof. Vijay Wase, receiving the Fellowship



Prof. Suresh Mohapatra, receiving the Fellowship



Chief Guest of the Validictory Function,
Madam Kiran Bedi, Governor of Puducherry,
with the awardees



Chairpersons of a Scientific Session with the
President IAFM

