Volume 42
Number 3
July - September
2020

JOURNAL OF INDIAN ACADEMY OF FORENSIC MEDICINE

JIAFM is a UGC approved journal. It is Indexed with Scopus, Index Copernicus, IndMED & IMSEAR

Publication Quarterly
ISSN : 0971 - 0973
e- ISSN : 0974-0848

(A Peer Reviewed Journal)

(Official Publication of the Indian Academy of Forensic Medicine)

www.iafmonline.in

Indian Academy of Forensic Medicine

Registration No.349, Panaji, Goa

Official website - www.iafmonline.in

Governing Council (2019-2022)

President
Dr. P.C. Vyas

General Secretary
Dr. Mukesh Yadav

Treasurer
Dr. C.B. Jani

Vice-President

North Zone: Dr. Vijay Pal Khanagwal
South Zone: Dr. Cyriac Job
East Zone: Dr. T.K. Bose
West Zone: Dr. Mohd. Iliyas Sheikh
Central Zone: Dr. Anil Kumar Mittal

Joint Secretary

North Zone: Dr. Ajay Kumar
South Zone: Dr. Siddhartha Das
East Zone: Dr. Tulsi Mahto
West Zone: Dr. Saumil Merchant
Central Zone: Dr. Manish Kumath

Editor: Dr. Tanuj Kanchan

Joint Editor: Dr. Manish Nigam

Executive Members

Ex-Officio Members

Past President: Dr. Kalpesh Shah

Past General Secretary: Dr. Madhu Ghodkirekar

Elected Members

North Zone:	Dr. Pankaj Gupta	Dr. Amandeep
South Zone:	Dr. R. Sudha	Dr. Vinod Chaudhari
East Zone:	Dr. A.J. Patowary	Dr. Gunajit Das
West Zone:	Dr. Sudhir Ninave	Dr. Dharmesh A. Silajiya
Central Zone:	Dr. S.K. Dadu	Dr. P.K. Tiwari

Journal of Indian Academy of Forensic Medicine
(JIAFM)

The Official Publication of Indian Academy of Forensic Medicine

Published by:
Dr. Tanuj Kanchan, Editor, JIAFM and Dr. Manish Nigam, Joint Editor, JIAFM
on behalf of the Indian Academy of Forensic Medicine

The Journal of Indian Academy of Forensic Medicine (JIAFM)

About the Journal (Print ISSN: 0971-0973 Electronic ISSN:0974-0848):
JIAFM is a peer reviewed medical journal published quarterly by the Editor of the Academy on behalf of the Indian Academy of Forensic Medicine.

Aim and Scope of the Journal:
The Journal covers all technical, medico-legal and clinical aspects including the ethical and social issues related to the subject specialty of Forensic Medicine and Toxicology and allied specialities. The journal promotes dissemination of original research findings.

Abstracting and Indexing:
The journal is included in Scopus, Index Copernicus, IndMED, Index Medicus for South East Asia Region, Indian Citation Index, JIAFM is a UGC Approved Journal (No. 28596). Journal issues are available online at: www.iafmonline.in; http://indmed.nic.in; and www.indianjournals.com

Research ethics and Authorship:
JIAFM follows the ICMJE's Recommendations for the Conduct, Reporting, Editing and Publication of Scholarly Work in Medical Journals. JIAFM take issues of copyright infringement, plagiarism or any other act of academic dishonesty very seriously, and encourages the authors to ensure that the submitted manuscripts are their original work and free of any plagiarism.

Subscription Information:
JIAFM is published quarterly, and following are its annual subscription rates:
Individual: ₹1000 (In India) and USD 200 or equivalent (Rest of the world)
Institutions: ₹7500 (In India) and USD 400 or equivalent (Rest of the world)
Subscription orders and payments should be made in favour of "Editor IAFM", payable at Jodhpur, Rajasthan. All communications in this regard should be made with the Editor at the address given below.

Claims for missing issue(s):
A copy will be sent free to the member/ subscriber provided the claim is made within 2 months of publication of the issue & a self-addressed envelope of the size 9" x 12" is sent to the Editor. (Those who want the journal to be dispatched by 'Registered Post' must affix postage stamps of ₹ 50).

Editorial Office
Dr. Tanuj Kanchan (Editor, JIAFM)
Room No. 3050,
Department of Forensic Medicine & Toxicology
All India Institute of Medical Sciences, Jodhpur
Basni Industrial Area, Phase-2, Jodhpur-342005, Rajasthan
Mobile: +91-9448252394
Email: editor.jiafm@gmail.com

Journal of Indian Academy of Forensic Medicine

Volume 42 Number 3 July - September 2020

Contents

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 153-154
doi:10.5958/0974-0848.2020.00042.1

EDITORIAL

Healthcare workers and COVID-19 pandemic: A fight amidst fear of burnout

Tanuj Kanchan[1], Vikas P Meshram[1], Raghvendra Singh Shekhawat[1], Sanjeev Misra[2]

1 Department of Forensic Medicine and Toxicology, All India Institute of Medical Sciences, Jodhpur, Rajasthan

2 Director and CEO, All India Institute of Medical Sciences, Jodhpur, Rajasthan

COVID-19 pandemic is continuing to cause a huge impact on the wellbeing of the global population. The first case of COVID-19 in the world was reported in Wuhan, China in December 2019, and since then, it has spread worldwide. As the cases kept on increasing exponentially, the WHO declared COVID-19 as global pandemic on 11 March 2020. Fight against such health crisis required an exceptional response from the healthcare system and administrators. In India, it was always anticipated to be a daunting task to control the spread of infection due to a large and dense population and overburdened healthcare system. Healthcare workers, police personnel, defence personnel, sanitation workers, local administrators, etc., have been the frontline warriors in the fight against COVID-19 pandemic. Healthcare workers have been playing a pivotal role in the hospitals as well as community settings in management of the disease outbreak. In hospital set up, planning, preparedness and the optimal management of resources and manpower have been emphasized. The fight against COVID-19 pandemic has been long and continuing. In this long fight, physical and mental exhaustion leading to burnout among healthcare workers can be a major concern. Burnout can result from long term involvement in the work which is demanding and can lead to emotional exhaustion, depersonalization, and a reduced sense of personal accomplishment. Multiple factors like fear of acquiring infection, lack of social support, discrimination and distancing behaviour from society, long working hours, inadequate work condition, inadequate protective measures have been identified.[1,2]

Healthcare workers have the most crucial role to play in times of such health crisis. Doctors, along with paramedical staff, have been shouldering the duties like screening triage, laboratory diagnosis, management of stable and critical cases of COVID-19, dead body management, etc. according to their core specialities. Medical personnel including residents as well as faculty were hence, trained irrespective of their speciality as an additional working force. Additionally, they are also involved in a community screening, contact tracing, sample collections, etc. However, there have been some unfortunate deterrents along the way. Assault on the healthcare workers while discharging their duties in the community and the hospitals, accusing them of spreading the infection, denying them entry in their locality, denying of the ambulance and burial space to the doctor dying of COVID-19 infection, etc. were some of the discouraging incidences that compounded the problem. Increase in the incidences of severe morbidity and mortality due to COVID-19 illness among healthcare workers also had a detrimental effect. Besides, some of the healthcare workers underwent apprehension and anxiety owing to unpredictable and fatal nature of COVID-19 illness, for the fear for personal health, fear of being quarantined, and fear of spreading infection to family members, etc.

A vital responsibility of faculty is to teach and train undergraduate and postgraduate medical students. In order to follow social distancing and lock down restrictions following COVID-19 pandemic, the traditional methods of teaching could not be adhered to. Hence, novel methods of teaching and assessment needed to be adopted. In this regard, teaching-learning through online portal became an alternative way to impart education. This paradigm shift in methodology has its own challenges in the form of imparting training to the trainers, and getting them involved and motivated in following the new system of teaching-learning. This could be another reason for burn-out; however, medical teachers have been largely successful in overcoming these challenges. Besides being a healthcare worker and a teacher, role of a doctor in research cannot be undermined especially in times of COVID-19 where entire world is trying to understand the various aspects of the arduous COVID-19 disease viz. its pathophysiology, ever changing and varied manifestations and affective management of disease, etc. Continued research is being conducted on multiple aspects of COVID-19 infection which again is keeping the medical personnel on the toes.

Mortality due to COVID-19 infection has been on the rise, and till date, more than one lakh deaths have been reported in India. Besides, the clinical management, dead body management is another critical aspect of COVID-19 pandemic. Forensic pathologists and mortuary staff are an important stakeholder in the dead body management. Dead body management involves the strict implementation of infection control and prevention protocols right from the packing of the body in the ward to the handing over the body to relatives or the administration for the last rituals. With a substantial rise in the COVID-19 fatalities, dead body management has been a continuously daunting task. It mandates the coordination with medical staff working in the hospitals and also district administration officials. Strict adherence to infection control and prevention is mandated for

Corresponding Author
Tanuj Kanchan (Editor-in-chief; Journal of Indian Academy of Forensic Medicine)
Email: tanujkanchan@yahoo.co.in, kanchant@aiimsjodhpur.edu.in
Mobile: +91 9448252394

dead body disposal as well. Hence relatives have to be strictly informed and trained about these protocols prior to handing over the dead body. In India, many mortuaries required updation in term of resources and infrastructure.[3] Hence, it can be additionally stressful for Forensic pathologist and mortuary staff working amidst fear of infection. The bodies are handed over to district/local administration officials for last rituals if next of kin wished for the same. Coordination with district/local administration officials is essential for smooth conduction of these tasks. All these procedures also mandate meticulous paperwork and record-keeping. There have been unfortunate instances of dead body exchange in some places which can be distressful to the healthcare staff working in the mortuary. With the increase in the number of deaths due to COVID-19 pandemic, job associated stressors can have pronounced effects among dead body handlers. It can have a negative impact on behavioural health and can lead to increase risk of compassion fatigue and distress among the mortuary staff. Frustration, stress or anger of the grieving relatives towards mortuary and death care workers also remains a possibility. These reactions can affect the behavioural health of mortuary staff.[3]

The war against COVID-19 has been continuing for almost a year with no assured foreseeable end. The psychological impact of this pandemic among healthcare workers and possible burnout has been recognized. The World Health Organization (WHO) has also released a document about mental health and psychosocial consideration during COVID-19 outbreak. Use of coping strategies like sufficient rest and respite during work or between shifts, eating sufficient and healthy food, engaging in physical activity, and stay in contact with family and friends and avoiding tobacco, alcohol or other drugs is recommended.[4] Peer support and connectedness along with healthy individual coping mechanism can be helpful. Education and awareness among the public are needed to avoid stigma and social discrimination. Various health helplines and counselling sessions are being made available for healthcare workers. In spite of all the hurdles, healthcare workers are standing their ground in this war. However, cooperation from all ends is crucial to prevent stress and burn-out among healthcare workers and for a sustained effort in this long fight against novel Coronavirus.

References

1. Kisely S, Warren N, McMahon L, Dalais C, Henry I, Siskind D. Occurrence, prevention, and management of the psychological effects of emerging virus outbreaks on healthcare workers: rapid review and meta-analysis.BMJ.2020;369:m1642.
2. Cabarkapa S, Nadjidai SE, Murgier J, Ng CH. The psychological impact of COVID-19 and other viral epidemics on frontline healthcare workers and ways to address it: A rapid systematic review. Brain Behav Immun Health.2020;8:100144.
3. Kanchan T, Saraf A, Misra S. COVID-19 outbreak: A testing times for medicolegal facilities in India. J Indian Acad Forensic Med 2020;42(10):1-2.
4. Mental health and psychosocial considerations during the COVID-19 outbreak. Available from:
   https://www.who.int/docs/default-source/coronaviruse/mental-health-considerations.pdf [cited 30 June 2020].

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 155-160
doi:10.5958/0974-0848.2020.00043.3

ORIGINAL ARTICLE

Modeling of Central Incisors Position Indicators in boys and girls according to CC. Steiner method for Forensic Dental Identification

Mykola Dmitriev,[1] Valery Gunas,[2] Sergiy Polishchuk,[3] Iryna Olkhova,[4] Adarsh Kumar[5]

1 Department of Pediatric Dentistry National Pirogov Memorial Medical University, Vinnytsya, Ukraine
2 Department of Pathological Anatomy, Forensic Medicine and Law of National Pirogov Memorial Medical University, Vinnytsya, Ukraine
3 Department of Surgical Dentistry and Maxillofacial Surgery of National Pirogov Memorial Medical University, Vinnytsya, Ukraine
4 Department of Nervous Diseases of National Pirogov Memorial Medical University, Vinnytsya, Ukraine
5 Department of Forensic Medicine & Toxicology, All India Institute of Medical Sciences;, New Delhi, India

Abstract

Personal identification remains one of the main focuses of forensic experts. A foreseeable method of conducting forensic research in the case of an unknown person's examination is a forensic dental examination. However, like other anthropometric studies, it requires adjustment for variables such as age, gender, and most importantly, ethnicity. The purpose of this study is to investigate the correct use of central incisors for Ukrainian boys and girls according to the data recommended by C.C.Steiner for their implementation in forensic identification. 93 lateral cephalometric images (38 boys and 55 girls) of 16-21 years of age with normal bite were examined. Cephalometric analysis was performed in OnyxCeph 3D pro. Statistical analysis and construction of regression models were carried out in the "Statistica 6.0" license package. A number of discrepancies in the percentile range of indexes of the position of the central incisors of the upper and lower jaws, depending on the value of the angle ANB in Ukrainian boys and girls with the results provided by CC. Steiner, were established. As a result of the regression analysis, reliable models of the characteristics of the position of the central incisors of the upper and lower jaws were constructed for Ukrainian boys and girls by Steiner method. The coefficient of determination in boys was found to be from 0.542 to 0.796; and in girls – from 0.503 to 0.622. The study confirmed the relationship of the angle ANB with angular (angles Max1_NA and Max1_SN) and linear (distance 1u_NA) characteristics of the position of the upper central incisors and the inclination angle of the lower central incisors (Mand1_NB). Ethnic differences in the characteristics of the position of the central incisors were determined depending on the magnitude of the ANB angle, and the general nature of the relationships of the main diagnostic parameters proposed by Steiner was confirmed. The results obtained allow their further use in routine practice for the purpose of forensic identification.

Keywords

Forensic Odontology; Identification; Cephalometry; Steiner method.

Introduction

Forensic medicine faces many of the challenges and problems of today: like armed conflicts, illegal migration, natural disasters, massive anthropogenic and natural disasters etc. In all these cases, the forensic expert deals with numerous fragmentary remains of human bodies, often in a state of corpse decay, which makes it impossible to identify the person by conventional methods by forensic expert. In such cases, forensic dentistry, which has become a full-fledged independent section of forensic medicine, is well established in different parts of world. Despite the fact that the first forensic dentist can be considered Paul Revere, who in 1775 identified the skeletonized remains of a person using a denture of the deceased, this discipline became independent only in 1898 after the publication of the monograph by cuban dentist Oscar Amoeda worked in France, who is rightly considered as the father of forensic dentistry.[1]

Forensic dental examination is a complex process that starts from the moment of the inspection of the corpse at the scene of incidence. An external examination of the corpse is carried out, and visible damage to the body, in particular teeth and damage resulting from the action of the teeth (bites) are described. The physical evidence is also recorded, as they may be displaced or deformed during the transportation of the corpse. The next stage, which takes place in the morgue, is a description of the dental formula, describes the traces of dental procedures, prostheses, etc. It should be noted separately that this stage is also accompanied by the participation of a forensic laboratory. At the last stage of forming the research part of the expert's opinion the analysis of the medical records of the deceased, archival data on dental manipulations is carried out. All the above procedures are performed according to DVI protocols.[2]

Not only teeth are used to identify a dead person; at the present stage of the development of forensic dentistry, work is

Corresponding Author
Dr Adarsh Kumar (Professor & In-charge Forensic Anthropology & Forensic Radiology)
Email: dradrashk@yahoo.com
Mobile: +91-9868438856

Article History
Received: 27th of March, 2020; Revision received on: 13th June, 2020
Accepted: 17th June, 2020

underway to study the individual features of the morphology of the palate. According to the results of recent work, this method is specific and highly efficient.[3,4] In addition, the development of modern technology greatly expands the capabilities of forensic dentistry. The use of computer algorithms to process digital radiographs improves the accuracy of identification.[5]

A particular type of focus in forensic dentistry is the examination of bites. There are 4 classes of bite marks: from class 1, which is just visible traces of teeth to class 4 – when there remain clearly visible anatomical disruption, among which one can see their individual characteristics[6]. Bites are especially important material evidence in cases of sexual crimes, in particular in cases of child abuse and sexual homicide.[7-9]

In Ukraine as well as India the field of forensic dentistry has just begin to emerge. Kostenko S. and his co-authors proposed a new approach to the identification of dental composites using a spectrophotometric algorithm,[10] and Goncharuk-Khomyn et al.[11] modified the technique for determining dental age in children of the Transcarpathian region.

Considering that one of the main tools in forensic dentistry is radiological examination,[12] an affordable and inexpensive method, there is a need to improve its capabilities and adapt it to all possible capacities. One of the potential strengths of this method is the cephalometric study, which combines both cephalometric and odontometric parameters. CC.Steiner's cephalometric analysis proposed as early as 1953 has long been a reliable satellite of clinical dentistry and has the potential to be used for the purpose of forensic dental identification.[13] The development of models of this method, adapted for the Ukrainian population, and especially each individual historical and administrative, is a promising task for forensic dentistry.

The purpose of the study is to investigate the correct use of central incisors for Ukrainian boys and girls, according to the data recommended by CC.Steiner for their implementation in forensic identification.

Material and Methods

Using the Veraviewepocs 3D device, Morita (Japan), in 38 boys (17 to 21 years of age) and 55 girls (16 to 20 years of age) with normal occlusion, as close to orthognathic as possible, obtained and analyzed lateral radiographs according to CC. Steiner method.[13]

The Bioethics Committee of the National Pirogov Memorial Medical University, Vinnytsya found that the studies carried out corresponding to the bioethical and moral-law requirements of the Declaration of Helsinki, the Council of Europe Convention on Human Rights and Biomedicine (1977) are in accordance with WHO and laws of Ukraine.

According to the method of CC.Steiner we determined the following indicators (Figures 1, 2): angle SNA – formed by lines S-N (Sella -Nasion line) and N-A (characterizing the location of the upper jaw with respect to the anterior cranial base in the anterior-posterior direction); SNB angle – formed by the lines S-N (anterior cranial base) and N-B (characterizing the location of the mandible with respect to the anterior cranial base in the anterior-posterior direction); ANB angle – inter-jaw angle formed by the lines A-N and N-B (indicates the inter-jaw ratio in the anterior-posterior direction); angle SND – formed by lines S-N and N-D (indicating the anterior-posterior arrangement of the symphysis (D – center of the symphysis) of the mandible to the anterior cranial base); inter-incisor angle II – formed by the central axes of the upper central (Ap1u-Is1u) and lower central (Ar1L-Is1L) incisors; angle SN_OcP – formed by lines apOcP-ppOcP and S-N (slope of the closing plane to the base of the skull); angle SN_GoGn – formed by lines Go-Gn and S-N (angle of inclination of the mandibular plane to the anterior cranial base); angle Max1_NA – formed by lines Ap1u-Is1u (inclination of the central axis of the upper central incisor) and N-A; angle Max1_SN – formed by lines Ap1u-Is1u (inclination of the central axis of the upper central incisor) and S-N; Mand1_NB angle – formed by the lines Ap1L-Is1L (inclination of the central axis of the lower central incisor) and N-B; distance 1u_NA – from point Ls1u to line N-A (determines anteroposterior location of crown of upper central incisor to line N-A); distance 1l_NB – from point Li1L to line N-B (determines the anteroposterior location of the crown of the lower central incisor to line N-B); distance Pog_NB – from the point Pog to the line N-B (characterizes the location of the chin to the line N-B); Holdaway ratio – the difference between the distances between the points Li1L and Pog to line N-B (characterizing the anterior posterior location of the crown of the lower central incisor relative to the size of the chin); the distance S_L is from the point S to the design point L, which is formed at the intersection of the perpendicular drawn from the point Pog to the line S-N; the distance S_E - from point S to the design point E, which is located at the intersection of the perpendicular drawn from the point ppCond to the line S-N.

Statistical processing of the results was carried out in the license package "Statistica 6.0". A direct stepwise regression analysis was used to construct the index models of the position of the central incisors of the lower and upper jaws. We have defined several conditions: 1) the final version of the regression polynomial must have a coefficient of determination (R^2) of at least 0.50, that is, the accuracy of the description of the trait being modeled at least 50.0%; 2) the value of the F-criterion is not less than 3.0, ie the contribution of the variable to the regression should be significant enough; 3) the number of free members included in the polynomial should be as low as

possible. In all cases, after the selection of the multiple regression equation, we analyzed the residuals, since emissions can significantly shift the results and lead to erroneous conclusions. When observations fell within ±3 standard deviations from the mean, we conducted repeated analyzes with and without emissions, in order to have confidence that they had no effect on the shift in the final results.

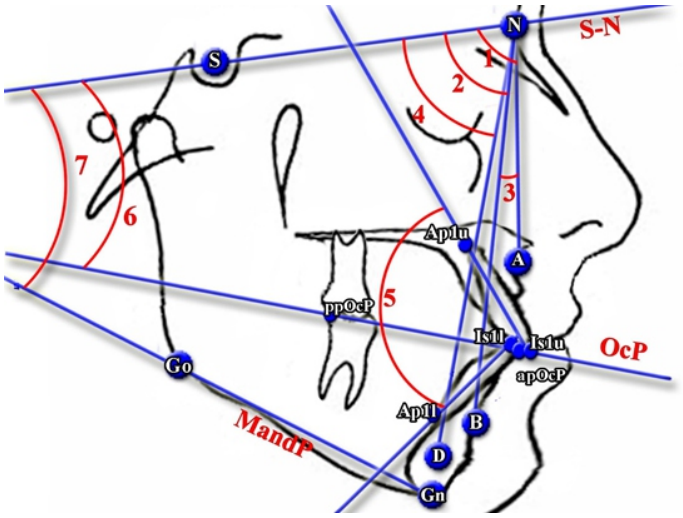


Figure 1: Cephalometric indicators according to Steiner: 1 – angle SNA; 2 – angle SNB; 3 – angle ANB; 4 – angle SND; 5 – inter-incisor angle II; 6 – angle SN_OcP; 7 – angle SN_GoGn.

Results

We studied the position indicators of the central incisors of the upper (Max1_NA, 1u_NA) and lower (Mand1_NB, 1l_NB) jaws for which Steiner developed values depending on the value of the inter-jaw angle ANB.[13] To evaluate the indicators, we used the percentile method, which is based on the percentage distribution of the frequencies of occurrence of the magnitude of the severity of a particular indicator. In the percentile method, the magnitude of the observed trait is considered average (typical) if it is within the 25th -75th percentile. The ANB angle values and the corresponding percentile values of the position characteristics of the central incisors for Ukrainian boys and girls, as well as the values developed by CC.Steiner, are presented in Tables 1-4.

As a result of the regression analysis, it was found that the boys dependent variable of the Max1_NA angle model by 70.6% depends on the total complex of the following characteristics included in the regression polynomial: angles ANB and SN_OcP (R^2=0.706). All the coefficients of this model have high reliability. The results of the ANOVA confirm the high significance (p<0.001) of the regression polynomial. The model has the form of the following linear equation: Max1_NA = 30.73 - 1.791*ANB - 0.399*SN_OcP.

In boys, the dependent variable of the Max1_SN angle model at 79.6% depends on the total complex of the following characteristics that are included in the regression polynomial: SND and ANB angles (R^2 = 0.796). All the coefficients of this model have high enough reliability. The results of the ANOVA confirm the high significance (p<0.001) of the regression polynomial. The model has the form of the following linear equation: Max1_SN = -10.75 + 1.488*SND - 0.638*ANB.

In boys, the dependent variable of the distance 1u_NA model 76.8% depends on the total complex of the following characteristics, which are included in the regression polynomial: ANB angle, distances S_L and S_E and angle SN_GoGn (R^2 = 0.768). All the coefficients of this model have high enough reliability. The results of the ANOVA confirm the high significance (p<0.001) of the regression polynomial. The model has the form of the following linear equation: 1u_NA = -4,396 - 0.486*ANB + 0.167*SE + 0.084*SL + 0.086*SN_GoGn.

Table 1: The value of the angle of inclination of the central axis of the upper central incisor relative to the line N-A (MAX1_NA), depending on the magnitude of the ANB angle in Ukrainian boys and girls and by Steiner.

Angle ANB (degrees)	The magnitude of the angle Max1_NA (degrees)						
	Ukrainian boys			Steiner[13]	Ukrainian girls		
	n	25,000th	75,000th		n	25,000th	75,000th
-2					4	2.2	27.9
-1				25	3	25.8	35.4
0	7	22.0	28.5	24	5	21.0	27.9
1	5	20.7	25.5	23	12	19.0	25.6
2	4	21.0	28.4	22	15	18.1	22.9
3	6	17.2	21.9	21	6	21.7	22.3
4	7	17.0	20.5	20	4	13.1	19.1
5	6	14.5	16.9	19	3	11.3	24.9

Notes: here and in the following tables, n – number of people; 25,000th and 75,000th – percentile limits; horizontally, the values for the angle ANB 2° are indicated, which is considered the norm, and in the vertical direction, the values of the corresponding central incisors, that are recommended by CC.Steiner for the corresponding angle ANB values; yellow indicates the values of indicators for Ukrainian boys and girls, which are significantly different from those proposed by CC.Steiner.

In boys, the dependent variable of the Mand1_NB angle model at 54.2% depends on the total set of characteristics included in the regression polynomial: ANB and SN_OcP angles and the Pog_NB distance (R^2 = 0.542). All the coefficients of this model have high enough reliability. The results of the ANOVA confirm the high significance (p<0.001) of the regression polynomial. The model has the form of the following linear

Table 2: The value of the location of the crown of the upper central incisor to the line N-A (1u_NA), depending on the size of the angle ANB in Ukrainian boys and girls and by Steiner.

Angle ANB (degrees)	The magnitude of the distance 1u_NA (mm)						
	Ukrainian boys			Steiner[13]	Ukrainian girls		
	n	25,000th	75,000th		n	25,000th	75,000th
-2				8	4	5.5	8.0
-1				7	3	6.0	8.0
0	7	5.0	6.0	6	5	5.0	7.0
1	5	4.0	5.0	5	12	4.0	7.0
2	4	5.0	8.5	4	15	4.0	5.0
3	6	3.0	5.0	3	6	4.0	5.0
4	7	4.0	5.0	2	4	2.5	4.5
5	6	3.0	3.0	1	3	2.0	5.0

Table 3: The value of the angle of inclination of the central axis of the lower central incisor relative to the line N-B (Mand1_NB), depending on the magnitude of the ANB angle in Ukrainian boys and girls and by Steiner.

Angle ANB (degrees)	The magnitude of the angle Mand1_NB (degrees)						
	Ukrainian boys			Steiner[13]	Ukrainian girls		
	n	25,000th	75,000th		n	25,000th	75,000th
-2					4	14.7	20.5
-1				22	3	16.9	23.8
0	7	14.5	25.7	23	5	17.0	22.6
1	5	17.0	23.5	24	12	19.7	27.4
2	4	23.6	27.9	25	15	22.1	25.2
3	6	22.2	29.1	26	6	21.1	29.5
4	7	22.4	31.1	27	4	27.6	33.8
5	6	26.1	28.7	28	3	28.4	34.2

equation: Mand1_NB = 26.90 + 1.548*ANB - 0.363*SN_OcP - 0.621*Pog_NB.

In boys, for 1l_NB the value is $R^2 = 0.459$ (less than 0.5), ie the accuracy of the description of the trait is negligible.

In girls, the dependent variable of the Max1_NA angle model is 54.2% dependent on the total set of characteristics included in the regression polynomial: ANB angle and Pog_NB distance ($R^2 = 0.542$). All the coefficients of this model have high reliability. The results of the ANOVA confirm the high significance ($p<0.001$) of the regression polynomial. The model has the form of the following linear equation: Max1_NA = 27.71 - 2.036*ANB - 0.953*Pog_NB.

In girls, the dependent variable of the Max1_SN angle of 52.2% depends on the total set of characteristics included in the regression polynomial: the SNA angle, the Pog_NB distance, and the SND angle ($R^2 = 0.522$). All the coefficients of this model have high enough reliability. The results of the ANOVA confirm the high significance ($p<0.001$) of the regression polynomial. The model has the form of the following linear equation: Max1_SN = 36.14 - 0.979*SNA - 1.712*Pog_NB + 1.949*SND.

In girls, the dependent variable of the 1u_NA distance model is 50.3% dependent on the total set of characteristics included in the regression polynomial: ANB angle and Pog_NB distance ($R^2 = 0.503$). All the coefficients of this model have high reliability. The results of the ANOVA confirm the high significance ($p<0.001$) of the regression polynomial. The model has the form of the following linear equation: 1u_NA = 6.859 - 0.660*ANB - 0.306*Pog_NB.

In girls, the dependent variable of the Mand1_NB angle model at 62.2% depends on the total set of characteristics included in the regression polynomial: ANB angle, Pog_NB distance, SNA angle, and S_L distance ($R^2 = 0.622$). All the coefficients of this model have high reliability. The results of the ANOVA confirm the high significance ($p<0.001$) of the regression polynomial. The model has the form of the following linear equation: Mand1_NB = 76.61 + 2.424*ANB - 2.064*Pog_NB - 0.816*SNA + 0.282*SL.

For indicator 1l_NB, the value of the coefficient of determination, as in boys is less than 0.5 ($R^2 = 0.445$), I.e. the accuracy of the description of the sign is negligible.

Table 4: The value of the location of the crown of the lower central incisor to the line N-B (1l_NB), depending on the size of the angle ANB in Ukrainian boys and girls and by Steiner.

Angle ANB (degrees)	The magnitude of the distance 1l_NB (mm)						
	Ukrainian boys			Steiner[13]	Ukrainian girls		
	n	25,000th	75,000th		N	25,000th	75,000th
-2				3.0	4	1.0	3.0
-1				3.25	3	3.0	5.0
0	7	3.0	4.0	3.5	5	2.0	4.0
1	5	3.0	4.0	3.75	12	3.0	5.5
2	4	5.0	7.0	4.0	15	3.0	5.0
3	6	3.0	7.0	4.25	6	4.0	5.0
4	7	5.0	5.0	4.5	4	3.5	6.5
5	6	5.0	6.0	4.75	3	5.0	9.0

Discussion

Directly close to forensic dentistry scientific discipline is forensic anthropology, which studies physical anthropology to identify individuals. Particularly noteworthy are works performed under the guidance of the anthropologist Gunas IV. in the field of both forensic anthropology[14] and forensic dentistry in the population of Podillia region of Ukraine.[15-17]

During the work with 243 boys and girls, with different forms of head and face who were residents of Podillia region of Ukraine, Gunas I. with co-authors[15] found the boundary percentile scope values of transversal characteristics of the dental arch:. In girls differences were found in the transversal dimensions of the lower and upper jaws, in the distribution of the type of face and shape of the head; while in boys such statistically significant differences were not found.

In another work performed by Marchenko et al. on the same population it was found that in mesocephals majority values of length of the teeth, root of medial and lateral incisors in the upper and lower jaws are significantly higher compared to brachycephals.[16]

18 reliable regression mathematical models were built for Ukrainian mesocephal girls to construct correct dental arch shape depending on the features of cephalometric and odontometric parameters. In 61.2% such models included tooth sizes and in 38.8% cephalometric indicators.[17]

Comparing the percentile span of the indexes of the position of the central incisors of the upper (Max1_NA, 1u_NA) and lower (Mand1_NB, 1l_NB) jaws, depending on the value of the ANB angle in Ukrainian boys and girls with the results provided by CC.Steiner,[13] we established a number of differences. Thus, the values of the Max1_NA angle in Ukrainian boys have smaller values (14.5-16.9°) than those of CC.Steiner (19°) with an angle ANB 5°; and girls have smaller values (13.1-19.1°) than according to CC.Steiner (20°) at ANB angle of 4°. The values of 1u_NA in Ukrainian boys are greater (5.0-8.5 mm, 4.0-5.0 mm and 3.0-3.0 mm) than those according to CC.Steiner (4 mm, 2 mm and 1 mm) when the angle ANB is 2°, 4° and 5°, respectively; and girls have higher values (4.0-5.0 mm, 2.5-4.5 mm and 2.0-5.0 mm) than according to CC.Steiner (3 mm, 2 mm and 1 mm) in magnitude ANB angles of 3°, 4° and 5°. The values of the Mand1_NB angle in Ukrainian boys are smaller (17.0-23.5°) than those according to CC.Steiner (24°) at an ANB angle of 1°; and girls have smaller values (17.0-22.6°) than those according to CC.Steiner (23°) at an angle ANB of 0°. The values of 1l_NA in Ukrainian boys have higher values (5.0-7.0 mm, 5.0-5.0 mm and 5.0-6.0 mm) than according to Steiner (4 mm, 4.5 mm and 4.75 mm) at an angle ANB of 2°, 4° and 5°, respectively; and girls have higher values (5.0-9.0 mm) than according to CC.Steiner (4.75 mm) at ANB angle of 5°.

Thus, with the exception of angle location of lower incisors (Mand1_NB angle), most differences in the characteristics of the position of the central incisors, both for Ukrainian boys and for Ukrainian girls, are observed at ANB values greater than 2°, that is, characteristic of the more distal location of the mandible.

The analysis of the regression models we developed showed that in determining the position of the central incisors of the lower and upper jaws in boys, the models include 100% of the angle ANB and 50% of the angle SN_OcP. For girls, models have 100% Pog_NB distance and 75% ANB angle. Therefore, the recommendation of CC.Steiner that the importance of taking into account the magnitude of the ANB angle and the distance Pog_NB in determining the position of the central incisors of the lower and upper jaws, found almost complete confirmation only in Ukrainian girls. In the Ukrainian boys, according to the recommendations of CC.Steiner, only the importance of the ANB angle value was confirmed.

Also interesting was the fact that the Ukrainian boys and girls regression models of distance 1l_NB had a low accuracy of description of the trait (R^2<0.5). This indicates the natural variability of this indicator independent of other indicators considered within the method of CC.Steiner.

Thus, in small steps, a strong theoretical anthropometric and odontometric base is formed, which serves as a reliable foundation for building a forensic dental service. One of the important bricks of this process is the method of analysis of lateral teleroentgenograms by the method of CC.Steiner for the Ukrainian population and development of mathematical models for determining the indexes of the position of the teeth of the upper and lower jaws.

Conclusions

Established ethnic differences in the characteristics of the position of the central incisors, depending on the size of the angle ANB – most differences for Ukrainian boys and girls from the values proposed by CC.Steiner observed with a more distal location of the mandible. The results of the regression analysis confirm the overall nature of the relationship of the main diagnostic parameters proposed by CC.Steiner. However, for more accurate prognostic purposes, it is better to use tailored ethnic and sex data. Mathematical models for determining the position of the central incisors of the lower and upper jaws, developed for Ukrainian boys and girls, can be used for forensic dental identification. Similar type of study is recommended for Indian population also to have more ethnic database

Ethical clearance: A prior approval was obtained from the Institutional ethics committee

Conflict of interest: None to declare

Source of Funding: None to declare

Acknowledgements: None to declare

References

1. Kumar A, Mahanta P, Logani A, Chaitra V. Forensic Odontology. In: Putul Mahanta Modern Textbook of Forensic Medicine & Toxicology. Jaypee publishers New Delhi 1st Edn 2014.pp 142-170.
2. Berketa JW, James H, Lake AW. Forensic odontology involvement in disaster victim identification. Forensic Sci Med Pathol. 2012;8(2):148-156.
3. De Angelis D, Riboli F, Gibelli D, Cappella A, Cattaneo C. Palatal rugae as an individualising marker: reliability for forensic odontology and personal identification. Sci Justice. 2012;52(3):181-184.
4. Krishan K, Kanchan T, Garg AK. Dental evidence in forensic identification–An overview, methodology and present status. Open Dent J. 2015;9:250-256.
5. Van Der Meer DT, Brumit PC, Schrader BA, Dove SB, Senn DR. Root morphology and anatomical patterns in forensic dental identification: a comparison of computer-aided identification with traditional forensic dental identification. J Forensic Sci. 2010;55(6):1499-1503.
6. Kaur S, Krishan K, Chatterjee PM, Kanchan T. Analysis and identification of bite marks in forensic casework. Oral Health Dent Manag. 2013;12(3):127-131.
7. Kumar A, Yadav M, Kumar S, Kumar N, Gupta K. Analysis of Bite Mark Evidence. J Indian Acad Forensic Med. 2012;34(2):175-176.
8. Bhargava K, Bhargava D, Yadav M, Paul M, Paul R, Singla A. Bite Marks: Teeth as Weapons of Violence. J Indian Acad Forensic Med. 2012;34(3):255-259.
9. Sharma G, Yadav M, Singh H, Aggarwal AD, Sandhu R. Bite mark analysis-An important tool in crime investigation. J Indian Acad Forensic Med. 2006;28(2):69-71.
10. Kostenko S, Dzupa P, Levandovskyi R, Bun Y, Mishalov V, Goncharuk-Khomyn M. Optimized approach of dental composites identification with the use of original spectrophotometric algorithm. J Int Dent Med Res. 2018;11(2):403-408.
11. Goncharuk-Khomyn M, Begzati A, Meqa K, Xhemali-Latifi B, Kutllovci T. Modification of Dental Age Estimation Technique among Children from Transcarpathian Region. J Int Dent Med Res. 2017;10(3):851-855.
12. Sharma G, Yadav M, Singh H, Aggarwal AD, Sandhu R. Forensic odontology: Role in mass disasters. J Indian Acad Forensic Med. 2006;28(2):43-45.
13. Steiner, CC. (1959). Cephalometrics in clinical practice. Angle Orthod. 29: 8-29.
14. Gunas I, Shinkaruk-Dykovytska MM, Kotsyura OO, Orlovskiy VO, Dmytrenko SV, Shayuk AV, Glushak AA. Differences of craniotype distribution and types of face among apparently healthy men from different regions of Ukraine. Folia morphologica. 2017;76(3):473-477.
15. Gunas I, Glushak A, Samoylenko A. Dental arch Transversal characteristics in boys and girls with orthognathic bite: head shape and face type dependence. Curr Issues Pharm Med Sci. 2015;28(1):42-45.
16. Marchenko AV, Gunas IV, Petrushanko TO, Serebrennikova OA, Trofimenko YY. Computer-tomographic characteristics of root length incisors and canines of the upper and lower jaws in boys and girls with different craniotypes and physiological bite. Wiadomosci lekarskie (Warsaw, Poland: 1960). 2017;70(3 pt 1):499-502.
17. Marchenko AV, Gunas IV, Petrushanko TO. Regression models of individual linear dimensions required for constructing the correct dental arch shape in mesocephals youth, depending on the features of odontometric and cephalometric indicators. World of medicine and biology. 2017;2(60):83-88.

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 161-163
doi:10.5958/0974-0848.2020.00044.5

ORIGINAL ARTICLE

Sexual dimorphism in sacrum

Dayananda R,[1] Priyadarshee Pradhan,[2] Jagdeesh Kamal Chander,[2] Venkatesan,[2] Kumar MP[1]
1 Department of Forensic Medicine, Mysore Medical College & Research Institute, Mysore, India
2 Department of Forensic Medicine, Sri Ramachandra Medical College, Chennai, India

Abstract
The sacrum is a large triangular fusion of five vertebrae and forms the posterior wall of the pelvic cavity. It supports the spine and provides stability to the pelvis to transmit body weight. Determination of sex from the skeletal remains is of tremendous medico-legal importance for establishing the identity of an individual. Sacrum has always attracted the attention of medico-legal experts for establishing sex, possibly because of its contribution to pelvic girdle and associated functional sex differences. Hence, it becomes necessary to study the various parameters of sacrum to identify a male from a female sacrum. The aim of the present study was to investigate the sex differences in an adult human sacrum and thus identify a male from a female sacrum using various parameters. 254 dried, completely ossified, grossly normal human adult sacrum of both sexes was taken from Department of Forensic Medicine and Department of Anatomy of Mysore Medical College & Research Institute, Mysuru and from students of 1st year MBBS. In our study, the male sacrum shows significantly higher values for ventral straight length, ventral curved length, transverse diameter of S1 and anteroposterior of S1, than the female sacrum, while the female sacral index showed higher values when compared with that of male. Demarking point of the sacrum helps in differentiating the two sexes. The most useful index for sex determination of sacrum in the present study is sacral index. Continued study over a period of time in a defined area will definitely help in establishing the anthropometric standards.

Keywords
Forensic Anthropology; Sexual dimorphism; Sacrum; Sacral index

Introduction

The bones of the body are the last to perish after death, next to the enamel of teeth. Hence in establishing the personal identity with respect to sex, age and stature Forensic experts use the skeletal remains for giving their opinion. The examination of bones also helps in the archaeological specimen obtained after excavation, as well as in medico-legal cases for establishing identity.

Estimation of sex in medico-legal specimens of bones depends on the number of bones sent for examination. Krogman has opined the accuracy of sex identification based on the study of complete skeleton was 100%, skull with pelvis 98%, pelvis alone 95%, skull alone 90% and long bones alone was 80%. Morphological features of the bones also depend on the nutritional, geographic and occupational factors.[1]

While indicators of sex such as pelvis and the skull have been thoroughly researched in the science of Forensics, it is observed that there is a paucity of literature available regarding estimation of sex using "sacrum".[1] Hence the present study is an attempt to establish some of the parameters which will be of great help in sex estimation, both in medico-legal and anthropometric study.

Sacrum is derived from the Latin word 'sacer' which means 'Holy' or 'consecrated'. Greek called it 'Heiron Ostoum', again meaning 'the sacred bone'. In the midst of 18th century, the os sacrum (sacred bone) was so named by the Romans as a direct translation.[2] This was probably because the ancients observed that 'because of its bulk, the sacrum appeared to be the last of the bones of an interred corpse to decay, hence this bone must be the nidus around which the body should be reassembled.

So vast is the overlap between sexual characters of male and female skeletons belonging to different races that Hooton is compelled to comment, "Every anthropologist unless he deceives himself must recognize that many of his decisions as to sex are questionable."[3] Sexual dimorphic characters can be studied both morphologically and metrically. Morphometric studies pose several problems such as difficulties with quantification and inter-observer bias. Geometric morphometrics is relatively a more reliable method.

Materials and Methods

Approval from the institutional ethics committee was obtained prior to the commencement of the study. 254 sacra of both sexes were investigated for sexual dimorphism in the present study (190 males and 64 females). These sacra were collected from Department of Forensic Medicine, Anatomy and MBBS students of Mysore Medical College & Research Institute,

Corresponding Author
Dr Dayananda R (Associate Professor)
Email: drdaya.r@gmail.
Mobile: +91-9900076248

Article History
Received: 2nd March, 2020; Revision received on: 14th June, 2020
Accepted: 16th June, 2020

Mysuru. All the sacra which are completely ossified and devoid of any deformity were taken for the study. Sacra that are not ossified and mutilated were excluded.

Following measurements were made on each of the sacra to estimate sex:

Mid-Ventral straight length (Maximum length): distance from the antero-superior margin of promontory to the middle of antero-inferior margin of the last sacral vertebra measured using sliding vernier calipers. Sacral mid ventral curved length**:** was measured by using the tape from midpoint of sacral promontory to the midpoint of sacrum. True diameter of the base of the sacrum (EF): maximum distance between the lateral midpoint of left and right alae of sacrum measured using sliding vernier calipers. Minimum sacral width: With the help of Vernier calipers, minimum distance was measured at the apex of the sacrum in cm. True diameter of body of S1 (E' F'): maximum width of the body of the first sacral vertebra. Antero-posterior diameter of the S1 vertebra: maximum antero-posterior distance of the body of the first sacral vertebra was measured using the sliding vernier calipers. Sacral Index: Sacral width (width for S1)/ Sacral ventral straight length X 100. Index for body of first sacral vertebra: Antero-posterior diameter of body of S1/ Transverse diameter of body of S1 X 100.

For the obtained values, range was calculated on the lines of Jit[4] and Singh[5]. Calculated range was obtained by adding 2 times the value of standard deviation to the mean of the measurement. (2xS.D±mean=Calculated range).

Table 1: Descriptive statistics of the various sacral measurements in both the sexes

Parameter	Males		Females	
	Range	Mean ± SD	Range	Mean ± SD
Mid-ventral straight length (cm)	9.32– 12.68	11.00 ± 0.84	7.75– 11.15	9.45 ± 0.85
Ventral curved length (cm)	9.65- 12.87	11.26 ± 0.81	8.42– 11.62	10.02 ± 0.80
True diameter of the base of sacrum (cm)	8.62– 12.22	10.42 ± 0.90	9.25– 12.01	10.63 ± 0.69
Minimum sacral width	1.93– 4.25	3.09 ± 0.58	1.71– 2.91	2.31 ± 0.30
True diameter of body of S1(cm)	3.25– 6.53	4.89 ± 0.82	2.12– 5.68	3.90 ± 0.89
Anterior Posterior of S1 (cm)	2.11– 3.59	2.85 ± 0.37	2.00 – 3.44	2.72 ± 0.36
Sacral Index	70.68– 117.8	94.24 ± 11.78	92.67–133.71	113.19 ± 10.26
Index of S1	32.69– 86.89	59.79 ± 13.55	34.96 –109.84	72.4 ± 18.72

SD: Standard deviation; S1: 1st Sacral vertebra

Results

Among the 254 human adult sacrum bones examined 190 are males and 64 are females. For all the studied parameters, the mean, standard deviation and range in both the sexes are depicted in Table 1. Sexual dimorphism for each of the sacral parameter was calculated using independent t-test, and the results of this are shown in Table 2.

Table 2: : Sex differences in the different sacral measurements

Parameter	T-value	P-value
Mid-ventral straight length (cm)	13.47	p<0.001
Ventral curved length (cm)	10.68	p<0.001
True diameter of the base of sacrum (cm)	1.94	p>0.05
Minimum sacral width	13.84	p<0.001
True diameter of body of S1 (cm)	7.85	p<0.001
Anterior Posterior of S1 (cm)	2.48	p>0.05
Sacral Index	12.29	p<0.001
Index of S1	4.97	p<0.001

S1: 1st Sacral vertebra

Table 3: Summary of sexual dimorphism results of other studies

Studies	Mishra et al.[6]		Sachdeva et al.[7]		Raju et al.[8]	
Parameter	Males	Females	Males	Females	Males	Females
Mid-ventral straight length (cm)	10.75	9.06	10.50	9.27	10.41	9.18
Ventral curved length (cm)	11.96	10.95	11.28	10.48	11.35	10.45
True diameter of the base of sacrum (cm)	10.53	10.58	10.53	10.35	10.31	10.17
Minimum sacral width	-	-	-	-	11.18	10.44
True diameter of body of S1 (cm)	4.91	4.28	4.73	4.21	4.76	4.55
Anterior Posterior of S1 (cm)	3.00	2.93	3.03	2.76	3.15	2.85
Sacral Index	3.00	3.17	-	-	3.35	3.00
Index of S1	98.21	117.84	100.85	111.39	100.24	111.74

Discussion

It was observed that the ventral straight length and ventral curved length was more in males than the females. These findings are similar to previous studies done by Mishra et al.,[6] Sachdeva et al.,[7] and Raju et al.[8] Difference between mean of ventral straight length and ventral curved length in male and female is statistically significant (Table 2).

Mean of true diameter of base of sacrum was more in females than in males (Table 1) but this was not statistically significant. The results observed in our study were different from those in Varanasi and in Punjab, where true diameter of sacrum was

more in males, the mean sex difference being statistically significant. True diameter of apex of sacrum was more in males compared to females and this mean sex difference was statistically significant. This measurement has not been considered by other workers.

As far as true diameter of body of first sacral vertebra is concerned it was more in males than females, the mean sex difference being statistically significant. This was in contrast to other studies done in Punjab (where it was statistically insignificant).

A larger transverse diameter of body of S1 in males is attributed by Francis to a larger articular facet for centrum of L5 in them, occupying almost half of transverse width of base of sacrum. In females the facet is relatively small occupying only a little more than one-third.

Antero-posterior diameter of body of S1 was more in males than females and the mean sex difference was statistically significant. This was in consonance with studies done by previous workers.

As per studies done by previous researchers, sacral index was more in females than males and sex difference was statistically significant which was in agreement with our study. Index for S1 – Sacrum with index of body of S1 above 120.8 is definitely a female and 34.96 is definitely a male.

Conclusion

Out of the 8 parameters studied, which includes 2 indices, seven parameters yielded statistically significant results. Sex difference in width of the sacrum was not statistically significant. This finding of our study differed from the observations by other authors. Minimum sacral width was a unique parameter taken into account in our study for sex difference in sacrum. This parameter was statistically significant.

Ethical clearance: A prior approval was obtained from the Institutional Ethics Committee

Conflict of interest: None to declare

Source of funding: None to declare

References

1. Derry DE. Note on the innominate bone as a factor in the determination of sex with special reference to the sulcus-preauricularis. J.Anat. and Physiol. 1909; 43: 266- 76.
2. Sugar O. How the sacrum got its name. JAMA, 1987; 257: 2061-63.
3. Hooton EA. The Indians of Pecor Pueblo. Yale University Press, New Haven; 1930,
4. Jit I and Singh S. The sexing of the adult clavicles. Ind.J. Med. Res.1966; 54:551-71.
5. Singh S and Gangarde KG. Sexing of adult clavicles, verification and applicability of demarking points. J Indian Acad Forensic Sci. 1968; 7:20-30.
6. Mishra SR, Singh PJ, Agrawal AK, Gupta RN. Identification of sex of sacrum of Agra region. J Anat Soc Ind. 2003; 52(2): 132-136.
7. Sachdeva K, Singla RK, Kalsey G, Sharma G. Role of Sacrum in Sexual Dimorphism-A Morphometric Study, J Indian Acad Forensic Med, 2011; 33(3): 206-10
8. Raju PB, Singh S, Padmanabhan R. Sex determination and sacrum. J Anat Soc Ind. 1980; 30(1): 13-15.

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 164-166
doi:10.5958/0974-0848.2020.00045.7

ORIGINAL ARTICLE

Sex Differentiation by Ischio-pubic Index: A Radiological study over the Population of Bihar

Gautam Kumar,[1] Avinash Kumar,[2] Amit Patil,[2] Binay Kumar,[2] Ashok Kumar Rastogi,[2] Prabhat Kumar[2]

1 Department of Forensic Medicine & Toxicology, Dumka Medical College & Hospital, Dumka, Jharkhand, India
2 Department of Forensic Medicine & Toxicology, All India Institute of Medical Sciences, Patna, Bihar, India

Abstract

Identification is establishment of identity of a person with the help of different physical characteristics. The different physical characteristics of human skeleton between both the sexs is the reason of Sexual dimorphism. Many researchers have studied and observed the different parameters for sexual dimorphism in different bones. Pelvis is most important bone for determination of sex because the sexual dimorphism is present even in fetal stage. In modern era of advancement, pathological autopsy is shifting towards the virtual autopsy in which CT scan, MRI and X-rays are replacing the conventional autopsy instruments. The present study was conducted with an aim to establish sex differentiation criteria in population of Bihar based on ischio-pubic index. 200 AP view pelvic digital radiographs were analysed in the present study, and the ischio-pubic index was calculated by measuring the length of pubis and ischium using the DICOM software. Ischio-pubic Index of pelvis in male and female sex is 94.04±11.02 and 114.16±14.85 respectively. The differences between males and females with respect to the ischio-pubic index are statistically significant ($p<0.0001$).

Keywords

Sexual dimorphism; Pubis; Ischium; Ischio-Pubic index; DICOM software

Introduction

Identification is establishment of individuality of a person based on certain physical characteristics, and its establishment is an essential in civil cases and as a component of corpus delicti in criminal cases.[1] Among all identification data, sex is one of the most important components. Sex can be determined by external genitalia, internal sexual organs, sex chromatin and by the gross examination of skeleton/Osteology.[2] Osteological determination of sex is a routine practice in Forensic Medicine and Toxicology. Sex estimation is easier when person is alive or if corpse is not mutilated or not in an advance stage of decomposition. In mutilated and highly decomposed body due to absence of external and internal sexual organs, sex identification becomes difficult. In these situations, osteometry becomes very useful for sex differentiation. Osteometric measurement can be done in the living or during postmortem examination. During postmortem bones should be extracted and measurement can be taken by osteometric board. Through radiological means osteometric measurements can be taken both in the living and the dead, without cumbersome process of extraction. So, radiology can contribute to sex determination by providing precise dimension both in living as well as in the dead.[3]

In osteometry various bones are taken in consideration for sexual differentiation but among them pelvis alone is best to differentiate sex among all other bones. Due to evolution and birth capacity, the female pelvis shows sexual dimorphism. The renowned anthropologist "William krogman's" study says pelvis shows sexual dimorphism since birth and it can predict sex up to 95% accuracy.[4] There are any parameters and indexes by which sexual dimorphism can be certified, out of which ischio-pubic index is one of them and can be estimated with minor effort.[5]

In conventional methods, these measurements can be taken from osteometric board, calipers and measuring scales. In the era of the recent advances in medical sciences, such measurements can be assessed through digital x - ray with DICOM software.

In the present study, we have tried to validate the ischio-pubic index, measured radiologically to differentiate male and female sex.

Materials and methods

Approval from the institutional research committee was obtained before commencement of the study. The present investigation included measuring the length of ischium and pubis bones in 200 digital radiographs (100 males, 100 females) with an age range of 3 months to 85 years. These radiographs taken from the hospital records belonged to those patients who visited to the department of radiology during the course of treatment and were advised for anterio-posterior view of pelvic x-ray. The digital x-rays of only those individuals whose sex was properly documented on the x-rau film were included in the study. Patient x-rays showing any signs of pelvic injury or deformity were excluded from the study. Overexposed and underexposed x-ray films were excluded as well. The digital x

Corresponding Author
Dr. Avinash Kumar (Senior Resident)
Email: staravinash008@gmail.com
Mobile: +91-9570073048

Article History
Received: 19th March, 2020; Revision received on: 16th July, 2020
Accepted: 17th July, 2020

ray films were studied with the help of DICOM software. Through DICOM software, the lengths of pubis and ischium bones were measured as shown in Table 1 and Figure 1.[5]

Table 1: Methodology for measuring the length of pubis, length of ischium, and the ischio-pubis index.

Length of pubis (mm)	Distance between the reference point of acetabulum and the midpoint of the symphysis pubis
Length of ischium (mm)	Distance between the reference point of the acetabulum and the farthest edge of the ischium
Ischio-pubic index	By multiplying the ratio of length of pubis and length of ischium by 100

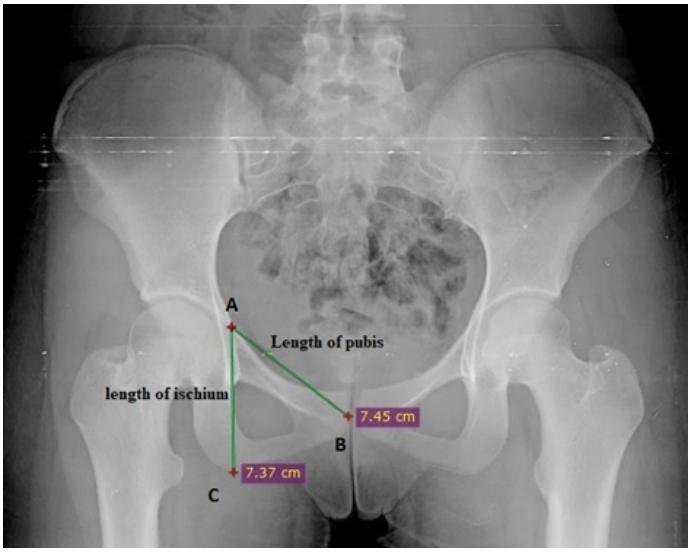


Figure 1: Measurement of lengths of pubis and ischium bones on a digital radiograph

All data thus collected was entered in excel sheet and statistical analysis were done through excel and SPSS. Descriptive statistics of the pubis and ischium bone lengths were calculated, and independent t-test was performed to measure the extent of sexual dimorphism. ROC analysis was conducted to calculate the sensitivity and specificity of the ischio-pubic index in differentiating males and females.

Results

Ischio-Pubic Index of pelvis in male and female sex was calculated to be 94.04±11.02 and 114.16±14.85 respectively. The results of independent t-test are shown in Table 2.

Comparison of Ischio-pubic index between male and female

For Ischio-pubic index the area under ROC curve is 86.9% (95% CI 82%- 91.7%, p<0.0001) for sex differentiation as seen in Figure 2. Ischio-pubic index is different in male and female. In the study population, applying a differentiation point of 100.94 the sensitivity of 86%, specificity of 75% for female sex. In the study population of Bihar, a significant difference is noted in the average size of Ischio-pubic index between men and woman, with average size is significantly less than female that in men (p< 0.0001).

Table 2: Sex differences in the ischio-pubic index

Ischio-pubic index	Female		Male		T-value	P-value
	Mean	SD	Mean	SD		
	114.16	14.85	94.04	11.02	10.88	<0.0001

SD: Standard Deviation

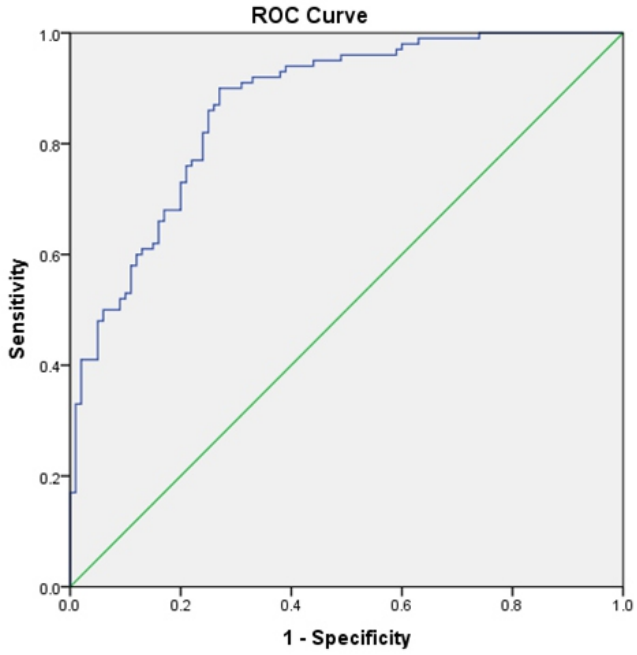


Figure 2: ROC analysis for utility of ischio-pubic index in sexual dimorphism

Discussion

A total of 200 digital x-rays of pelvis, including both the sex in equal proportion from population of Bihar were investigated in the present study. In anterio-posterior view of pelvic digital x-ray, ischio-pubic index was calculated. The length of pubis is larger than ischium in females and vice versa in males. So, theoretically, the ischio-pubic index should be higher in females than in males.[6] This exact observation was reported in the present study where the females were seen to have higher ischio-pubic index than males. The mean value of ischio-pubic index in females was observed to be 114.16 ± 14.85 while in males it was observed to be 94.04 ± 11.02. In a study by Memarian and Aghakhani on an Iranian population, the mean

value of the ischio-pubic index in females was reported to be 107.96 ± 11.54 and it was observed to be 94.28 ± 9.18 in males.[5] Ekanem et al. did a study in Nigeria and found that the ischio-pubic index was higher in females than males, with it being 94.2 in males and 118.8 in females.[7] Oladipo et al. found mean values of ischio-pubic index in Urhobo male to be 91.66 ± 5.86 and for Urhobo female the mean was 114.93 ± 18.14.[8]

Conclusion

In our study we used digital radiograph of pelvic bone for estimation of sex. Through digital radiograph of pelvis, the length of pubis and length of ischium and calculated ischio-pubic index and finally found statistically significant to be used as a parameter for differentiation of sex.

Ethical clearance: A prior approval was obtained from the Institutional Ethics Committee

Conflict of interest: None to declare

Source of funding: None to declare

References

1. Reddy KSN. The essentials of Forensic Medicine and Toxicology. 34th ed. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.; 2017. p. 55.
2. Reddy KSN. The essentials of Forensic Medicine and Toxicology. 34th ed. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.; 2017. p. 57-62.
3. G. DiVella, C.P. Campobasso, M. Dragone, F.Introna Jr. Skeletal sex determination by scapular measurements Boll Soc Ital Biol Sper, 70 (1994):299-305.
4. Krogman WM, Iscan MY. The Human skeleton in Forensic Medicine. 2nd ed. Illinosis : Charles C Thomas ; 1986.228.
5. Memarian A, Aghakhani K, Mehrpisheh S, Fares F. Sex determination from diagnostic factors on anteroposterior pelvic radiographs. J Chin Med Assoc. 2017; (80):161- 68.
6. Aggrawal A. Textbbook of Forensic Medicine and Toxicology. 1st ed. Delhi: Avichal Publishing Company; 2014; p 68-9.
7. Ekanem T, Udongwu A, Singh S. Radiographic determination of sex differences in ischiopubic index of a Nigerian population. Internet J Biol Anthropol 2009;3:1e6.
8. Oladipo G, Anugweje K, Rosemary E, Godwin C. Radiologic study of ischiopubic index of Urhobos and Itsekiris of Nigeria. Br J Med Med Res 2015;5:1114 e 20.

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 167-171
doi:10.5958/0974-0848.2020.00046.9

ORIGINAL ARTICLE

Determination of sex from hand and finger dimensions in a regional eastern Indian population using discriminant function analysis

Kumarjit Sarkar,[1] Soumeek Chowdhuri,[2] Tapas Kumar Bose[3]

1 Department of Forensic Medicine, Suri District Hospital, Suri, West Bengal, India
2 Department of Forensic Medicine, Calcutta National Medical College, Kolkata, India
3 Department of Forensic Medicine, Shri Ramakrishna Institute of Medical Sciences & Sanaka Hospital, Durgapur, West Bengal, India

Abstract

Sex determination is one of the important facets of human identification. It becomes especially difficult, when fragmentary remains are brought for forensic examination or when bare/gloved hand prints are recovered from a crime scene. In this study we try to determine mathematical models to find out sexual dimorphism from hand and finger dimensions among adult Eastern Indian population. 170 2nd Year medical undergraduate students (125 males and 45 female) between the age group of 20-25 years were examined, and their hand and finger dimensions estimated. The average hand and finger dimensions were greater in males as compared to females. Discriminant function analysis was used to analyse the data, which could estimate sexual dimorphism from right hand finger lengths in 74.7% cases, based on cross-validated results, with a Wilk's Lambda value of 0.703 while from left hand finger lengths, the same was 72.4%, with a Wilk's Lambda value of 0.762. While, the model for the right-hand dimensions had a predictive accuracy of 90 %, based on cross-validated results, with a Wilks's Lambda value of 0.455, and the same for left hand dimensions was 87.6% with a Wilk's Lambda value of 0.468. Since anthropometric variations exist between different ethnic groups residing in different geographical areas, the results obtained in this study can be exclusively applied to the Eastern Indian regional population. Although it has a moderately high predictive accuracy, this should act as an adjunctive in forensic case work in future.

Keywords

Anthropometry; Identification; Medicolegal Investigation; Fragmentary Remains; Sexual Dimorphism; Discriminant Function Analysis.

Introduction

Sex determination is an essential component of personal identification. This becomes especially important for forensic investigations in medicolegal cases.[1] When mutilated dead bodies with fragmentary remains are brought for forensic examination, sexual discrimination of such body parts become extremely difficult. This is also true when a bare/gloved hand or foot print is recovered during a Crime Scene Investigation. Sex is considered to be one of the big four parameters in forensic identification besides race, age and stature. This is so because sexing of human remains or prints helps the forensic scientist to narrow down the possible pool of human matches.[2] Human population exhibits certain anatomical features which to a certain extent aid in sexual discrimination, for example the human male skeleton is roughly larger in dimension than the female skeleton and this can be used to estimate sex.[3] Forensic Anthropology, is defined as, that branch of physical anthropology, which for forensic purposes, deals with the identification of more or less skeletonised remains, known to be or suspected to be human in nature.[4] Traditionally pelvis and cranium taken together, (or separately), have been used for differentiating sex, but more recently, in cases of fragmentary human remains, being recovered, hand anthropometry have been shown to be sexually dimorphic in various studies conducted in many countries.[5] Many of such studies have utilised Discriminant Function Analysis as their principal statistical tool, as the accuracy of results increases many folds.[6] It has been seen that the data obtained from people in such studies is highly specific to a particular geographical area or ethnic group or in people sharing a common ancestry, because of common morphological features in such people.[7] Therefore the data obtained in such study should not be replicated on another ethnic group. As very few similar studies (only one done on the North Bengali tribal population as referred below) have been done in this part of the country, the present investigation was undertaken, as an attempt to find a mathematical model to find out sexual dimorphism of the hand and finger dimensions among adult Bengalis.

Corresponding Author
Dr Soumeek Chowdhuri (Tutor)
Email: smk.kgp@gmail.com
Mobile: +91-9007580064, +91-9674388496

Article History
Received: 19th March, 2020; Revision received on: 24th July, 2020
Accepted: 28th July, 2020

Materials and Methods

The study was conducted on 2nd Year medical students, aged between 20–25 years, at a tertiary level medical institute, in India. It was a descriptive, cross-sectional study, conducted by purposive sampling of 170 subjects (125 male and 45 female) over a period of two months after obtaining approval from the Institutional ethical committee. The current study was done on a

population, those who were born, brought up and currently residing in the defined geographical area of West Bengal, whose mother tongue is Bengali language and whose parents fulfil the above criteria as well. However, any student with any disease, deformity, injury, fracture, amputation, or history of any surgical procedures of either hand, and poorly defined flexion creases were excluded from the study.[8] Left-handed students were also excluded as the effect of hand dominance on morphometric measurements of the hand has been suggested.[9] A consent cum proforma form was supplied to each student where their signature was taken. All measurements were recorded by the same observer (the 1st author of the study) to eliminate any inter-observer variation in recording of data. The data was recorded thrice and mean of all the data was subsequently taken to make the recording more accurate. The morphometric measurements of the hand were recorded for each and in cm to the nearest mm using Vernier Callipers (long scale 12"/30cm, Vernier scale having a least count 0.02 mm) as described by Weiner and Lourie.[10]

The following Hand dimensions were recorded:

Length of the hand (HL): The distance between the mid-point of the inter-styloid line (line joining the most distal point on the styloid processes of radius and ulna) to the most anterior projection of the middle finger.

Breadth of the hand (HB): The distance between the radial side of the second metacarpo- phalyngeal joint and the ulnar side of the fifth metacarpo-phalyngeal joint.[8]

Finger Length: The distance between the tip of the digit to the ventral proximal crease, where there was a band of crease at the base of the digit, the most proximal crease was used.[11]

The students, while measuring the hand length, were asked to place their hands supine on a flat hard horizontal surface with fingers extended and adducted. However, while measuring the hand breadth, the thumb was abducted whereas the other fingers remained adducted. When the finger lengths measured, it was seen that all the individual fingers were adducted and extended. Care was taken to see that there was no abduction or adduction at the wrist joint.[8]

The data obtained was computed and analysed with SPSS (version 23.0, Armonk, NY, IBM Corp.) and results drawn. Descriptive statistics of the finger measurements were calculated. Discriminant function analysis was conducted using these measurements to estimate sex. ROC curve analysis was performed to study the sensitivity and specificity of the discriminant function analysis in estimating sex.

Results

This study consists of data from 170 study subjects form 20 years to 25 years, comprising of 125 males and 45 females. The measurements of the right- and left-hand fingers, as well as the right-hand and left-hand dimensions of the study participants were compared, and the results are shown in Table 1. It was observed that in both the sides, the male finger dimensions were larger than that of females, and the dimensions of the hands of males were larger than that of the females.

Discriminant function analysis was performed using the data from the measurements of right- and left-hand fingers. The Wilk's Lambda is 0.703 with significance value of <0.0001 for the right-hand fingers, while it was 0.762 with significance value of <0.0001 for the left-hand fingers. ROC curves for both the hand fingers showed good discrimination function between male and female.

The discrimination function equation for right-hand fingers is, Df = 0.989RT –0.242RI +1.238RM +0.631RR –0.303RL –15.855 (constant). The cutoff point is 0.387 –1.076 = -0.689**.** So, above the value –0.689, the cases are male. Below this value -0.689, the cases are female. Overall, 77.1% of the sample was correctly classified as male or female by this model. Cross-validated results showed 74.7% of the cases correctly classified by this model. For the left-hand fingers, the discrimination function equation is, Df = 1.043LTH –0.137LI +0.755LM +0.501LR +0.228LL –15.494 (constant). The cutoff point is 0.333 –0.925 = -0.592. So, above this value –0.592, the cases are male. Below this value -0.592, the cases are female. Overall, 74.1% of the sample was correctly classified as male or female by this model. Cross-validated results showed 72.4% of the cases correctly classified by this model.

Discriminant function analysis was performed using the data from the measurements of right- and left-hands. The Wilk's Lambda was 0.455 with significance value of <0.0001 for the right-hand dimensions, and it was 0.468 with significance value of <0.0001 for the left-hand dimensions. ROC curves for both hand dimensions showed good discrimination function between male and female.

The discrimination function equation for right hand dimensions is, Df = 0.237RHL +2.070RHB –19.663 (constant). The cutoff point is 0.652 –1.812 = -1.160. So, above this value -1.160, the cases are male. Below this value -1.160, the cases are female. Overall. 90.0% of the sample was correctly classified as male or female by this model while cross-validated results showed 90.0% of the cases correctly classified by this model. For the left-hand dimensions, the discrimination function equation is, Df = 0.459LHL +1.822LHB –21.544 (constant). The cutoff point is 0.636 –1.766 = -1.130. So, above this value -1.130, the cases are male. Below this value -1.130, the cases are female. Overall, 88.8% of the sample was correctly classified as male or female by this model. Cross-validated results showed 87.6% of the cases correctly classified by this model. After all the results were obtained, the formulae were used on a separate sample of 20 cases to validate the results.

Table 1: Descriptive statistics of the hand and finger dimensions

Variables	Male (n= 125)	Female (n = 45)	Total (n= 170)
	Mean ± SD (cm)	Mean ± SD (cm)	Mean ± SD (cm)
Right thumb	5.99 ± 0.49	5.45 ± 0.57	5.85 ± 0.56
Right index	6.88 ± 0.49	6.35 ± 0.57	6.74 ± 0.57
Right middle	7.54 ± 0.52	6.89 ± 0.46	7.36 ± 0.58
Right ring	6.93 ± 0.53	6.34 ± 0.47	6.77 ± 0.57
Right little	5.70 ± 0.48	5.32 ± 0.44	5.60 ± 0.50
Left thumb	6.08 ± 0.53	5.50 ± 0.52	5.92 ± 0.58
Left index	6.84 ± 0.50	6.40 ± 0.46	6.73 ± 0.53
Left middle	7.51 ± 0.48	7.00 ± 0.47	7.37 ± 0.53
Left ring	6.92 ± 0.49	6.41 ± 0.51	6.78 ± 0.54
Left little	5.68 ± 0.46	5.30 ± 0.45	5.58± 0.49
Right hand length	17.65 ± 1.00	16.02 ± 1.06	17.22 ± 1.24
Right hand breadth	7.79 ± 0.38	6.79 ± 0.51	7.53 ± 0.61
Left hand length	17.64 ± 0.97	16.10 ± 0.93	17.23 ± 1.18
Left hand breadth	7.73 ± 0.40	6.80 ± 0.50	7.49 ± 0.59

Table 2: Canonical coefficients used in formation of discriminant equations

Variables	Canonical coefficient	Constants
Right thumb	0.989	- 15.855
Right index	- 0.242	
Right middle	1.238	
Right ring	0.631	
Right little	- 0.303	
Left thumb	1.04	- 15.494
Left index	- 0.137	
Left middle	0.755	
Left ring	0.501	
Left little	0.228	
Right hand length	0.237	- 19.663
Right hand breadth	2.07	
Left hand length	0.459	- 21.544
Left hand breadth	1.822	

Discussion

Identification of human remains is one of the main challenges of forensic investigations. Sex determination is one of the main facets of human identification, along with estimation of stature and age. The challenges are more so when peripheral or terminal parts of human, like parts of hand or feet are brought of forensic examination. These are very common in cases of mass disaster, or when body parts are deliberately dismembered in cases in order to conceal identity of the victim. DNA analysis still remains the gold standard for such investigations. However, this being a highly costly, requiring excess manpower, and is more time consuming, this test is fairly unpopular in a developing country like India. It is for these reasons that forensic anthropology still remains highly popular for forensic examination when such human remains are brought for medicolegal examination.[2]

This study was conducted on a regional Indian population, has focussed on estimation of sex from finger lengths and hand dimensions of both right and left hand. It is seen that the average length of skeletal dimensions is greater in males as compared to females, and various body dimensions in female is only 94% of that males, in an individual belonging to the same race.[3] This can be applied to hand dimensions as well, as has been seen in various studies.[8,22,28,32,33]

In the current study it is seen that both the hand and finger dimensions are greater in males as compared to females as is seen in various studies conducted in various ethnic population across the world.[20-24] In the same context it can be said that there is significant gender difference in the finger length of both the genders, as reported by Kanchan et al.[20] However, it is seen in the current study that there is no significant bilateral variation in the hand and finger length of individuals of both sexes as is seen in these studies in the past, on different ethnic population,[26,27] whereas certain studies have noted significant bilateral differences in hand and phalanges length in both hands in either sex.[28-30]

From the model, in our study, which evaluates sexual discrimination based on right hand finger length of individuals, obtained by use of discriminant function analysis on our data, was found to be correctly cross validated in 74.2% cases. This is similar to the study done on Nigerian population by Oladipo et al.[12] which found the predictive model to be 70.5 % efficient in predicting sex. While a similar Indian study done in Madhya Pradesh by Setiya et al.in 2017 where Index / Ring Finger ratio was utilised to determine sex and the model tested with Discriminant Function Analysis and was found to be 83.55% accurate.[19] This result was slightly higher than that our model, although it can be argued that we did not use any finger ratio in our study like that in the above study. The previous study done on Eastern Indian Population (West Bengal) (Rajbanshi and Karbi tribe) by Sen et al. in 2015 used sectioning point for differentiation between the sexes.[13] They found, by using Binary Logistic Regression, sex could be estimated with a mean correct prediction percentage ranging between 61.0% and 66.0% in the test group. This predictive percentage is less than that obtained by use of

discriminant function analysis used in our study. In the study on neonates conducted on Western Indian population by Shelake et al. in 2015,[11] found sectioning point of 0.93 of Index finger length to Ring finger length ratio for differentiation between sexes, with a mean correct prediction percentage ranging from 63.33% male neonate from right hand and 70% from left hand and 76.66% female neonates from right hand and 73.33% from left hand. However, in the study done by Kanchan et al. in 2010 on South Indian children could not show any sexual dimorphism based on Index and Ring finger lengths individually, however the sectioning point achieved (0.97) for the Index/Ring finger ratio could make sexual discrimination.[17] This result is not similar to our study. In the study on Saudi Arabian population by Ibrahim et. al. in 2016 deduced the sectioning point for Index/Ring finger ratio of 1.0321 for right hand and 1.0432 for left hand to determine sex.[14] By use of ROC curve, the predictive accuracy of male sex was found to be 98% and 98% for females from the right hand, and in 96% for male sex and 94% for female sex from the left hand which is much higher than our study.

In a study similar on Egyptian population by Aboul-Hagag et al., 2011 (sectioning point of 0.976 from Index/Ring Finger ratio), it was found to accurately determine sex in 90.4% males and 85.6% females for the right hand, and in 88.8% males and 80.4% females for the left hand which is slightly more than our study.[2] In the study conducted on Egyptian population of Fayoum city by Elazeem et al. in 2013, finger lengths and ratios were used to determine sexual dimorphism, and they found that the predictive accuracy from Right Middle finger was 73.5%, Right Ring Finger was 74%, Left Index Finger was 72.5 %, Left Middle Finger was 81%, Left Little Finger was 71.5%, Left Middle/Ring Finger ratio was 58.5%, Left Ring/Little finger was 59%.[15] Our study model gives higher predictive accuracy than this study.

In the present study, the model determining sex from right hand length and breadth, taken separately, was found to be correctly cross validated in 90% of the cases. In the study done on south and north Indian population by Kanchan et al.,[8] in the year 2009, determination of sexual dimorphism was done on the basis of determination of a sectioning point of the hand length, hand breadth, hand and palm indices, the percentage accuracy of sex determination obtained from the right hand variables were as follows 83% for male and 88.5% for female from right hand length, 85.7% for male and 89.6% for female right palm length, 87% for male and 91.1% for female from right hand breadth, 82.6% for male and 88.9% for female from left hand length, 81.7% for male and 91.9% for female from left palm length, 88.7% for male and 91.5% for female from left hand breadth, and from left hand index 53.9% for males and 55.9% for female. Apart from the hand index, the other values are almost similar to our study. In a similar study done in on the Rajasthani population by Dey et al.[6] in 2015, it was found that the predictive accuracy of sex from Hand length was 77% for males and 80% for females from the right hand and 79% for males and 81% for females from the left hand. Whereas Hand Breadth, accurately determined sex in 80% males and 83% females from the right hand and 81% males and 82% females from the left hand. Our study shows higher predictive accuracy.

In the study conducted on North Indian population by Krishan et al. in 2011,[16] sectioning points and Binary Logistic Regression equations were used to determine sexual dimorphism in the study subjects found a predictive accuracy of 41.6% from Right hand length, 50.4% from Right Hand Breadth, 40.1% from Left Hand Length, 46.7% from Left Hand Breadth which is very less than our study result. In the study done on the Nepalese population by Sah et al. in 2018, based on hand index determination the predictive accuracy was seen to be 77.30 % of male and in 75 % of females for right hand 79.90% and 72.5 % for male and female respectively for left hand, which has clearly achieved much less accuracy as compared to our study.[18] Therefore, it can be argued that Discriminant function analysis is a more accurate statistical tool for determination of sex when compared to any of the methods applied in the above studies.

Conclusion

From this study conducted on a regional Indian population, we can thus conclude that hand dimensions and finger length can only provide moderate degree of predictive value. Thus, it can be only used as an adjunctive in case of real forensic case work. However considering the scarcity of human data with regards to determination of sex in individuals, from fragmentary remains in this part of the country, the results of the current study can be used to evaluate sexual dimorphism. It is also essential to note that further research in this field is required, using a larger sample, done on a multicentric basis over a larger time frame for further improvement in the predictive accuracy of such statistical result. In the results obtained it is notable that predictive accuracy of the equations is higher in case of females as compared to males when studied separately. The major limitation of the study was the disproportion in the number of female populations as compared to the male population, as can be justified from a single batch of 2nd Professional MBBS undergraduate students, due to the limitation of time.

Ethical clearance: A prior approval was obtained from the Institutional Ethics Committee

Conflict of interest: None to declare

Source of funding: None to declare

References

1. Paola M, Stefano D, Inmaculad L, Aleman K, Miguel C. Sex assessment from the carpal bone, Forensic Sci Int. 2011: 206- 16.
2. Aboul-Hagag KE, Mohamed SA, Hilal MA, Mohamed EA.

Determination of sex from hand dimensions and index finger/ ring finger length ratio in Upper Egyptians, Egypt J Forensic Sci. 2011;1: 80-6.

3. Nancy E, Paul M, Schivilli L. Forensic medicine of the lower extremity. Anthropological analysis of the lower extremity. Forensic Sci Med. 2011: 69-98.
4. Ubelaker D. Introduction to Forensic Anthropology. In: Forensic Anthropology and Medicine: Complementary Sciences From Recovery to Cause of Death. 2006. p. 3–12.
5. Eshak G, Ahmed H, Abdelgwad E. Gender determination from hand bone length and volume using multidirector computed tomography. J Forensic Leg Med. 2011; 18(6):246-52.
6. Dey S, Kapoor AK. Sex determination from hand dimensions for forensic identification. Int J Res Med Sci. 2015;3(6):1466-72.
7. Potdar AB, Kiran GY, Shrikanthan G, Potdar PA, Mittal A. Correlation of Stature and Foot Length among Medical Students from Southern Parts of India. J Indian Acad Forensic Med. 2016; 38(1): 49-51.
8. Kanchan T, Rastogi P. Sex Determination from Hand Dimensions of North and South Indians. J Forensic Sci. 2009;54(3): 546-50.
9. Means LW, Walter RE. Sex handedness and asymmetry of hand and foot length. Neuropsychologia.1982;20:715-9.
10. Weiner JS, Lourie JA. Human biology, a guide to field methods. Oxford, London: Blackwell Scientific Publications. 1969: 32–33.
11. Shelake M, Ninal N, Bardale R, Sonar V. Determination of Sex from Index and Ring Finger Ratio in Neonates. J Indian Acad Forensic Med.2015;37(4): 378-80.
12. Oladipo GS, Amasiatu VC, Alabi AS, Paul JN, Maduabuchukwu CV. Sex Estimation by Discriminant Function Analysis of Hand Dimensions of the Igbos in Nigeria. Int J Pharma Res Health Sci. 2018; 6 (5): 2776-81.
13. Sen J, Kanchan T, Ghosh A, Mondal N, Krishan K. Estimation of sex from Index and Ring finger Length in An Indigenous Population of Eastern India. J Clin Diagn Res. 2015;9(11): HC01-HC05.
14. Ibrahim MAB, Khalifa AM, Hagras AM, Alwakid NI. Sex determination from hand dimensions and index/ring finger length ratio in North Saudi population: Medico-legal review. Egypt J Forensic Sci.2016;6(4):435-44.
15. Elazeem GMA, Yousef W. Sex Determination using Finger Length, Finger Ratio and Foot Dimension, in Foyoum Governorate. Ain Shams J Forensic Med Clin Toxicol.2013; 21:12-9.
16. Krishan K, Kanchan T, Sharma A. Sex Determination from Hand and Foot Dimensions in North Indian Population. J Forensic Sci. 2011; 56(2): 453-9.
17. Kanchan T, Kumar GP. Index and ring finger ratio- a morphologic sex determinant in South-Indian children. Forensic Sci Med Pathol.2010; 6:255–60.
18. Sah SK, Jeelani BA. Hand Index - A forensic tool for Sexual Dimorphism. J Lumbini Med Coll. 2018;6(2):5.
19. Setiya M, Jehan M, Godwin R, Sastya A. Sexual Dimorphism of Digit Ratio (2D:4D) in Madhya Pradesh. Int J Sci Study. 2017; 4(10):155-9.
20. Kanchan T, Kumar GP, Menezes RG, et al. Sexual dimorphism of the index to ring finger ratio in South Indian adolescents. J Forensic Leg Med. 2010;17 (5):243–46.
21. Lippa RA. Are 2D: 4D finger-length ratios related to sexual orientation? Yes for men, no for women. J Pers Soc Psychol. 2003;85(1):179.
22. Agnihotri AK, Purwar B, Jeebun N, et al. Determination of sex by hand dimensions. Int J Forensic Sci. 2006;1(2):12–24.
23. Kar SK, Ghosh S, Manna I, et al. An investigation of hand anthropometry of agricultural workers. J Hum Ecol. 2003;14(1):57–62.
24. Ibeachu PC, Abu EC, Didia BC. Anthropometric sexual dimorphism of hand length, breadth and hand indices of University of Port-Harcourt students. Asian J Med Sci. 2011;3(4):146–50.
25. Kanchan T, Krishan K, Sharma A, et al. A study of correlation of hand and foot dimensions for personal identification in mass disasters. Forensic Sci Int. 2010;199(1-3): 112e1-e6.
26. Krishan K, Kanchan T, Ngangom C. A study of sex differences in fingerprint ridge density in a North Indian young adult population. J Forensic Leg Med. 2013;20(4):217–22.
27. Habib SR, Kamal NN. Stature estimation from hand and phalanges lengths of Egypt J Forensic Leg Med. 2010;17(3):156–60.
28. Jasuja OP, Singh G. Estimation of stature from hand and phalange length. J Indian Acad Forensic Med. 2004;26(3):100–06.
29. Rastogi P, Nagesh KR, Yoganarasimha K. Estimation of stature from hand dimensions of north and south Indians. Leg Med. 2008;10(4):185–89.
30. Rastogi P, Kanchan T, Menezes RG, et al. Middle finger length—a predictor of stature in the Indian population. Med Sci Law. 2009;49(2):123–26.
31. Kinght B, Saukko P. Forensic pathology. 3rd ed. UK: Arnold; 2004. 98–129.
32. Abdel-Malek AK, Ahmed AM, El Sharkawi SA, et al. Prediction of stature from hand measurements. Forensic Sci Int. 1990;46(3):181–87.
33. Krishan K, Sharma A. Estimation of stature from dimensions of hands and feet in a North Indian population. J Forensic Leg Med. 2007;14(6):327–32.

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 172-176
doi:10.5958/0974-0848.2020.00047.0

ORIGINAL ARTICLE

Sexual dimorphism in frontal sinus volume: A CBCT comparative study

Laxmikanth Chatra, Fasla EK, Prashanth Shenoy, Veena KM, Rachana Prabhu

Department of Oral Medicine & Radiology, Yenepoya Dental college, Yenepoya University, Deralakatte, Mangalore, India

Abstract

Bones and teeth are parts of human body which are more resistant to decomposition. Owing to highly mineralised biological composition of this structure they tend to be indispensable in terms of forensic evidence. Morphometry of skeleton is the one of the many methods used for sexual dimorphism in forensic identification. Morphometry involves both linear as well as volumetric measurement. Like many other parts of skeleton, Frontal sinus is also of significant interest in forensic identification due to its individual characteristics which make the frontal sinus unique for every individual just as with finger print. This study was done with an aim of assessing the presence of dimorphism in frontal sinus among gender, based on analysis of frontal sinus volume using Romexis software of CBCT. The results showed that there is significant volume difference between males and females. Males are having higher volume when compared to females. So, it can be used in forensic personal identification.

Keywords

Cone beam computed tomography; Frontal sinus; Sexual dimorphism; Forensics

Introduction

In modern life many disasters, accidents, and natural calamities occur quite often. Identification of living or dead persons in such incident is done by various methods which include finger print, DNA profile, and forensic dentistry.[1] Human identification is not a difficult task, when it is about a live individual or a cadaver chronologically recent and intact. However, when there is not a complete skeleton, but a group of bones, a bone alone or just part of it, the identification process becomes progressively harder and sometimes impossible to be accomplished, and in cases in which the soft tissue of human remains is decomposed or burnt, or where DNA is severely tarnished, fingerprint analysis or DNA identification does not prove to be successful. Forensic dentistry is very important in personal identification as skull is the best-preserved part of skeleton after death. However, identification by the traditional method of forensic dentistry becomes unfeasible, when the skull fragments fail to allow identification based on the dental arches and for individuals with no teeth. In this context radiographic identification has a very important role.[2]

Radiological features depicted on the radiograph must have the following two requirements in order to be of forensic identification value. First, the feature has to be unique to the individual. Second, it has to remain stable over time despite the ongoing life process. Many studies have shown that both these criteria are fulfilled by the frontal sinus,[3] which makes it significant in forensic identification just like fingerprint.[4] The frontal sinuses are two, situated in the posterior part of the superciliary arches, between the external and internal faces of frontal bone.[5] It is widely accepted that the frontal sinus will be completely developed by about 20 years of age and remains stable until the advanced age in which further enlargement of the chambers occurs as a result of bone resorption.[6]

Various two-dimensional studies have been conducted to see the dimorphism of frontal sinus in different genders. Most of these studies are based on antero-posterior view and lateral Cephalogram. Three dimensional radiographs are very useful in determining the volume of frontal sinus and obtaining great precision in all measurements, since it is available in three dimensional reconstructive volumetric views.

Cone beam computed tomography (CBCT) is progressively replacing the conventional two-dimensional radiography and multi slice computed tomography in head and neck region for personal identification.[7] Literature review shows a very few studies have been carried out on frontal sinus in sex estimation by use of CBCT volumetric evaluation. CBCT, provide high accuracy and ability to give images in all three planes, volumetric analysis and also enable to view a detailed and clean display of each body slice.[8] For volumetric analysis various software have been used. Among that our study used Romexis software. Various volumetric studies have been reported in literature by using linear measurements in Romexis software. The present study is unique in a way that volumetric evaluation of frontal sinus was done directly.

Materials and Methods

A retrospective radiographic study was conducted with an aim of assessing the presence of dimorphism in frontal sinus among the males and females by using CBCT images of frontal sinus taken

Corresponding Author
Dr. Laxmikanth Chatra (Head of the Department)
Email: lkchatraomr@gmail.com
Mobile: +91-9845296395

Article History
Received: 15th March, 2020; Revision received on: 17th May, 2020Accepted: 19th May, 2020

from the archives of Department of Oral Medicine and Radiology, which have been taken for various diagnostic and therapeutic purposes. Ethical clearance was obtained from the institution Ethical Committee. A documented consent of the patient is a part of imaging protocol of the department and hence documented consents of all the patients were available. The Romexis software of the planmeca promax 3D mid CBCT machine was used to study the frontal sinus.

On the basis of cconvenience sampling method, a sample size of 92 (46 females and 46 males) were considered and a total of 140 CBCT taken in full FOV were screened. Cases above the age of 20 years and CBCT images with clear view of frontal sinus were included in the study. Cases having developmental disorders, syndromes affecting head and neck region, frontal sinus with pathology, patients with maxillofacial fractures or history of fractures, patients with tumours and cyst that may change the morphology of frontal sinus, patients with systemic disorders like bone disease, nutritional and endocrinal disease were excluded from study.

Few studies have been done previously for assessing the volume of frontal sinus by using CBCT, but most of those studies were based on the linear measurements by using various other software. The level of accuracy tends to get reduced in this methodology due to multiple linear measurement and the volume is obtained by calculation from all these measurements (length X breadth X height). All these steps like measuring individual parameter and calculation can cause errors.

In our study, we have measured volume by using sophisticated tool provided by the planmeca Romexis software, which is "ellipse tool". By this, the volume could be calculated as a single value so this method is more accurate, less time consuming and software is user friendly. Another study by using similar methodology has been done by Ana-Gabriela Benghiac in 2017[9] which showed that, the results were more accurate when comparing with the linear measurements. Moreover, using this software, the volume calculation was more accurately done irrespective of unilateral or bilateral presence. Use of this software, has one more advantage that if the sinus has septa which appears to divide the sinus, it will provide volume separately for each compartment by considering all the sections. Whereas if the septa are present only in some sections, but not in all sections which we considered as partial septa the volume was calculated as single volume. This would not have been possible if calculation of volume using linear measurements would have been followed.

Selection of cases was done by a radiologist well experienced in CBCT interpretation after decoding and delinking of personal data of the patient except the gender and age. The CBCT images included in the study were high quality images free of artefacts, taken in medium or large field of views (FOV). The parameters for exposure in acquiring these images were 90kVp, 10mA, and 12s. The resolution of the images was 0.40mm, the bit depth of image being 12. An initial exploration of the images was done in all three sections including coronal, sagittal and axial views for detecting the maximum area of dimension in three sections simultaneously.

The volume was measured by using special tool (ellipse feature) which is provided by the CBCT Romexis software. For this purpose; we traced manually the external contour of the frontal sinus and generated with the aid of the software its volume, based on the air space volume within the cavities. Due to the ability of the software to distinguish between structurally different components seen on the CBCT scans, the FS mucosa did not interfere with our measurements. All the measurements were done and recorded separately for males and females.

The bilateral presence of frontal sinus was noted irrespective of inter sinus septa and recorded. In case of presence of septum which is dividing the frontal sinus into right and left ,the volume measured separately and then added together (Figures 1 and 2).

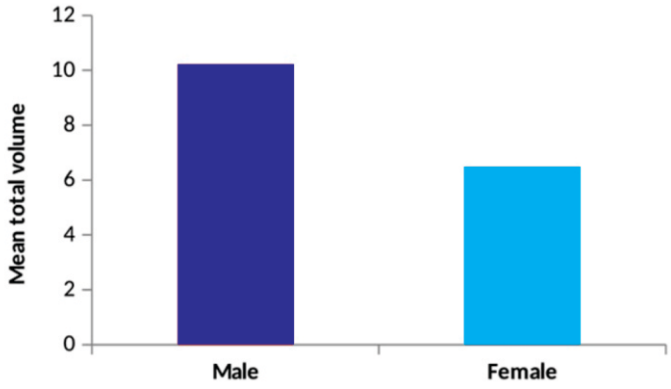


Figure 1: Comparison of mean frontal sinus volume in males and females

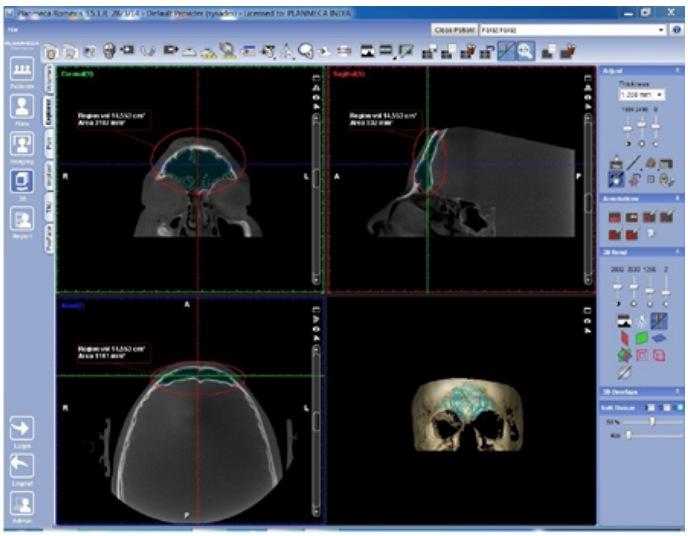


Figure 2: Volume of frontal sinus with bilateral presence

In cases of septa which is found to be in some slices only, considered as partial septa and volume measured as single cavity only. In case of absence of septum, a single regional volume measurement was done. (Figure 3)

Categorical data were expressed as frequency and percentages, Continuous data were expressed in terms of mean and SD. Independent t-test was used to compare between the groups. Binary logistic regression is used for predicting the gender. Appropriate data were used for data visualization and Data was analyzed using SPSS version 22, P<0.05 is considered to be significant

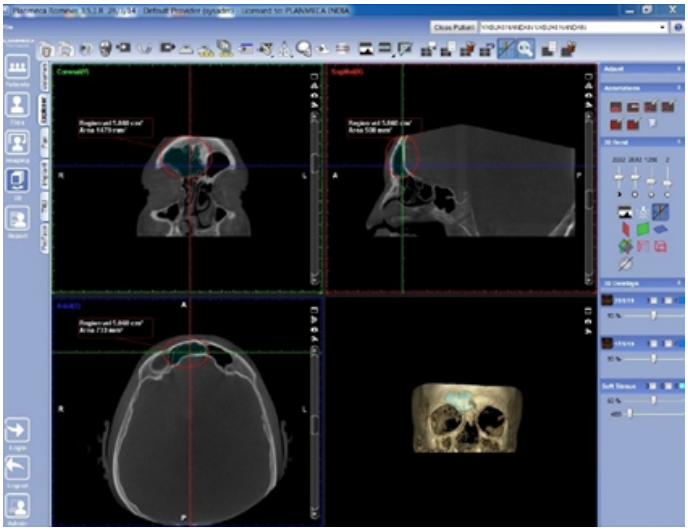


Figure 3: Volume of frontal sinus with complete inter sinus septa

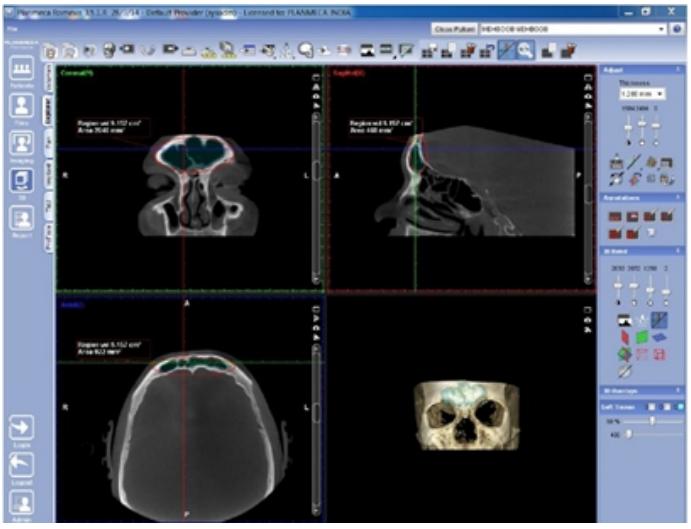


Figure 4: Frontal sinus volume with partial septa

Results

Out of total 92 samples, the volume of frontal sinus in male group comprising 46 images ranges from minimum of 1.07cm^3 to maximum volume of 29.5cm^3 in males. in female group comprising 46 samples the volume of frontal sinus ranges from a minimum of 0.256 cm ^{3}to maximum value of 24.34cm^3.The mean volume obtained among male is 10.2161 with a standard deviation of 6.56964 and in female group it is 6.4730cm ^{3} with standard deviation of 5.19022 cm ^{3}(Table 1 & Figure 1)

Independent t test was used to compare total volume of frontal sinus between males and females. We observed that, there is significant difference in mean total volume between males and females with p=0.003(found to be statically significant) and males are having higher volume than the females with mean difference of 3.74(1.23) cm ^{3}. (Table 2)

Logistic regression was performed at the end of our study and proposed an equation for gender prediction from volume measurements with cut off value as 0.5. Sex = 0.936 - (0.116) X volume. An individual with a score of greater than 0.5 is interpreted to be a female while a score of less than 0.5 is interpreted to be male. In our study we observed that 54.3% males are correctly predicted as males and 73.9% females are correctly predicted as females. Accuracy of prediction is 64.1% (Table 3)

Table 1: Descriptive analysis of frontal sinus volume in males and females

Males		Females	
Range in cm^3	Mean ± SD	Range in cm^3	Mean ± SD
1.07– 29.50	10.22 ± 6.57	0.26– 24.34	6.47 ± 5.19

Table 2: Sex differences with respect to the frontal sinus volume

Parameter	t-value	P-value
Frontal sinus volume	3.03	<0.005

Table 3: Classification of males and females using the logistic regression model derived in the present study

Actual sex	Predicted sex		Correct classification percentage
	Male	Female	
Male	25	21	54.3%
Female	12	34	73.9%
Total			64.1%

Discussion

Frontal sinus is an air-filled cavity located within the frontal bone that consists of paired, irregularly shaped, lobulated cavities, which communicate with the nasal cavity through the infundibulum.[10] The anatomic location of the frontal sinus ensures that the region remains intact even when subjected to abuse or trauma, and thus has great implications for utility in identification. The thick bone of the anterior wall of the frontal sinus and its curved convexity forms a barrier to resist fracture thereby

providing great resiliency. It has been found that a force of 800–1600-foot pounds (high impact accidents, GSW (gunshot wounds) is required to fracture the anterior wall. That is twice as much required to fracture the parasymphyseal area of the mandible and 50% more than that required to fracture the malar eminence of zygoma. The frontal sinus presents a high degree of unicity, even among mono and dizygotic twins. It has a relatively stable structure throughout adult life.[11] Unlike maxillary sinus frontal sinus is not located in close approximation to teeth & jaws and hence it is free from odontogenic influences that affect the maxillary sinus in many ways.

Many techniques are available for the identification of individuals, and newer techniques are developing recently however imaging techniques are part of autopsy techniques and play an important role in forensic science especially in difficult cases where DNA analysis is not feasible. Identification of human remains by comparison of ante mortem and post mortem radiographs of frontal sinuses is a well-established procedure among forensic scientists and even some of the authors claim to use them as a substitute for fingerprints and frontal sinuses in particular have always been assumed to be different in every person.[12] Schuler was the first to report the use of radiographs for the purpose of identification in 1921.[13] It has become common practice to take paranasal sinus radiographs for diagnostic purposes and hence can be easily available for comparative radiography.[14]

Various studies have been done in forensic science of fontal sinus by using 2 dimensional and 3-dimensional imaging techniques in different populations. There are many studies which are showing the accuracy rate of three-dimensional image is better when comparing with the 2-dimensional radiographs. Two dimensional radiographs have limited use in forensic science not only because of their two-dimensional nature but also due to inherent magnification, distortion and superimposition resulting in potentially inaccurate measurement. CT overcomes many of the limitations and offers high resolution images. However, drawbacks of this methodology include expense and increase radiation exposure, because of that in recent years CT is replaced with CBCT in head and neck region.

The present research was CBCT based, with an aim of evaluating the dimorphism of frontal sinus in males and females. Similar kind of studies by using CBCT to detect the frontal sinus dimorphism were found which includes, study by Faisal et al. in 2018,[15] Cossellu et al. in 2015,[7] Marques et al. in 2014,[16] Begum et al. in 2017,[17] and Benghiac et al. in 2017.[9] But different variants and methodology and software were used in each study. Our study used the direct detection of volume of frontal sinus by using ellipse tool, similar methodology was followed in another study, that is Benghiac et al. in 2017,[9] but the parameter which they have evaluated varies from our study.

The mean volume of frontal sinus obtained in our study was 10.216 and 6.473 with a standard deviation of 6.569 and 5.190 in males and females respectively (Table 1). Volumetric measurements of the FS showing that the minimum volume was found in female group ($V = 0.256\ cm^3$) and the maximum volume measurement was recorded in male group ($V = 29.5\ cm^3$).

It has been found that when comparing the mean volume of frontal sinus among genders there is significant difference between males and females with $p = 0.003$ and males are having higher volume than the females with mean difference of 3.74 (1.23) cm^3 (Table 2), which is in accordance with many other studies – Benghiac et al.,[9] Uthman et al.,[18] Kim et al.,[19] Tatlisumak et al.,[20] Belaldavar et al.,[21] Akhlaghiet al.,[22] Pirner et al.,[23] and Tatlisumak et al.[24] Only a few authors have reported that the frontal sinus measurements for females and males were not significantly different, Kirk et al.,[25] and Verma et al.[26]

The reason being morphological difference in cranium between males and females are primarily determined by genetic factors, although nutrition, hormone and muscular factors also play an important role.[17]

At the end of our study Logistic regression analysis was performed and an equation was derived for gender prediction from volume measurements with cut-off value as 0.5. Sex = 0.936 - (0.116) X volume. An individual with a score>0.5 is predicted as female and <0.5 is predicted as male. In our study 54.3% males were correctly predicted as males and 73.9% females were correctly predicted as females (Table 3). Accuracy of prediction is 64.1%. A similar type of study was done by Kanimozhi et al.[27] and found that using frontal sinus dimensions 79.2% males and 47.1% females were correctly categorised. The overall accuracy of maxillary and frontal sinus was 64.0% and 65.9% respectively. Other study by Uthman et al.[19] emphasized the ability of the frontal sinus to identify gender was 76.9%. And in a study by Belaldavar et al.[21] the accuracy rate was 64.6% for frontal sinus.

Thus, frontal sinus provides average accuracy in sex determination among Indian population when comparing our study with other studies. This may be due to greater variation in morphology of frontal sinus or may be due to the lesser no. of samples used in all these studies. The predictive value of FS for determining sex may need to be supplemented with other information like unilateral or bilateral presence, presence of complete or partial septa etc to achieve a high level of accuracy. Determination of the gender by purely measuring the volume of the sinus may sometimes give arbitrary result as the volume of frontal sinus may also depend on overall built of the person. Hence accurate information can be achieved by correlating the frontal sinus volume with other skeletal morphometric measurements.

Conclusion

The present study, done on CBCT image in males and female for evaluating the sexual dimorphism on the basis volume of frontal

sinus concluded that the mean volume of frontal sinus is larger in males compared to females and the difference was found statistically significant. (p=<0.003). This inference proves that frontal sinus volumetric measurements can be used for sexual dimorphism in study population. According to regression formula drawn from the result of this study depicted 54.3% males can be correctly predicted as males and 73.9% females can be correctly predicted as females. CBCT, as an imaging modality has become popular for diagnosis in oral and maxillofacial region. So, it is not uncommon for CBCT images of individuals to be available as dental records. These dental records can be used as ante mortem data for person identification in this population in the interest of forensic sciences.

Ethical clearance: A prior approval was obtained from the Institutional Ethics Committee

Conflict of interest: None to declare

Source of funding: None to declare

References

1. Patil N, Karjodkar FR, Sontakke S, Sansare K, Salvi R. Uniqueness of radiographic patterns of the frontal sinus for personal identification. Imaging Sci Dent. 2012; 42(4):213-7.
2. Choi IG, Duailibi-Neto EF, Beaini TL, Da Silva RL, Chilvarquer I. The Frontal Sinus Cavity Exhibits Sexual Dimorphism in 3D Cone-beam CT Images and can be Used for Sex Determination. J Forensic Sci. 2018; 63(3):692-8.
3. Soman BA, Sujatha GP, Lingappa A. Morphometric evaluation of the frontal sinus in relation to age and gender in subjects residing in Davangere, Karnataka. J Forensic Dent Sci. 2016;8(1):57.
4. Camargo JR, Daruge E, Prado FB, Caria PH, Alves MC, Silva RF, et al. The frontal sinus morphology in radiographs of Brazilian subjects: its forensic importance. Braz. J. Morphol. Sci. 2004; 24(4):239-43.
5. Pondé JM, Metzger P, Amaral G, Machado M, Prandini M. Anatomic variations of the frontal sinus. Minim Invasive Neurosurg. 2003; 46(01):29-32.
6. Sheikh NN, Ashwinirani SR, Suragimath G, Kumar KS. Evaluation of gender based on the size of maxillary sinus and frontal sinus using paranasal sinus view radiographs in Maharashtra population, India. J Oral Res Rev. 2018; 10(2):57.
7. Cossellu G, De Luca S, Biagi R, Farronato G, Cingolani M, Ferrante L, et al. Reliability of frontal sinus by cone beam-computed tomography (CBCT) for individual identification. Radiol Med. 2015; 120(12):1130-6.
8. Dawood A, Patel S, Brown J. Cone beam CT in dental practice. British Dent J. 2009; 207(1):23.
9. Benghiac AG, Thiel BA, Haba D. Reliability of the frontal sinus index for sex determination using CBCT. Rom J Leg Med. 2015; 23(4):275-8.
10. Benghiac AG, Budacu C, Moscalu M, Loan BG, Moldovanu A, Haba D. CBCT assessment of the frontal sinus volume and anatomical variations for sex determination. Rom J Leg Med. 2017; 25(2):174-9.
11. Kumar AP, Doggalli N, Patil K. Frontal sinus as a tool in identification. International J Forensic Odontol. 2018; 3(2):55.
12. Tatlisumak E, Asirdizer M, Yavuz MS. Usability of CT images of frontal sinus in forensic personal identification. Theory and imaging of CT imaging and analysis. In Tech, Croatia:257-65.
13. Nikam SS, Gadgil RM, Bhoosreddy AR, Shah KR, Shirsekar VU. Personal identification in forensic science using uniqueness of radiographic image of frontal sinus. J Forensic Odontostomatol. 2015; 33(1):1.
14. Chaudhary S, Singh U. Uniqueness of frontal sinus as tool for personal identification in forensic Odontology. Ann Int Med Dent Res. 2016; 2.
15. Arshad F, Begum S, Jan S. Scholars Journal of Dental Sciences (SJDS) ISSN 2394-4951 (Print). Imaging; 3:2-9.
16. Marques JA, Musse JD, Gois BC, Galvão LC, Paranhos LR. Cone-beam computed tomography analysis of the frontal sinus in forensic investigation. Int J Morphol. 2014; 32(2):660-5.
17. Begum S, kataria G, Sharma N. Research Article study of frontal sinuses in cbct. Int J Recent Sci.2017; 8(9): 19867-19870.
18. Uthman AT, Al-Rawi NH, Al-Naaimi AS, Tawfeeq AS, Suhail EH. Evaluation of frontal sinus and skull measurements using spiral CT scanning: an aid in unknown person identification. Forensic Sci Int. 2010;197(1-3):124-e1.
19. Kim DI, Lee UY, Park SO, Kwak DS, Han SH. Identification using frontal sinus by three-dimensional reconstruction from computed tomography. J Forensic Sci. 2013; 58(1):5-12.
20. Tatlisumak E, Ovali GY, Asirdizer M, Aslan A, Ozyurt B, Bayindir P, et al. CT study on morphometry of frontal sinus. Clinical Anatomy: Clin Anat. 2008; 21(4):287-93.
21. Belaldavar C, Kotrashetti VS, Hallikerimath SR, Kale AD. Assessment of frontal sinus dimensions to determine sexual dimorphism among Indian adults. J forensic Dent Sci. 2014; 6(1):25.
22. Akhlaghi M, Bakhtavar K, Moarefdoost J, Kamali A, Rafeifar S. Frontal sinus parameters in computed tomography and sex determination. Leg Med. 2016; 19:22-7.
23. Pirner S, Tingelhoff K, Wagner I, Westphal R, Rilk M, Wahl FM,et al. CT-based manual segmentation and evaluation of paranasal sinuses. Eur Arch Otorhinolaryngol. 2009; 266(4):507-18.
24. Tatlisumak E, Asirdizer M, Bora A, Hekimoglu Y, Etli Y, Gumus O,et al. The effects of gender and age on forensic personal identification from frontal sinus in a Turkish population. Saudi Med J. 2017 Jan; 38(1):41.
25. Kirk NJ, Wood RE, Goldstein M. Skeletal identification using the frontal sinus region: a retrospective study of 39 cases. J Forensic Sci. 2002 Mar 1; 47(2):318-23.
26. Verma S, Mahima VG, Patil K. Radiomorphometric analysis of frontal sinus for sex determination. J Forensic Dent Sci. 2014 Sep; 6(3):177.
27. Kanimozhi D. Gender determination using computed tomographic measurement of maxillary and frontal sinus: a comparative study. The Tamilnadu DR. M.G.R. Medical University: 2017.

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 177-180
doi:10.5958/0974-0848.2020.00048.2

ORIGINAL ARTICLE

A study on the reliability and accuracy of stature estimation from handprint in adults of ethnic Tamil origin

Dipayan Deb Barman,[1] Ranganathan Karnaboopathy[2]

1 Department of Forensic Medicine, Shri Sathya Sai Medical College & Research Institute, Kanchipuram, Tamil Nadu, India

2 Department of Community Medicine, Shri Sathya Sai Medical College & Research Institute, Kanchipuram, Tamil Nadu, India

Abstract

Stature estimation is an important task for Forensic anthropologists and this greatly helps when dismembered remains are found. In a big country like India where there are so many diverse ethnicities a single stature estimation formula cannot be applied for all. There is a correlation between dimensions of various parts of our limbs and stature. Handprint dimensions in both males and females have been studied here to find out the reliability and accuracy of the correlation and to develop a multiple regression formula for males and females. In this study the Pearson correlation test showed that there is a strong statistical significance of correlation between male hand print dimensions (p value <.000) and stature and also between the hand print dimensions of the right and left hand-, however in females there is no significant statistical correlation between hand print length and breadth with stature (p value >.551) but there was a positive correlation with palm print dimensions and stature, in females (p value <.000) The multiple regression formula developed for male is $Y=146.32+3.15X_1+4.36X_2+0.21X_3+0.51X_4+0.96X_5$; and for females it is $Y=150.43+0.06X_1+1.44X_2+2.65X_3$. The standard error of estimate was very less with value of 1.4047 in males and 1.5367 in females

Keywords

Stature; Hand print length; Hand print breadth; Palm print length; Multiple regression equation

Introduction

Stature estimation is an important task for forensic anthropologists and this becomes more challenging when dismembered remains are found. In a big country like India where there are so many diverse ethnicities a single stature estimation formula cannot be applied for all During forensic investigations establishment of the identity is a very crucial challenge and there are certain situations where there can be only presence of latent impressions of the hands and feet, and in such conditions these impressions have been found to be useful in predicting the approximate stature of the individual.[1,2]

There is a strong relationship that exists between different parts of body and stature and this has been a matter of great interest for forensic anthropologists and medical scientists for many years.[3] As because stature is one of the cardinal indexes in formulating the biological profile, stature reconstruction is very much important key element that can provide useful data in narrowing down the possible identity.[4] Human stature is one of the prime physical attributes employed in ascertaining the identification of such unknown mutilated deceased bodies found in crime sites.[5] However, in a big country with so much ethnic diversities practical problems are faced during forensic investigations where stature reconstruction from mutilated remains or hand or foot print impressions has to be done keeping in mind the varied and diverse ethnicities. Data from recently conducted studies shows that stature of an individual can be effectively predicted from the measurement of the length of separated long bones of both the upper and lower limbs.[6] Fingerprints, handprints and footprints are frequently found at crime scene. Handprint at the scene of crime is a valuable tool for establishing the identity of the assailant.[7] Handprints are very useful in predicting sex and stature of an individual since they are made by the most prominent part of the hand and give clue about the real dimensions of the hand of the person who deposited them at the scene of crime. However, there are very few studies around the world on handprint/palm print and very few from the southern part of India. It has been observed that in about 30% of cases the latent prints which are recovered from the scene of crime are handprints.[8] Hence this study was done to estimate stature from handprint measurements in people of ethnic Tamil origin and to test the accuracy and reliability of handprint as a tool for estimation of stature.

Materials and Methods

This cross-sectional study was carried out in the Ammapettai area of Kancheepuram district of Tamil Nadu after obtaining permission from the institute ethical committee of Shri Sathya Sai Medical College & Research Institute. A total of 200 adult participants (100 males and 100 females) between the age of 20-40 were included this study. Individuals who are healthy and

Corresponding Author
Dr. Dipayan Deb Barman (Associate Professor)
Email: dipayandebbarman@gmail.com
Mobile: +91-8754096962

Article History
Received: 24th February, 2020; Revision received on: 17th May, 2020
Accepted: 19th May, 2020

who have voluntarily participated in the study were included in this study after obtaining informed written consent. However, those with spinal deformity such as kyphosis, scoliosis or those with any deformity or injury of the hands were excluded from this study.

After properly explaining the subjects about the study and procedure of the study and after obtaining informed written consent, the subjects were asked to stand straight on a stadiometer and then their stature was recorded in accordance with the Frankfurt plane which is an imaginary line joining the anthropometric line between the porion and orbitale; (the reproducible position when the upper margin of the ear opening and the lower margins of the orbit of the eye are horizontal). Then their stature was recorded from vertex to the heel in centimeters.

Thereafter subjects were asked to wash their hands and pat them towel dry. Then they were asked to prone their right hand and place them on the constructed ink pad which contained the ink. They were then asked to gently put their ink smeared hand on a plain A4 size paper; similarly, hand print impression of the left hands was also taken. A total of three hand prints of both right and left hand has been taken from each subject. Then measurement of the linear dimension of the hand prints (hand print length, hand breadth length, and palm print length) was obtained;

Hand print length (HPL) was measured as the distance between the mid-points of the distal transverse crease of the wrist to the most anterior projection of the skin of the middle finger (dactylion). Hand print breadth (HPB) was measured as the distance between the most remote points on the heads of the 2nd and 5th metacarpal bones. Palm print length (PPL) was measured as the distance from the mid-point of the distal transverse (Mid-stylion) crease of the wrist to the proximal flexion crease of the middle finger.

Each measurement has been repeated thrice and the mean value has been recorded in order to minimize observer error.

Statistical analysis

After collection of data these were computed and analyzed with SPSS software 20. Data was subjected to descriptive statistics (mean, standard deviation) and then Karl Pearson correlation test was used for finding the significance of correlation between the stature and the various dimensions of the hand in both males and females. A multiple regression equation was developed for calculation of stature using various hand print dimensions for males and females.

Results

In this study, the minimum and maximum stature among males were 165.4 cm and 175.0 with a mean stature of 170.67 and standard deviation of 3.18, while the hand print length of right and left hand showed a mean of 21.92 and 21.96 and standard deviation of 2.066 and 2.109 respectively. The results of the hand print breadth of right and left hand showed a mean of 13.21 and 13.23 and standard deviation of 1.361 and 1.368 respectively as shown in Table 1. The results of stature in females showed a minimum and maximum stature of 159.6 cm and 167.0 cm respectively with a mean of 164.23, and standard deviation of 1.741. The results of the hand print length in females showed a mean of 18.32 and standard deviation of 0.874 respectively, and the results of female handprint breadth showed a mean of 11.15 and a standard deviation of 0.676 as shown in Table 1. The results of palm print length showed a mean and standard deviation of 11.97 and 0.827 and a mean and standard deviation of 10.83 and 0.517 respectively in males and females, as shown in Table 1.

Table 1: Descriptive statistics of stature, hand print length and hand print breadth for male and female study participants

Parameter	Male		Female	
	Range	Mean ± SD	Range	Mean ± SD
Stature	165.4– 175.0	172.67± 3.18	159.6– 167.0	164.23± 1.74
HPL-R	17.1 – 24.5	21.92± 2.07	16.8 – 19.8	18.32± 0.87
HPL-L	17.1 – 24.5	21.96± 2.11	16.8 – 19.8	18.32± 0.87
HPB-R	10.1 – 14.6	13.21± 1.36	10.0 – 12.5	11.15± 0.68
HPB-L	10.1 – 14.6	13.23± 1.37	10.0 – 12.5	11.15± 0.68
PPL	10.0 – 13.4	11.97± 0.83	10.0 – 12.1	10.83±0.52

Table 2: Pearson's correlation (r) between stature and various handprint dimensions in both male and female participants

Parameters		Correlation value (P-value)
Male Stature	Male hand print length right hand	0.877 (<0.001)
	Male hand print length left hand	0.884 (<0.001)
	Male hand print breadth right	0.804 (<0.001)
	Male hand print breadth left	0.794 (<0.001)
	Male Palm Print length	0.749 (<0.001)
Female Stature	Female hand print length right hand	0.060 (0.551)
	Female hand print length left hand	0.060 (0.551)
	Female hand print breadth right	0.077 (0.449)
	Female hand print breadth left	0.077 (0.449)
	Female palm print length	0.363 (<0.001)

The Pearson correlation test showed that there is a strong statistical significance of correlation between male hand print dimensions (p value <0.001) and stature and also between the hand print dimensions of the right and left hand, however in females there is no significant statistical correlation between female hand print length and breadth with stature (p value of 0.551 and 0.449, which were not statistically significant) but there was a positive correlation with palm print dimensions and stature (p value <.000) as shown in Table 2.

Multiple regression equation developed for males and females is shown in Table 3. The multiple regression equation for males was $Y=146.32+3.15X_1+4.36X_2+0.21X_3+0.51X_4+0.96X_5$, where Y is the male stature (dependent variable), X1 is the right-hand print length of males, X2 is the left-hand print length of males, X3 is the right-hand print breadth of males, X4 is the left-hand print breadth of males and X5 is the palm print length of males. Similarly, for the females a multiple regression equation was developed as $Y=150.43+0.06X_1+1.44X_2+2.65X_3$, where Y is the female stature (dependent variable), X1 is the hand print length of females, X2 is hand print breadth of females and X3 is the palm print length of females.

Table 3: Multiple linear regression models for estimation of stature of males and females

Sex	Model	SEE
Male	146.32 – 3.15(HPL-R) + 4.36(HPL-L) + 0.21(HPB-R) + 0.51 (HPB-L) – 0.995(PPL)	1.405
Female	150.43 + 0.07(HPL) – 1.44(HPB) + 2.65(PPL)	1.537

SEE: Standard estimation of error; HPL: hand print length; HPB: hand print breadth; PPL: palm print length; R: right; L: left.

In this study the multiple regression equation which was developed has a significant accuracy in predicting the stature from the measurement of the various hand dimensions in both males and females, since the standard error of estimate was less in this study and which were 1.405 and 1.537 for males and females respectively.

Discussion

In this study there is an attempt to establish the theory that whether handprint can be used as a reliable and accurate tool for estimation of stature. Handprints are often found at the scene of crime and form an important data especially when fragmented remains are found at the site of crime or at the site of a disaster and this can sometime provide crucial clue to personal identification.[9]

There have been several previous studies where hand dimensions were directly measured and their correlation with stature was assessed by various researchers in different parts of the world and on different ethnic populations.[10-12] Use of handprint and measurements of handprints have been used in last few years in different studies such as of Jasuja and Singh[13], and that of Ahemad and Pukait[14] who have used inked impression of hand print to establish correlation with stature. The age group chosen for this study is between 20-40 years of age and this is justified by the fact that skeletal growth is completed at the age of approximately 18 years in a normal healthy individual and this is in agreement with previous researchers.[15,16]

In this study the mean stature and standard deviation in males was found to be 170.673 and 3.1800 respectively and the mean stature and standard deviation in females was 164.234 and 1.1.7410 which differs from the findings of Moorthy and Yin[17] and Kornieieva and Elelemi,[18] but are similar to the findings of Nandi et al.[19]

In this study the hand print of males was larger in males than in females and this finding was similar to the findings of various previous studies.[20-23] The reason behind males having bigger hand dimensions and consequently bigger handprint dimensions could be explained by the fact that males generally have a bigger and taller built morphologically than as compared to females of human species.

In this study a strong correlation was seen between the hand print of males and stature. The results of the present study are similar to that of the studies by Melad and Paulis,[24] Krishan et al.,[25] and Ozalan et al.,[26] who state that correlation between hand print lengths of males and stature is higher than that of females. However, this is in contrast to the observations made in the study by Nandi et al.[18] which reports that in comparison to males, females have had a greater correlation between handprint dimensions and stature. On the other hand, Ishak states in his study that the correlation was irregular between hand print dimensions and stature in both males and females.[4] Multiple regression equation was developed in this study for both males and females and this has accuracy in estimation of the stature for both the genders as the SEE (standard error of estimate) is less which is 1.405 in males and 1.537 in females. The development of multiple regression equation with less standard error of estimate increased the accuracy of the stature calculation from handprint dimension measurement and analysis, and this is in agreement with previous researchers.[9, 27]

Conclusion

Stature reconstruction is a very challenging task and use of handprint impressions found at a scene of crime for stature calculation has been the focus of study in past few years. A population specific study aimed at a specific ethnic group is needed which will cater to a particular place and population. In this study, which involved adult males and females of ethnic Tamil origin a positive correlation of statistical significance has been found between handprint dimensions in males and

females. Accordingly, a multiple regression equation has been developed for both males and females of ethnic Tamil origin. This would be useful in situations where if complete handprint impression is found at the crime scene then by using the regression equation derived from this study the approximate stature of the individual to whom the handprint belonged could be calculated. The limitation of this study was that it has been conducted over a particular area of Tamil Nadu and thus there is a need for similar studies to be conducted over more areas of the region. There is a need to have similar studies for estimation of stature from handprint dimensions in different ethnicities and in different regions of India in order to develop regression equation formulae for calculation of approximate stature from handprint impressions which will be highly specific for that particular ethnic group and region.

Ethical clearance: A prior approval was obtained from the Institutional Ethics Committee

Conflict of interest: None to declare

Source of funding: None to declare

References

1. Kapoor AK. Estimation of stature from hand length as obtained through palm prints among the Lodhas of district Midnapur, West Bengal. Indian J Phys Anthropol 1987; 13:139.
2. Sharma PK, Kapoor AK. Estimation of stature from fingertip length and finger print tip length among criminals. In: Guru AK, Shrivastava P, editors. Recent advances in forensic biology. Delhi, India: Kamla-Raj Publishers, 2001;117–27.
3. Banik SD, Azcorra H, Valentin G, Bogin B, Dickson F. Estimation of stature from upper arm length in Children aged 4.0 to 6.92 years in Merida, Yacatan. Indian J of Pediatrics 2012; 79(5): 640-646.
4. Ishak NI. Sex and stature estimation using hand and handprints measurement in a Western Australian population. Centre for forensic science and University of western Australian 2010: 1-170.
5. Kanchan T, Krishan K. Anthropometry of hand in sex determination of dismembered remains-a review of literature. J of Forensic and Leg Med 2011; 18(1): 14-17.
6. Kozak J. Stature reconstruction from long bones. The estimation of the usefulness of some selected methods for skeletal populations from Poland. Variability and Evolution 1996; 5: 83–94
7. Paulis MG. Estimation of stature from handprint dimensions in Egyptian population. J Forensic Leg Med 2015; 34: 55–61.
8. Jain AK, Feng J. Latent palm print matching. IEEE Trans Pattern Anal Mach Intell 2009; 31:1032–1047.
9. Kornieieva M, Elelemi AH. Estimation of stature from hand measurements and handprints in a sample of Saudi population. Arab J Forensic Sci & Forensic Med 2016; 1(3): 289-298.
10. Krishan K. Sharma A. Estimation of stature from dimensions of hand and feet in a North Indian population. J Forensic Leg Med. 2007; 14:327-332.
11. Rastogi P, Nagesh KR, Yoganarasimha K. Estimation of stature from hand dimensions in north and south Indians. Leg Med 2008; 10: 185-189.
12. Shintaku K, Furuya Y. Estimation of stature based on the proximal phalangeal length of Japanese women's hand. J. UOEH. 1999; 12 (2): 215-219
13. Jasuja OP, Singh G. Estimation of stature from hand and phalange length. J Indian Acad Forensic Med. 2004; 26(3):971–973
14. Ahemad N, Purkait R. Estimation of Stature from Hand Impression: A Nonconventional Approach. J Forensic Sci. 2011; 56:706-710.
15. Singh I. Functional asymmetries in lower limbs. Acta. Anat. 1970; 77:131-138.
16. Roche AF, Davila GH. Late adolescent growth in stature. Pediatrics. 1972; 50: 874-880
17. Moorthy TN, Yin TY. Estimation of stature from handprint anthropometry of Malaysian Chinese for forensic investigation. Indonesian J Leg Forensic Sci. 2016; 6: 1-5.
18. Kornieieva M, Elelemi AH. Estimation of Stature from Hand Measurements and Handprints in a Sample of Saudi Population. Arab J Forensic Sci Forensic Med. 2016; 1(3); 289-298.
19. Nandi ME, Ibeabuchi NM, Olabiyi OA, Okubike EA, Iheaza EC. Stature Reconstruction from Handprint Dimensions in an Adult Nigerian Student Population. Forensic Sci Add Res. March 2018; 2 (5): 1-9.
20. Habib SR, Kamal NN. Stature estimation from hand and phalanges lengths of Egyptians. J Forensic Leg Med. 2010; 17:156–160.
21. Aboul-Hagag KE, Mohamed EA, Mohamed SA, Hilal MA. Determination of sexnfrom hand dimensions and index/ring finger length ratio in Upper Egyptians. Egyptian J Forensic Sci. 2011; 1:80-86.
22. Tang J, Chen R, Lai X. Stature Estimation from Hand Dimensions in a Han Population of Southern China. J Forensic Sci. 2012; 57(6):1541-1544.
23. Abdel-Malek AK, Ahmed AM, El Sharkawp SA, El Hamidb NA. Prediction of stature from hand measurements. Forensic Sci Int.1990; 46 (3):181- 187.
24. Melad G., Paulis R. Estimation of stature from handprint dimensions in Eygyptian population. J Forensic Leg Med. 2015; 34: 55-61.
25. Krishan K, Kanchan T, Sharma A. Multiplication factor versus regression analysis in stature estimation from hand and foot dimensions. J Forensic Leg Med. 2012; 19 (4):211-214.
26. Ozaslan A, Karadayi B, Kolusayin MO, Kaya A, Afsin H. Predictive role of hand and foot dimensions in stature estimation. Rom J Leg Med. 2012; 20: 41-46.
27. Sen J, Kanchan T, Ghosh A, Mondal N, Krishan K. Estimation of stature from lengths of index and ring fingers in a North-eastern Indian population. J Forensic Leg Med. 2014; (22): 10-5

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 181-188
doi:10.5958/0974-0848.2020.00049.4

ORIGINAL ARTICLE

Estimation of stature from hand dimensions among adult Rajbanshi individuals of Eastern India

Shreyasi Roy,[1] Pradipan Ganguly,[1] Nitish Mondal,[2] Kewal Krishan,[3] Jaydip Sen[1]

1 Department of Anthropology, University of North Bengal, Darjeeling, West Bengal, India.
2 Department of Anthropology, Assam University, Diphu Campus. Diphu, Karbi Anglong, Assam, India.
3 Department of Anthropology, Panjab University, Chandigarh, India.

Abstract

Estimation of stature from hand dimensions among adults is of great importance in establishing identity and individuality. The primary objective of the present study was to estimate stature from hand length and hand breadth among Rajbanshi adults of eastern India. The data for the present study were obtained from 400 unrelated (males: 200; females: 200) adult Rajbanshi individuals (aged between 20 years to 60 years). The data obtained was statistically analyzed using statistical tests which included descriptive statistics, correlation, regression, paired t-test and one-way analysis of variance (ANOVA). Linear and step-wise multiple regression equations were formulated. The results show that mean value of stature and hand length (HL), and breadth (HB) of males were higher than of females. The F-values were statistically significant for HL, left hand length (LHL) and right-hand length (RHL) ($p<0.05$). The bilateral difference in HL and HB were observed to be statistically not significant in both sexes ($p>0.05$). Simple linear regression analysis was conducted to estimate stature from the anthropometric variables. The regression coefficients were observed to be statistically significant ($p<0.05$). The stepwise multiple regression equations were also observed to be statistically significant. The present study has been successful in estimating stature from LHL, RHL, LHB and RHB. It has also observed the relationships between these anthropometric measures as well as estimated bilateral differences and sex differences with respect to these variables. The results may be used for estimating the stature from hand dimensions in medico-legal cases and forensic examinations.

Keywords

Forensic science; Forensic anthropology; Stature; Hand breadth; Hand length; Rajbanshi; India

Introduction

Forensic anthropology is defined as "the application of physical anthropologists' specialized knowledge of human sexual, racial, age and individual variation to problems of medical jurisprudence".[1] Several studies have evaluated the scope of anthropological contributions to human rights investigations.[2-8] The role and status of forensic anthropology have been discussed in the previous studies with context to different countries.[9-13] Identification of victims of mass disasters remain essential from humanitarian, civil as well as from criminal point of views.[14-16] The problem of stature reconstruction has attracted attention of anatomists and physical anthropologists since the middle of eighteenth century when forensic anthropology as a sub-discipline of physical anthropology never existed. Thomas Dwight described two methods for the purpose of stature estimation.[17] These methods were a) Anatomical b) Mathematical. In a recent study, it was confirmed that the regression analysis method proved to be better in comparison to multiplication factor analysis in estimating stature as range of error in regression analysis method is less compared to multiplication factor method.[18]

There exists ample number of means to demonstrate stature and their significance lies in the transparency of measurement, applicability and validity in prediction.[19] Identification of an individual from dismembered, mutilated and fragmentary remains is a challenge to forensic experts. This is encountered in cases of mass disasters, explosions, and assault cases where the body is dismembered to conceal the identity of the victim. The foot and hand have been extensively studied to provide valuable information about an individual when an individual hand or foot is recovered and brought for forensic examination.[20-21]

The importance of predicting stature from body dimensions lies in the fact that such methods are easy, reliable and can predict stature with a good level of accuracy. However, most of the studies have utilized foot dimensions to predict stature.[20,22-37] There have been a limited number of studies using other body dimensions such as finger length, tibia and fibula length.[38-50] Many years ago it was opined that that regional studies on stature estimations were very much needed due to racial and ethnic variations present in different regions of the world.[51] Studies have subsequently been initiated in many countries to obtain equations for predicting stature from body dimensions for different ethnic groups.

Corresponding Author
Jaydip Sen (Professor)
Email: jaydipsen@rediffmail.com
Mobile: +91-9932268224

Article History
Received: 13th March, 2020; Revision received on: 21st May, 2020
Accepted: 23rd May, 2020

Contemporary India is composed of a sizable number of ethnic and indigenous elements having enormous amounts of ethnic and genetic diversity.[52] Studies on the estimation of stature from body dimensions among various Indian populations began to be published in different peer-reviewed indexed scientific journals.[19,20,32,48,53-62]

Studies are almost non-existed among populations from northern part of the state of West Bengal, India. North Bengal, as it is popularly known, is the home to a number of tribal communities (Lepcha, Rabha, Meche, Toto, Oraon, Santal and Munda), and non-tribal communities (Rajbanshi, Bengali Caste and Bengali Muslim). Only one study is available in literature on the estimation of stature from foot dimension among individuals belonging to the Rajbanshi community.[32] The present study, therefore, is an attempt to study the estimation of stature from hand length and hand breadth. The study further explores the bilateral and sex differences in hand length and hand breadth.

Material and Methods

The data for the present study were obtained from 400 unrelated individuals (200 male, 200 female) adult Rajbanshi individuals (aged from 20 years to 60 years). The nature of the Rajbanshi population has been reported elsewhere.[75,76] Initially, a total of 432 Rajbanshi individuals were selected by random sampling and approached for the study. The nature of the study was explained in detail to them. All the individuals were free from any physical deformity of the limbs and they were interviewed for information regarding any previous physical injury and/or operation, or any trauma in the either hand. Individuals having abnormality, injuries or surgical episodes were excluded. Of them 32 individuals (5.30%) declined to take further part in the study. Informed consent was taken from the subjects who participated in the study. Necessary permissions have also been taken from the Jalash Nijamtara Gram Panchayat. The individuals were identified as Rajbanshi by observing their physical features, cultural features and by recording their surnames. These were subsequently verified from the official records of the Gram Panchayat (local village level governing authority). All the individuals were the residents of a Rajbanshi-inhabited village named 'Rangapani', 'Chotopathu' and 'Barapathu' located in Jalash Nijamtara Gram Panchayet, under Phansidewa Block, Police station Phansidewa, District Darjeeling of the state West Bengal, India. The nearest motorable road is the Siliguri-Phansidewa highway and railway station is Rangapani. The village is situated at a distance of approximately 25 kms southwest of Siliguri sub-division town of Darjeeling.

Five anthropometric measurements were recorded following standard procedures.[77] The measurements taken are as follows:

a) Stature/ Height vertex
b) Length of left hand (LHL)
c) Length of right hand (RHL)
d) Breadth of left hand (LHB)
e) Breadth of right hand (RHB)

Stature was measured using an anthropometer rod and was the vertical distance from vertex to floor with the head in the Frankfurt horizontal plane. Hand length (HL) was measured from the mid-point of distal transverse crease of wrist to the most anterior projection of the skin of the middle finger (e.g., inter stylion line). Hand breadth (HB) was measured as a distance between the radial side of the second metacarpophalangeal joint (e.g., metacarpal radiale) and the ulnar side of the fifth metacarpophalangeal joint (e.g., metacarpal ulnale). The LHL, RHL, LHB and RHB were recorded to the nearest millimeter with the aid of a sliding caliper. Owing to the diurnal variation in stature[78], the individuals were measured during the morning hours prior to leaving for their work. The technical errors of measurement (TEM) which is an accuracy index and measures the standard deviation between repeated measures have been determined to check the consistency of the data.[79] Even though a number of methods of measuring inconsistency are available, the preferred method involves calculation of relative TEM and subsequently determination of the coefficient of reliability (R).[80] The TEM were calculated from three repeated measurements were obtained from the 30 randomly selected Rajbanshi individuals by one of the authors (PG). Very high values of R was observed for all the measurements (R>0.980) and these were within the acceptable limits of 0.950. The measurements recorded by PG were considered to be reliable and reproducible. All the measurements in the present study were subsequently recorded by PG.

Statistical Analysis

The data obtained was statistically analyzed using statistical tests that included descriptive statistics, correlation, regression, paired t-test and one-way analysis of variance (ANOVA). Descriptive statistics included mean, standard deviation and range. Linear and step-wise multiple regression equations were formulated separately for each sex and also for the entire sample together to find out whether a single equation could be used for all age group or independent equations would be required separately for individual age group to estimate stature using HL and HB. Efforts were also made to formulate multiplication factors based equations by using HL, HB and age for estimation of stature. Linear regression was used to estimate stature from LHL, RHL, LHB and RHB. Step-wise multiple regressions were conducted in order to estimate stature from a combination of the recorded variables. ANOVA was utilized to assess bilateral differences in LHL, RHL, LHB and RHB.

ANOVA and paired t-test were conducted to understand the sex differences in stature, LHL, RHL, LHB and RHB. All statistical analysis was done using the Statistical Package for Social Science for windows (version 20.0). The p-values of <0.05 and <0.01 were considered to be statistically significant.

Results

The mean, standard deviation (SD) and range of stature, LHL, RHL, LHB and RHB among Rajbanshi male individuals of the present study are presented in Table 1. It is evident from Table 1 that the Rajbanshi male individuals exhibited higher mean stature, mean LHL, mean LHB, mean RHL and mean RHB as compared to the female individuals. Bilateral differences were present in all these measurements between both sexes. In the present study, it was further observed that in case of the male individuals, LHL varied between 23.16% to 28.60% of stature, LHB varied between 6.99% to 13.39% of stature; RHL varied between 23.01% and 28.91% of stature and RHB varied between 6.99% and 13.83% of stature. When the female individuals were taken into considered, LHL varied between 21.88% to 28.71% of stature, LHB varied between 8.07% to 13.19% of stature, RHL varied between 21.88% and 28.55% of stature and RHB varied between 7.91% and 13.66% of stature. Following the classification of stature proposed by Martin and Saller,[81] it can be observed that majority of the Rajbanshi male and female individuals fall in the 'short to medium' category.

Table 1: Descriptive statistics of stature, hand length (HL) and hand breadth (HB) among Rajbanshi male and female individuals

Measurements	Male (N=200)				Female (N=200)			
	Minimum	Maximum	Mean	SD	Minimum	Maximum	Mean	SD
Stature (cm)	149.20	166.60	155.45	1.82	149.00	166.30	155.19	1.57
LHL (cm)	14.90	18.40	16.36	0.67	14.10	18.30	16.19	0.61
RHL (cm)	14.80	18.60	16.38	0.68	14.10	18.50	16.22	0.63
HL (unknown) (cm)	14.90	18.50	16.37	0.67	14.10	18.40	16.20	0.62
LHB (cm)	4.50	8.60	6.64	0.78	5.20	8.50	6.57	0.60
RHB (cm)	4.50	8.90	6.68	0.79	5.10	8.80	6.59	0.61
HB (unknown) (cm)	4.50	8.75	6.66	0.78	5.15	8.65	6.58	0.60

It is perceptible that the females displayed slightly smaller stature and smaller HL and HB with respect to LHL, RHL, LHB and RHB when compared to the males. Using ANOVA, it was observed that the F-values were statistically significant for HL, LHL and RHL ($p<0.05$) but the different between the stature, HB, LHB and RHB were not statistically significant ($p>0.05$) (Table 2). Using the paired t-test, it was further observed that there were statistically significant differences ($p<0.05$) between male and female individuals when HL, LHL and RHL were taken into consideration but the differences were not statistically significant in case of stature, HB, LHB and RHB were not found statistically significant ($p>0.05$) (Table 3).

Table 2: Sex differences in stature, hand length (HL) and hand breadth (HB) among Rajbanshi individuals using ANOVA

Measurements	F-value	df.	P
Stature (cm)	2.31	199	0.129
LHL (cm)	7.52	199	0.006
RHL (cm)	6.28	199	0.013
HL	6.93	199	0.009
LHB (cm)	1.07	199	0.301
RHB (cm)	1.78	199	0.183
HB	1.42	199	0.234

df: degrees of freedom; P: significance

Table 3: Sex differences in stature, hand length (HL) and hand breadth (HB) among Rajbanshi individuals using paired t-test

Measurements	t -value	df.	P
Stature (cm)	1.42	199	0.156
LHL (cm)	3.39	199	0.001
RHL (cm)	3.12	199	0.002
HL	3.27	199	0.001
LHB (cm)	1.21	199	0.227
RHB (cm)	1.54	199	0.126
HB	1.38	199	0.168

df: degrees of freedom; P: significance

Table 4: Bilateral differences in hand length (HL) and hand breadth (HB) among male and female Rajbanshi individuals using ANOVA

Measurements	Male			Female		
	F-value	df.	P	F-value	df.	P
HL	0.12	399	0.727	0.31	399	0.580
HB	0.31	399	0.579	0.13	399	0.722

The bilateral difference in HL and HB among male and female Rajbanshi individuals was evaluated using ANOVA and the results of the statistical analysis was depicted in Table 4. It is evident from the table that the bilateral difference in HL and HB were not statistically significant among both sexes ($p>0.05$).

Simple linear regression analysis was conducted to estimate stature from the measured variables. For this analysis, stature was taken as the dependent variable and HL, LHL, RHL, HB,

LHB and RHB as the independent variables. The regression equations for the estimation of stature from HL, LHL, RHL, HB, LHB and RHB among Rajbanshi male and female individuals in the present study are displayed in the Table 5. In all the cases, the regression coefficients were statistically significant ($p<0.05$) and the values for the R and R^2 regression equations are also given in the Table 5. Therefore, the stature was thus observed to be dependent on HL, LHL, RHL, HB, LHB and RHB.

Table 5: Linear regression equations in stature (cm) estimation from hand length (HL) and hand breadth (HB) among the Rajbanshi individuals

Sex	Measurements (cm)	Equation	R	R^2	S.E.
Male (N=200)	HL	138.05+ 1.06 (HL)	0.392	0.154	2.91
	LHL	138.62+ 1.03 (LHL)	0.377	0.142	2.94
	RHL	137.79+ 1.08 (RHL)	0.403	0.163	2.85
	HB	150.35+ 0.77 (HB)	0.329	0.108	1.05
	LHB	150.60+ 0.73 (LHB)	0.314	0.099	1.04
	RHB	150.17+ 0.79 (RHB)	0.341	0.117	1.04
Female (N=200)	HL	146.89 + 0.51 (HL)	0.203	0.041	2.85
	LHL	147.63 + 0.47 (LHL)	0.183	0.033	2.90
	RHL	146.32 + 0.54 (RHL)	0.221	0.049	2.79
	HB	154.12 + 0.16 (HB)	0.062	0.004	1.22
	LHB	154.72+ 0.07 (LHB)	0.028	0.001	1.23
	RHB	153.57+ 0.25 (RHB)	0.096	0.009	1.20
Unknown (N=400)	HL	141.95 + 0.82 (HL)	0.314	0.099	2.03
	LHL	142.56 + 0.78 (LHL)	0.298	0.089	2.05
	RHL	141.58 + 0.84 (RHL)	0.328	0.107	1.99
	HB	151.68 + 0.55 (HB)	0.226	0.051	0.79
	LHB	152.04 + 0.50 (LHB)	0.203	0.041	0.80
	RHB	151.38+ 0.59 (RHB)	0.246	0.061	0.78

SE: Standard Error

In male Rajbanshi individuals, the regression coefficient for stature on HL was found to be statistically significant ($p<0.01$),. In case of stature on LHL, the regression coefficient was also found to be statistically significant ($p<0.01$). Similarly, the regression coefficient for stature on RHL was also statistically significant ($p<0.01$). In case of stature on HB the regression coefficient was also observed to be statistically significant ($p<0.01$). In case of stature on LHB and statue on RHB, the regression coefficients were again statistically significant ($p<0.01$). In case of the females, the regression coefficients for stature on HL, LHL and RHL were observed to be statistically significant ($p<0.01$). In case of stature on HB, LHB and RHB, the regression coefficients were also statistically significant ($p<0.01$). Linear regression analysis was also performed to obtained equations for estimation of stature in the case of unknown Rajbanshi individuals (Table 5). The regression coefficient for stature on HL was 0.82 ($p<0.01$). In all the cases, the regression coefficients were observed to be statistically significant ($p<0.01$).

The step-wise multiple regression equations for stature, regression correlation coefficient and standard error on both HL and HB among the Rajbanshi individuals is shown in Table 6. The regression coefficients were observed to be statistically significant ($p<0.05$) in all cases. It was observed that the values of the correlation coefficient R and the coefficient of determination (R^2) increased as the effects of the both HL and HB came into force. The regression coefficients and R^2 were found to be higher in right sides (e.g., RHL and RHB) in both male and female Rajbanshi individuals.

Table 6: Multiple regression equations in stature (cm) estimation from hand length (HL) and hand breadth (HB) among Rajbanshi individuals

Sex	Side	Equation	R	R^2	S.E.
Male (N=200)	Unknown	139.69+ 0.87 (HL) + 0.23 (HB)	0.398	0.159	3.27
	Left	140.10+ 0.86 (LHL) + 0.20 (LHB)	0.382	0.146	3.35
	Right	139.57+ 0.86 (RHL) + 0.28 (RHB)	0.413	0.170	3.14
Female (N=200)	Unknown	146.84+ 0.55 (HL) + -0.09 (HB)	0.205	0.042	2.86
	Left	147.58+ 0.53 (LHL) + -0.17 (LHB)	0.191	0.037	2.90
	Right	146.31+ 0.56 (RHL) + -0.02 (RHB	0.221	0.049	2.80
Unknown (N=400)	Unknown	142.50 + 0.73 (HL) + 0.14 (HB)	0.317	0.101	2.11
	Left	142.93 + 0.73 (LHL) + 0.09 (LHB)	0.299	0.089	2.14
	Right	142.29 + 0.72 (RHL) + 0.19 (RHB)	0.334	0.112	2.05

SE: Standard Error

Table 7: Multiple regression equations in stature (cm) estimation from hand length (HL), hand breadth (HB) and age among the Rajbanshi individuals

Sex	Side	Equation	R	R^2	S.E.
Male (N=200)	**Unknown**	139.52+ 0.86(HL) + 0.17(HB) + 0.018(AGE)	0.411	0.169	3.26
	Left	139.99+ 0.84(LHL) + 0.14(LHL) + 0.019(AGE)	0.397	0.158	3.34
	Right	139.41+ 0.86(RHL) + 0.21(RHB) + 0.017(AGE)	0.423	0.179	3.13
Female (N=200)	**Unknown**	146.73+ 0.57(HL) + -0.08(HB) + -0.005(AGE)	0.207	0.043	2.89
	Left	147.52+ 0.54(LHL) + -0.16(LHB) + -0.002(AGE)	0.192	0.037	2.92
	Right	146.14+ 0.57(RHL) + -0.01(RHB) + -0.007(AGE)	0.224	0.050	2.82
Unknown (N=400)	**Unknown**	142.54+ 0.72(HL) + 0.12(HB) + 0.007(AGE)	0.320	0.102	2.11
	Left	142.97+ 0.71(LHL) + 0.07(LHB) + 0.008(AGE)	0.303	0.092	2.14
	Right	142.33+ 0.71(RHL) + 0.18(RHB) + 0.006(AGE)	0.336	0.116	2.05

Table 7 yields the result of step-wise multiple regression equations for stature on both HL and HB among the Rajbanshi individuals adding age as a variable and correlation coefficient and standard error. The regression coefficients were also observed to be statistically significant ($p<0.05$). It was also noticed that the values of the correlation coefficient R and the coefficient of determination (R^2) increased as the effects of age came into force. Similarly, the regression coefficients and R^2 were found to be higher in right sides (e.g., RHL and RHB) in both male and female Rajbanshi individuals when age was introduced as independent variables with HL and HB.

Discussion

Anthropometric technique is the most portable, inexpensive and non-invasive technique employed to estimate body size and proportions holding the sole objective foridentification.[82,83] It has a prime role to play in the identification of skeletal material in the field of forensic anthropology and medico-legal issues. Several studies have been undertaken to estimate stature by taking measurements of long bones,[40,84-86] radiographic materials,[87-89] fingers and phalanges,[19,90-92] and foot dimensions.[20,32,53,93] There is scarcity of such forensic studies among the ethnic populations of North Bengal. A detailed literature search has yielded just two studies on the estimation of stature of foot dimension and estimation of sex from foot dimensions among individuals belonging to the Rajbanshi population.[32,94] It is a well-known fact that contemporary India is composed of a sizeable number of ethnic and indigenous elements having enormous amounts of ethnic and genetic diversity.[95,96] Stature varies with ancestry and is determined by genetics of a person, geographical location, environment and climatic conditions.[64,72] Therefore, a need for the regional studies on stature estimations is to be emphasized since long owing to the racial and ethnic variations present in different regions of the world that has been already advocated earlier.[51]

An individual hand when scrutinized for forensic examination can yield information about the age, sex, and stature of the individual.[97] There exists ample number of studies that have attempted to demonstrate the relation between stature and hand dimensions (in terms of HL and HB) from data obtained from different ethnic communities.[53,62,64,65,69,98] This study extends the findings of previous research conducted using hand dimension measurements (e.g., length and breadth) and height using linear and step-wise multiple regression models with HL, HB and age with indicator. These formulae can be applied to that population from where the data has been collected. This occurs due to inherent variations in these dimensions which may be ascribed to biological and environmental factors.[53, 99]

The preponderance of existing studies observed that women have smaller body dimensions than men. Several studies have reported the existence of sexual dimorphism in hand dimension between both sexes. [21, 53, 62, 64, 71] The results of present study supports the fact that males are genetically taller than females. Similar results have also been reported in another study.[71] It may be mentioned here that age of puberty is about two years later in males in comparison to females and this gives females an additional time for physical growth.[53, 64] As far as bilateral asymmetry is concerned, descriptive statistics in the present study did not exhibit any significant asymmetry in both hand length and breadth as their mean values and the differences were not found to be statistically significant ($p>0.05$). Similar findings have been reported in case of hand length only and not in hand breadth.[53, 71]

Using ANOVA and paired t-test, it has been observed that there were statistically significant sex differences between male and female Rajbanshi individuals in LHL and RHL but the sex difference was observed to be statistically not significant in stature, LHB and RHB. The results were in conformity with other studies conducted on the estimation of stature from hand dimensions.[53,71] However, sex difference was found to be statistically significant in HL only as reported in a similar study.[64] However, another study reported a significant difference in hand breadth, but no significant differences were present in hand length between right and left sides.[53] Hence, it may be concluded that although the Rajbanshi male and female individuals differ with respect to RHL, LHB ($p<0.05$), the differences were not statistically significant in stature, LHB, and RHB ($p>0.05$), thereby indicating sexual dimorphism respect to hand dimensions. A significant difference was observed in hand lengths among Indians females, west Europeans and natives of West Indies, while no such differences were found in hand breadth.[63] Using ANOVA, it was observed that there were statistically insignificant differences in hand dimension in HL and HB in both males and females in the present study and the t-values were also statistically insignificant among the Rajbanshi male individuals ($p>0.05$).

The present study has reported statistically significant coefficients when regressions of stature on LHL, RHL, LHB and RHB and regression of HL and HB were analyzed in both sexes. Stature was thus dependent on LHL, RHL, LHB and RHB. The predictability increased when step-wise regressions were done, and also when age was added as another variable. It was further observed that the values of the correlation coefficient (R) and the coefficient of determination (R^2) were remained similar as the effects of both HL and HB came into force. For unknown cases, the values of R and R^2 also remained appreciably higher in both sexes in liner regressions when both HL and HB are come into force. It may be concluded from the results of the present study that it was possible to estimate stature from LHL, RHL, LHB and RHB. In step-wise multiple regression equations, where age was added as a predictor

variable with HL and HB, there were positive increases in R and R^2 among both male and female Rajbanshi individuals. These estimations can, thus, play an important role in case of identification cases involving the Rajbanshi individuals.

Conclusion

It is justifiable to bring up that the present study is a pioneering study among Rajbanshi of North Bengal. The study has been successful in estimating stature from LHL, RHL, LHB and RHB. It has also successfully observed the relationships between these anthropometric measures as well as estimated bilateral differences and sex differences with respect to these variables. It is further expected that the present study will go a long way in encouraging further scientific studies among Rajbanshi ethnic population on different issues of interest to biological anthropologists. Further studies also recommended use and validation of equations of present study to determine the stature form hand dimensions using HL and HB of different ethnic populations in India. The results show that the regression equations in linear and step-wise multiple equations showed significant associations between stature and both HL and HB. The equations obtained may be helpful to estimate the approximate stature of an individual from the dimensions of the hands in forensic examinations.

Ethical clearance: A prior approval was obtained from the Institutional Ethics Committee.

Conflict of interest: None to declare.

Source of Funding: University Grants Commission [UGC-Ref. No. 617/(NET-JULY 2016)]

References

1. Snow CC. Forensic anthropology. In: Redfield A, editors. Anthropology beyond the University. Southern Anthropological Society Proceedings, No. 7. Athens, GA.: University of Georgia Press; 1973.p. 4-17.
2. Kirschner RH, Hannibal KE. The application of the forensic sciences to human rights investigations. Med Law. 1994;13:451-60.
3. Hughes SC. The Involvement of the Forensic Anthropologist in Human Rights Issues. Master's Thesis: University of Tennessee; 2001. https://trace.tennessee.edu/utk_gradthes/4136
4. Steadman DW, Haglund WD. The scope of anthropological contributions to human rights investigations. J Forensic Sci. 2005; 50:23-30.
5. Webb J. Professional Ethics: Forensic Anthropology and Human Rights Work. Syracuse University Honors Program Capstone Projects. 2016. https://surface.syr.edu/honors_capstone/642
6. Kimmerle EH. Practicing forensic anthropology: a human rights approach to the global problem of missing and unidentified persons. Ann Anthropol Pract. 2014;38:1-6.
7. Ferllini R. Evaluating the Role of Forensic Anthropologists in Human Rights Investigations of Missing Persons. In: Morewitz SJ, Colls CS, editors.Handbook of Missing Persons. Switzerland: Springer International Publishing; 2016.p.535-550.
8. Ubelaker DH, Shamlou A, Kunkle AE. Forensic anthropology in the global investigation of humanitarian and human rights abuse: Perspective from the published record. Sci Justice. 2019;59:203-9.
9. Işcan MY. Global forensic anthropology in the 21st century. Forensic Sci Int. 2001;117:1-6.
10. Cattaneo C. Forensic anthropology: developments of a classical discipline in the new millennium. Forensic Sci Int. 2007;165:185-93.
11. Traithepchanapai P, Mahakkanukrauh P, Kranioti EF. History, research and practice of forensic anthropology in Thailand. Forensic Sci Int. 2016;261:167.e1-6.
12. Ubelaker DH. A history of forensic anthropology. Am J Phys Anthropol. 2018;165:915-23.
13. Baryah N, Krishan K, Kanchan T. The development and status of forensic anthropology in India: A review of the literature and future directions. Med Sci Law. 2019;59:61-9.
14. Sarode SC, Zarkar GA, Kulkarni MA. Role of forensic odontology in the world's major mass disasters: facts and figures. Dent Update. 2009;36:430-6.
15. Blau S, Briggs CA. The role of forensic anthropology in Disaster Victim Identification (DVI). Forensic Sci Int. 2011;205:29-35.
16. Boer HH de, Blau S, Delabarde T, Hackman L. The role of forensic anthropology in disaster victim identification (DVI): recent developments and future prospects. Forensic Sci Res. 2019;4: 303-15.
17. Dwight T. Methods of estimating height from parts of skeleton. Med Rec NY. 1884;46:293-6.
18. Krishan K, Kanchan T, Sharma A. Multiplication factor versus regression analysis in stature estimation from hand and foot dimensions. J Forensic Leg Med. 2012;19:211-4.
19. Rastogi P, Kachan T, Menezes RG, Yoganarashima K. Middle finger length—a predictor of stature in Indian population. Med Sci Law 2009;49:123-6.
20. Kanchan T, Menezes RG, Moudgil R, Kaur R, Kotian MS, Garg RK. Stature estimations from foot dimensions, Forensic. Sci. Int. 2008;179:241e1-e5.
21. Krishan K, Kanchan T, Sharma A. Sex determination from hand and foot dimensions in a North Indian population. J Forensic Sci. 2011;56:453-9.
22. Macdonnel WR. On criminal anthropometry and the identification of criminals. Biometrika. 1901;1:177-227.
23. Qamra SR, Jit I, Deodhar SD. A model for reconstruction of height from foot measurements in an adult population of North West India. Indian J Med Res. 1980; 71:77 – 83.
24. Qamra SR, Deodar SD, Jit I. A metric study of feetof north-west Indians and its relationships to body height and weight. Ind J Phys Anthropol Hum Genet. 1986; 12:131-8.
25. Giles E, Vallanelighamm PH. Height estimation from foot and shoe print length. J Forensic Sci. 1991;36:1134-51.

26. Gordon CC, Buikstra JE. Linear models for the prediction of stature from foot and boot dimension. J Forensic Med Sci. 1992; 37(3): 771 – 82.
27. Singh TS, Phookan MN. Stature and foot size in four Thai communities of Assam, India. Anthropol ANZ. 1993; 51(4): 349 – 55.
28. Agnihotri AK, Purwar B, Googoolye K, Agnihotri S, Jeebun N. Estimation of stature by foot length. J Forensic Leg Med. 2007;14:279-83.
29. Grivas TB, Mihas C, Arapaki A, Vasiliadis E. Correlation of foot length with height and weight in school age children. J Forensic Leg Med. 2008;15:89-95.
30. Krishan K. Determination of stature from foot and its segments in a north Indian population. Am J Forensic Med Pathol. 2008;29:297-303.
31. Zeybek G, Ergur I, Demiroglu Z. Stature and gender estimation using foot measurements. Forensic Sci Int. 2008;181:54.e1-5.
32. Sen J, Ghosh S. Estimation of stature from foot length and foot breadth among the Rajbanshi: an indigenous population of North Bengal. Forensic Sci Int. 2008;181:55.e1-6.
33. Krishan K, Kanchan T, Passi N. Estimation of stature from the foot and its segments in a sub-adult female population of North India. J Foot Ankle Res. 2011;4:24.
34. Rani M, Tyagi AK, Ranga VK, Rani Y, Murari A. stature estimates from foot dimensions. J Punjab Acad Forensic Med Toxicol 2011;11: 26-30.
35. Dayananda R, Umesh B, Kiran J. Estimation of Stature from Dimensions of Foot. International Journal of Medical Toxicology and Forensic Medicine. 2014;4:1-5.
36. Malik AR, Akhter N, Ali R, Farrukh R, Aziz K. A study on estimation of stature from foot length. Professional Med J. 2015;22:632-9.
37. Sah, S., Karki, N., & Jeelani, B. Estimation of Height from Foot Dimensions. Journal of Lumbini Medical College. 2018;6:27–31.
38. Jantz RL. Modification of the Trotter and Gleser female stature estimation formulae. J Forensic Sci. 1992;37:1230-5.
39. Ryan I, Bidmos MA. Skeletal height reconstruction from measurements of the skull in indigenous South Africans. Forensic Sci Int. 2007;167:16-21.
40. Bidmos MA. Adult stature reconstruction from the calcaneus of South Africans of European descent. J Clin Fornsic Med. 2006;13:247-52.
41. Chibba K, Bidmos M.A. Using tibia fragments from South Africans of European descent to estimate maximum tibia length and stature. Forensic Sci Int. 2007:169:145-51.
42. Steyn M, Smith JR. Interpretation of ante-mortem stature estimates in South Africans, Forensic Sci Int. 2007;171:97-102.
43. Fan T, Chen XG, Zhou XR, Zhang ZH, Deng ZH, Wang HX. Stature estimation from length of tibias and fibulas measured in computed radiography of living body. Fa Yi Xue Za Zhi. 2008;24:118-21.
44. Jantz RL, Kimmerle EH, Baraybar JP. Sexing and stature estimation criteria for Balkan populations. J Forensic Sci. 2008;53:601-5.
45. Zhang ZH, Chang YF, Zhou XR, Deng ZH, Yu J.Q., L. Huang. Stature estimation from the cervical vertebrae of living male by measuring X ray films of computer radiography, Fa. Yi. Xue. Za. Zhi. 2008;24:25-31.
46. Didia BC, Nduka EC, Adele O. Stature estimation formulae for Nigerians. J Forensic Sci. 2009; 54:20-1.
47. Fawzy IA, Kamal NN. Stature and body weight estimation from various footprint measurements among Egyptian population. J Forensic Sci. 2010;55:884-8.
48. Supare M S, Pandit S V, Bagul A S. Estimation of stature from hand length and hand breadth in medical students of Maharashtra, India. Int J Health Allied Sci. 2015;4:154-9.
49. Shrestha RN, Banstola D, Nepal D, Baral P. Estimation of Stature from Nasal Length. J Nepal Med Assoc. 2016; 55:76-8.
50. Christal G, Manve P, Ahuja P and Dahiya MS. Estimation of Stature from Finger Length. J Forensic Sci & Criminal Invest. 2018;7:555709.
51. Telkka A. On the prediction of human stature from the long bones, Acta Anat. 1950;9:103-17.
52. Majumder PP. People of India: biological diversity and affinities. Evol Anthropol. 1998;6:100-10.
53. Krishan K, Sharma A. Estimation of stature from dimensions of hands and feet in a north Indian population. J Forensic Leg Med. 2007;14:327–32.
54. Kanchan T, Rastogi P. Sex determination from hand dimensions of North and South Indians. J Forensic Sci. 2009;54:546-50.
55. Menezes RG, Kanchan T, Kumar GP, Rao PP, Lobo SW, Uysal S, Krishan K, Kalthur SG, Nagesh KR, Shettigar S. Stature estimation from the length of the sternum in South Indian males: a preliminary study. J Forensic Leg Med. 2009; 16:441-3.
56. Krishan K, Kanchan T, DiMaggio JA. A study of limb asymmetry and its effect on estimation of stature in forensic case work. Forensic Sci Int. 2010; 200:181e1-5.
57. Rajkumar CM. The relationship between hand breadth and height in adult males of North Indian Punjabi population. J Evol Med Dent Sci. 2013;2:1880-7.
58. Srivastava A, Yadav VK. Reconstruction of stature using hand and foot dimensions among Indian Population. International Journal of Engineering Sciences & Emerging Technologies. 2014;6:400-4.
59. Geetha GN, Swathi, Athavale SA. Estimation of Stature from Hand and Foot Measurements in a Rare Tribe of Kerala State in India. J Clin Diagn Res. 2015;9:HC01-4.
60. Banik SD, Das S, Bose K, Gritlahre M. Estimation of stature from hand and foot dimensions among university girl-students in Bilaspur, Chhattisgarh, India. Anthropologie. 2016;54:291-7.
61. Pungle AS, Munjamkar P. Estimation of stature from hand length and foot length in Nagpur region of Maharashtra State. Int J Biomed Adv Res. 2017;8: 382-7.
62. Rongpi D, Mondal N. Estimation of stature from hand dimension among indigenous Karbi tribal population of Assam, Northeast India. J Clin Diag Res. 2019;13: HC01-7.
63. Davies BT, Abada A, Benson K, Courtney A, Minto I. A

comparison of hand anthropometry of females in three ethnic groups. Ergonomics. 1980; 23:179-82.

64. Bhatnagar DP, Thapar SP, Batish MK. Identification of personal height from the somatometry of the hand in Punjabi males. Forensic Sci Int. 1984;24:137-41.
65. Saxena SK. A study of correlations and estimation of stature from hand length, hand breadth and sole length. Anthropol Anz. 1984; 42:271-6.
66. Means LW, Walters RE. Sex handedness and asymmetry of hand and foot length. Neuropsychologia. 1982; 20:715-9.
67. Malek AKA, Ahmed AM, el-Sharkawi SA, el-Hamid NA. Prediction of stature from hand measurements. Forensic Sci Int. 1990;46:181-7.
68. Okunribido OO. Asurvey of hand anthropometry of female rural farm workers in Ibadan, western Nigeria. Ergonomics 2000;43:282–92.
69. Sanli SG, Kizilkanat ED, Boyan N, Ozsahin ET, Bozkir MG, Soames R, Erol H, Oguz O. Stature estimation based on hand length and foot length. Clin Anat. 2005;18:589–96.
70. Ozaslan A, Koc S, Ozaslan I, Tugcu H. Estimation of stature from upper extremity. Mil Med. 2006; 171:288–91.
71. Agnihotri AK, Agnihotri S, Jeebun N, Googoolye K. Prediction of stature using hand dimensions. J Forensic Leg Med. 2008;15:479-82.
72. Rastogi P, Nagesh KR, Yoganarasimha K. Estimation of stature from hand dimensions of north and south Indians. Leg Med. 2008;10:185-9.
73. Pal A, Aggarwal P, Bharati S, Panda M, Datta I, Roy P. Anthropometric measurements of the hand length and their correlation with the stature in eastern Indian population. Nat J Med Res. 2014;4: 303-5.
74. Shankar GS, Shankar VV, Radhika K, Shetty S. 2017. Correlation of human height with hand length in Indian individuals. Int J Anat Res. 2017;5:4478-81.
75. Sen J, Mondal N, Ghosh P. Upper Arm Composition as an Indicator of Body Composition and Nutritional Status of Adolescent Boys Aged 10-18 Years. J Nepal Paediatr Soc. 2015;35:152-61.
76. Sinha I, Pal A, Sen J. Age and sex variations in anthropometric characteristics and body composition of adults belonging to Rajbanshi population of Darjeeling district, West Bengal. South Asian Anthropologist. 2018;18: 203-13.
77. Singh IP, Bhasin MK. Anthropometry. Delhi: Kamla-Raj Enterprises. 1989.
78. Krishan K, Vij K. Diurnal variation of stature in three adults and one child. Anthropologist. 2007;9:113-7.
79. Goto R, Mascie-Taylor CGN. Precision of measurement as a component of human variation. J Physiol Anthropol. 2007;26:253–6.
80. Ulijaszek SA, Kerr DA. Anthropometric measurement error and the assessment of nutritional status. Br J Nutr. 1999;82:165–77.
81. Martin R, Saller K. Lehrbuch de Anthropologia. Vol 1. Stuttgart: Gustav Fisher Verlag. 1957.
82. Iscan MY Anthropometry. In: Siegel J, Saukko P, Knupfer G, editors. Encyclopedia of Forensic Sciences. London: Academic Press. 2000.p.284–290.
83. Ozaslan A, Iscan MY, Ozaslan I, Tug˘cu H, Koc S. Estimation of stature from body parts. Forensic Sci Int. 2003;132:40–5.
84. Mall G, Hubig M, Buttner A, Kuznik J, Penning R, Graw M. Sex determination and estimation of stature from the long bones of the arm. J Forensic Sci. 2001; 117:23-30.
85. Radioinova D, Tenekedjiev K, Yordanova Y. Stature estimation from long bone length in Bulgarians. Homo. 2002;52:221–32.
86. Hauser R, Smolinski J, Gos T. The estimation of stature on the basis of measurements of the femur. Forensic Sci Int. 2005;147:185-90.
87. Warren MW, Smith KR, Stubblefield PR, Martin SS, Walsh-Haney HA. Use of radiographic atlases in a mass fatality. J Forensic Sci. 2000;45:467–70.
88. Munoz JI, Linares-Iglesias M, Suarez-Penaranda JM, Mayo M, Mignuens X, Roriguez-Calvo MS, Concheiro L. Stature estimation from radiographically determined long bone length in a Spanish population sample. J Forensic Sci. 2001; 46:363–6.
89. Pelin C, Duyar I, Kayahan EM, Zagyapan R, Agildere AM, Erar A. Body height estimation based on dimensions of sacral and coccygeal vertebrae. J Forensic Sci. 2005; 50:294–7.
90. Habib SR, Kamal NN. Stature estimation from hand and phalanges lengths of Egyptians. J Forensic Leg Med. 2010;17:156-60.
91. Kanchan T, Kumar GP. Index and ring finger ratio- a morphologic sex determinant in South-Indian children, Forensic Sci Med Pathol. 2010;4:255-60.
92. Kanchan T, Kumar GP, Menezes RG, Rastogi P, Rao PP, Menon A, Shetty BS, Babu YP, Monteiro EN, Bhagavath P, Nayak VC. Sexual dimorphism of the index to ring finger ratio in South Indian adolescents. J Forensic Leg Med. 2010; 17:243-6.
93. Kanchan T, Menezes RG, Moudgil R, Kaur R, Kotian MS, Garg RK, Stature estimation from foot length using universal regression formula in a north Indian population. J Forensic Sci. 2010;55:163-6.
94. Sen J, Kanchan T, Ghosh S. Sex estimation from foot dimensions in an indigenous Indian population. J Forensic Sci. 2010; 56:S148-53.
95. Beiteille A. The Indian heritage – a sociological perspective. In: Balasubramanian D, Rao NR, editors. The Indian human heritage. Hyderabad: University Press. 1998.p.27–94.
96. Indian Genome Variation Consortium. Genetic landscape of the people of India: A canvas for disease gene exploration. J Genet. 2008; 87:3-20.
97. Kanchan T, Krishan K. Anthropometry of hand in sex determination of dismembered remains - A review of literature. J Forensic Leg Med. 2011;18:14-7.
98. Abdel-Malek AK, Ahmed AM, el-Sharkawi SA, el-Hamid NA. Prediction of statue from hand measurements. Forensic Sci Int. 1990;46:181-7.
99. Malina RM, Little BB, Stern MP, Gaskill SP, Hazuda HP. Ethnic and social class differences in selected anthropometric characteristics of Mexican American and Anglo adults: the San Antonio Heart Study. Hum Biol. 1983; 55:867-83.

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 189-192
doi:10.5958/0974-0848.2020.00050.0

ORIGINAL ARTICLE

Stature estimation and sex determination using anthropometric measurements of normal human ear auricle

Prateek Rastogi,[1] Deepali Singh,[2] Ashim Mishra,[3] Saumen Gupta[4]

1 Department of Forensic Medicine, Kasturba Medical College, Manglore, Manipal Academy of Higher Education, Manipal, Karnataka, India
2 Department of Otorhinolaryngology, Manipal Tata Medical College, Jamshedpur, Jharkhand, India
3 Department of Forensic Medicine, Sikkim Manipal University, Sikkim Manipal Institute of Medical Sciences, Gangtok, Sikkim, India
4 Sikkim Manipal University, Sikkim Manipal College Of Physiotherapy, Gangtok, Sikkim, India

Abstract

Identification is a subfield of forensics concerned with identifying someone from remains. People cannot only be identified from traces of their DNA, or from their teeth but also from anthropometric measurements of their body parts. Many studies have been conducted for estimation of stature from percutaneous measurements of various body parts such as arm, leg etc.

The aim of the present study was to estimate stature and sex of an individual using anthropometric measurement of normal ear auricle and to correlate between right and left ear symmetry. The present study is a cross sectional descriptive survey conducted over a period of 3 months under Forensic Medicine department in Kasturba Medical College, Mangalore with 297 medical students included as the study population. Vernier Calipers and stadiometer were used to measure the morphometric measurements. The variables measured included stature, total ear height, ear width, lobular height and lobular width of both the sides. It was observed that there is no significant asymmetry between ears of both sides in either sex. Ear measurements and stature are significantly higher in males as compared to females. The lobular lengths and lobular width were significantly higher in females as compared to males. The results of the present study could aid in disaster victim identification, aiding in design of ear aids and help in further study of cosmetic surgery and congenital malformations.

Keywords

Anthropometry; Stature estimation; Sex determination; Ear morphometry; Regression analysis.

Introduction

Identification is of fundamental importance in the field of anthropology and forensic investigation such as criminal cases and mass disasters for the identification of the deceased. Body identification is a subfield of forensics concerned with identifying someone from their remains. The measurements of different body parts contributed significantly to understand primary data of identification and morphological variation existing in different geographical areas and community. Earlier studies had already established a correlation of stature with different body parts.[1,2]

Literature suggests that the anthropometric measurements of body parts subtly points out the difference in primary data of identification.[3] Craniofacial anthropometry comprises a fundamental part of forensic anthropology.[4] The possibility of using the external ear as a tool for establishing personal identity was recognized as early as 1893 by Bertillon and later the aspect was extensively researched by Lannarelli on a large sample.[3,5] However, few studies are available for stature estimation from face alone.[6] An idea about the morphometric measurements of ear had aided in diagnosing congenital anomalies and laying down the plan for hearing aids.[7]

The development of ear start from 4th Intrauterine week from the auricular hillocks which fuse to form pinna and it owe its characteristic shape due to the elastic cartilage whereas the lobule is just an extension of the skin.[8] Even researchers have stated that ear being relatively immune to aging process since there is very slight variation throughout the life and could qualify as a biometric marker.[9]

This study was thus an attempt to yield parameters for ear morphology to explore variation in gender, symmetry and estimate the stature of an individual using anthropometric measurement of normal ear auricle with the following objectives:

1. To compare anthropometric measurements of normal ear auricle between males and females.

2. To estimate stature of an individual using anthropometric measurement of normal ear auricle.

Materials and Methods

This descriptive study was held in Forensic Medicine department in Kasturba Medical College, Mangalore with undergraduate medical students included as the study

Corresponding Author
Dr. Ashim Mishra (Associate Professor)
Email: mishra.ashim@rediffmail.com
Mobile: +91-8391934762

Article History
Received: 23rd March, 2020; Revision received on: 19th July, 2020
Accepted: 23rd July, 2020

population over a period of 90 days. Individuals unwilling to participate, or with any congenital/acquired anomalies to the ear or any part of the body that affects their stature were excluded from the study. Ethical clearance was obtained prior to study. Written informed consent was obtained before collecting the measurements. Based on the exclusion criteria measurements of 297 participants (147 boy students and 150 girl students) between the 18-26 years were recorded. The instrument used for the study was Bizinto Iron Vernier calliper for measurements of normal ear auricle and stadiometer for measurement of stature. Measurements and details of the individual were entered into a predesigned data sheet.

Bilateral sizes of the ear auricle were measured as per following parameters. The parameters measured were Ear height, Ear width, Lobular height and lobular width of ears of wither side. The ear height was measured as the distance from the most inferior point of the ear lobe to most superior point of the helix.

The ear width was measured as a distance between the most anterior and posterior points of the ear. The lobular height was taken as the distance from the most inferior end of the lobule to the base of the tragal notch [Figure 1A]. The lobular width was measured as the transverse or horizontal width of the lobule [Figure 1B]. The ear index was calculated as the ratio of ear width to ear length divided by hundred and lobule index as the ratio of lobular width to lobular length divided by hundred. The standing stature of individuals was measured on the stadiometer where participants stood erect barefooted and the dorsal body touched the vertical rod of the instrument and head in the Frankfort horizontal plane. Sufficient care was taken to maintain the accuracy of 0.1cm.

A B

Figure 1: (A)- Measurement of ear width; (B)- Measurement of Lobular Height

Data analysis was done by using proportions and association with SPSS version 20.0.1. The Student's unpaired “t” test and Regression analysis was done to establish relationship between variables. An attempt to find out the relationship between ear morphometric measurements and stature was done by analysing Karl Pearson's correlation coefficient. To predict the stature multiple linear regression analysis was used to arrive at an inference in the estimation of stature as done in an earlier study.[4]

Results

The measurement of stature and the anthropometric measurements of either ears with regard to sex distribution depicted in Tables 1 and 2 respectively. The lobular index and ear index were indirectly derived from the above measurements. There was no normal distribution for total population, but on visual inspection of plots normality was not seem to be an issue.

Table 1: Descriptive statistics of the stature and ear measurements of the study population

Measurements	Sex	N	Mean (cm)	SD (cm)
Stature (cm)	Male	147	160.27	4.98
	Female	150	168.30	6.00
Ear Height-R	Male	147	6.08	0.30
	Female	150	6.60	0.36
Ear width-R	Male	147	2.69	0.29
	Female	150	2.91	0.245
Ear height-L	Male	147	6.06	0.29
	Female	150	6.61	0.36
Ear width-L	Male	147	2.71	0.26
	Female	150	2.91	0.25
Ear Index (R)	Male	147	44.42	4.96
	Female	150	44.11	2.973
Ear Index (L)	Male	147	44.82	4.73
	Female	150	44.03	3.59

R=Right; L=Left; cm=centimeters; SD=Standard Deviation

The index of separation was calculated where the difference between mean of male and female was divided by pooled standard deviation as depicted in Table 3.

A multiple step wise regression was conducted to predict stature. The variables entered were ear height and ear width. The assumptions of linearity, independence of errors, homoscedasticity, unusual points and normality of residuals were met. The ear length and ear width of both sides were independent variables. Separate models were computed for males and females and each side respectively. The summary of multiple regression analysis with stature as dependent variable and ear height and ear Width as predictor variables for males and females are depicted in Tables 4, 5 respectively.

Table 2: Descriptive statistics of the ear lobule measurements of the study population

Measurements	Sex	N	Mean (cm)	SD (cm)
Lobular Height-R	Male	147	2.21	0.23
	Female	150	2.61	0.21
Lobular Width-R	Male	147	1.82	0.20
	Female	150	2.35	0.29
Lobular Height-L	Male	147	2.19	0.25
	Female	150	2.60	0.21
Lobular Width-L	Male	147	1.82	0.21
	Female	150	2.35	0.29
Lobular Index (R)	Male	147	82.94	9.75
	Female	150	90.05	6.90
Lobular Index (L)	Male	147	84.16	13.34
	Female	150	90.32	7.69

R=Right; L=Left; cm=centimeters; SD=Standard Deviation

Table 1: Degree of separation between males and females

Measurements	Male Mean (cm)	Female mean (cm)	SD Male (cm)	SD Female (cm)	Male mean Female Mean (cm)	Pooled SD (cm)	DS
Ear Height -R	6.6	6.08	0.36	0.3	0.52	0.33	1.58
Ear width -R	2.91	2.69	0.24	0.29	0.22	0.27	0.82
Ear Height -L	6.61	6.06	0.36	0.29	0.55	0.33	1.69
Ear Width -L	2.91	2.71	0.25	0.26	0.2	0.26	0.78
Lobular Height -R	2.61	2.21	0.21	0.23	0.4	0.22	1.82
Lobular Width -R	2.35	1.82	0.29	0.2	0.53	0.24	2.16
Lobular height -L	2.6	2.19	0.21	0.25	0.41	0.23	1.78
Lobular Width -L	2.35	1.82	0.29	0.21	0.53	0.25	2.12

R=Right; L=Left; cm=centimeters; SD=Standard Deviation; DS=Degree of Seperation

Table 4: Summary of multiple regression analysis for estimation of stature of males

Stature as dependent variable and ear height and width as predictor variables						
Variable	**B(L)**	**SEB (L)**	**β (L)**	**B(R)**	**SEB (R)**	**β(R)**
Intercept	69.396	4.127		68.972	4.090	
Ear height	13.963	0.682	0.846*	14.151	0.759	0.846*
Ear Width	2.292	0.968	0.098*	2.017	1.150	0.098*

*p<0.000; B=unstandardized coefficient; SEB =standard error of coefficient; β=standardized coefficient, R=Right, L=Left

The regression formula calculated from right ear and left ear were more reliable.

Stature in Males = 68.972 + (14.151 * Right Ear height) + (2.017 *Right Ear width)

Stature in Males = 69.396 + (13.963 *Left Ear height) + (2.292 * Left Ear width)

The lobular measurements were less reliable while predicting stature in males.

In females the regression formula for right ear and left ear were found more reliable while the lobular width and height were taken into consideration.

Stature in Females = 111.182 + (5.359 *Right Ear height) + (5.643 * Right Ear width) + (5.792 *Right Lobar Height) + (-6.334 * Right Lobar width)

Stature in Females= 101.41 + (7.227 *Left Ear height) + (8.032 * Left Ear width) + (1.063 *Left Lobular Height) + (-4.983 * Left Lobular width)

Table 5: Summary of multiple regression analysis for estimation of stature of females

Stature as dependent variable and ear height and width, and lobular height and width as predictor variables						
Variable	**B (L)**	**SE_B(L)**	**β (L)**	**B (R)**	**SE_B(R)**	**β (R)**
Intercept	101.410	8.086		111.182	7.143	
Ear height	7.227	1.404	0.431*	5.359	1.282	0.325*
Ear Width	8.032	1.524	0.418*	6.643	1.301	0.326*
Lobular height	1.063	1.760	0.053^{NS}	5.792	1.908	0.267*
Lobular Width	-4.983	1.814	-0.208*	-6.334	2.005	-0.250*

*p<0.05; B=unstandardized coefficient; SEB =standard error of coefficient; β=standardized coefficient; NS = not significant; R= Right; L= Left

Discussion

In this study, the mean and standard deviation were analysed for interpreting the findings for accuracy taken up to two decimal points. The variability could be well predicted by measuring the standard deviation. Our study pointed no significant asymmetry between ears of both sides in either sex which was similar to earlier studies.[10]

This study pointed very clearly that the morphometric measurements of ear i.e. ear length and ear width were higher in males as compared to females which was comparable to finding of other earlier studies done in India and Nigeria.[11,12] The gender dimorphism demonstrated in our study with statistically significant findings slightly differed from study done in Maharashtra.[13]

The lobular lengths and lobular width were significantly higher in females as compared to males similar to earlier studies done in China and India.[8,10] Even though it was done on medical students who were at age range of 18-26 years but the lobular width and length were similar to study done in Maharashtra done in different age groups could be due to practice of ear piercing and use of ear rings in females prevalent as a custom.[13]

Our study attempted to derive a regression equation for

estimating the stature which was in line with a study done at Egypt where indices of separation and the probability of sex were produced by regression analysis. In the following study it was pointed that best measurement for sex determination was ear breadth.[4] The measurements of lobules were less reliable predictors for male than females in our study.

Conclusion

Anthropometric measurements of different parts of body including stature, palm length, femur or humerus length has improved the earlier anthropometric systems. Present study established a relation between anthropometric measurements of normal ear auricle and stature of a person. Ear auricle measurements and indices could be useful parameters in sex determination and help to establish sexual dimorphism. The stature estimated by the ear measurements could pave a way for future studies. The limitation of the study was its restriction to one demographic region and done in a limited age range. Even though sufficient care was taken an element of subjectivity can also count as one of the limitations. Further somatoscopic studies could be done to substantiate the findings of this study.

Ethical clearance: A prior approval was obtained from the Institutional Ethics Committee

Conflict of interest: None to declare

Source of funding: None to declare

References

1. Chiba M, Terazawa K. Estimation of stature from somatometry of skull. Forensic Sci Int. 1998;97(2-3):87-92.
2. Ryan I, Bidmos MA. Skeletal height reconstruction from measurements of the skull in indigenous south Africans. Forensic Sci Int. 2007;167(1);16-21.
3. Bertillon A. Identification anthropometrique: instructions signaletiques. Masson: Paris;1893.
4. Nancy M. Zaghloul , Sarah A. Khater, Waleed A Badaway. Sex and stature determination from Maxillo-Facial anthropometry in an adult Egyptian Population sample. Egypt J Forensic Sci Appli Toxicol. 2019; 19 (2):13-27.
5. Iannarelli A. Ear identification. Forensic identification series. Paramont Publishing Company. Freemont: California; 1989.
6. Krishan K. Estimation of stature from cephalo- facial anthropometry in north Indian population. Forensic Sci Int. 2008;181:52-6.
7. Deopa D, Thakkar HK, Prakash C, Niranjan R, Barua MP. Anthropometric measurements of external ear of medical students in Uttrakhand region. J Anat Soc India. 2013;62:79-83
8. Wang B, Dong Y, Zhao Y, Shizhu BS, Wu G. Computed tomography measurement of the auricle in Han population of North China. J Plast Reconstr Aesthet Surg. 2011; 64 (1):34-40.
9. Cummings AH, Nixon MS, Carter JN.A Novel Ray Analogy for Enrolment of Ear Biometrics. IEEE Fourth Conference on Biometrics: Theory, Applications and Systems, United States. 2010. Available online at https://eprints.soton.ac.uk/271546/ accessed on 25.01.2020.
10. Sharma N. Anthropometric measurement and cross-sectional surveying of ear pinna characteristics in Northern India. J Exp Clin Anat. 2016;15:102-6.
11. Agnihotri G, Singh D. Craniofacial anthropometry in newborns and infants. Iran J Pediatr. 2007; 17 (4):332-8.
12. Ekanem AU, Garba SH, Musa TS, Dare ND. Anthropometric study of the pinna (Auricle) among adult Nigerians resident in Maiduguri metropolis. J Med Sci. 2010;10 (6):176-80.
13. Sharanbasappa RJ , Priyanka JE, Reddy MB, Tiwari AU, Siddegowda CY, and Hammannavar RB. Anthropometric Assessment of the Normal Adult Human Ear. Ann Maxillofac Surg. 2018 ; 8(1): 42–50.

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 193-198
doi:10.5958/0974-0848.2020.00051.2

ORIGINAL ARTICLE

What do the MBBS undergraduates think about the subject of Forensic Medicine & Toxicology? A survey-based evaluation of perception

Raghvendra Kumar Vidua, Abhijit Pakhare, Sweta Patel, Narendra Patel, Arneet Arora
Department of Forensic Medicine & Toxicology, All India Institute of Medical Sciences, Bhopal, MP, India.

Abstract
It is a very common point of discussion among the Forensic specialists that whether the MBBS students do have interest in the subject of Forensic Medicine & Toxicology and some of them would think towards it as their career perspective or not and what type of perception they do have exactly about the subject. To have a fair idea about this, a questionnaire-based survey was conducted among the MBBS undergraduate students of AIIMS Bhopal after dividing them in to different groups (Group A, B & C). In this survey, a total of 17 questions whose validity was determined before the survey were asked. The Students were asked to express their responses on a scale with grades ranging from 1 to 5. 80.7% of the students perceive the subject as interesting and 10.1% find it non-interesting while 9.1% say that they have no idea about it. When a question related with subject as their future career perspective was asked then only 14.2% were agreed to opt it as their career option. A paradox of high interest in the subject with poorer curiosity in opting it as a career option among the students has been reported. Therefore, there is need to enhance the scope and role of the subject to successfully face the future challenges of lack of sufficient number of forensic specialists in the field and in dealing with the emerging medico legal issues.

Keywords
Forensic Medicine & Toxicology; Questionnaire; Interest; Scope; Career; Medico legal investigation.

Introduction

The subject of Forensic medicine and Toxicology is mandatorily taught to the MBBS undergraduates in their 2nd professional year along with the other three Para-Clinical subjects which is 18 months long in India. This subject deals with the legal aspect of medicine (Forensic medicine) and poisons (Forensic Toxicology) and also train the MBBS undergraduates about the legal responsibilities of a doctor (Medical jurisprudence). The broad goal of teaching of Forensic Medicine in our country is to produce a physician who is well informed about the medico-legal responsibilities in the practice of medicine.[1]

The subject deals with different kind of medico legal works including the post-mortem examination at a hospital. So, a doctor working in this field must have to deal with police and the legal cases, dead bodies and to write the medico legal documents which are presented to the court of law. Therefore, many of the times the doctors have to visit the court as they are called by summons to testify their reports. During court procedure the Forensic specialists are cross examined by the defence lawyers. They are some intricacies of the subject which make the subject unpopular among the MBBS undergraduates and that is why students often do not prefer it as their carrier option even after deficiency of the doctors trained in this subject and availability of plenty of jobs.

Corresponding Author
Dr. Raghvendra Kumar Vidua (Associate Professor)
Email: raghvendra.fmt@aiimsbhopal.edu.in
Mobile: +91-8447569312

Article History
Received: 24th March, 2020; Revision received on: 19th July, 2020
Accepted: 25th July, 2020

Material and Methods

The study was done among a total of 275 MBBS undergraduates of AIIMS Bhopal after dividing them in to three groups. The first group (Group A, n = 96) was comprised of students who had no exposure to the subject, the second group (Group B, n = 88) was comprised of students who are undergoing Forensic Medicine and Toxicology (FMT) training and the third group (Group C, n = 91) was comprised of students who have completed training in the subject. The Students were asked to express their responses on a scale with grading from 1 to 5 on a questionnaire for survey (Figure 1). The questionnaire had a total of 17 out of 24 selected questions whose validity was determined before the survey and the questions with the validity value ≥ 0.8 were retained in the survey. The items in the questionnaire were targeted to analyse about the intrinsic interest (Q2,3,6,7,16) and extrinsic interest (Q1,9,14,17) about the subject and also their perception about the intricacies (Q12,13) and scope (Q4,5,8,10,11,15) of the subject among the different study groups. Their responses were also evaluated for overall rating of the subject on a different scale with grading from 1 to 5. The responses were tabulated and the result was analysed. The consent of ethical Institutional human ethical committee (IHEC) and participants was taken for the study.

Grading- 1-strongly agree, 2 -Somewhat agree, 3 -don't know, 4 -somewhat disagree, 5 strongly disagree

(Please mark 1, 2, 3, 4 or 5 in the brackets provided after each question)

1. You have heard about the subject before joining MBBS ( ).
2. The subject is interesting ( ).
3. The subject has utility in the MBBS curriculum ( ).
4. The subject requires reframing in relation to its practical application in the common practice ().
5. The subject is largely unexploited of its potential in medico legal investigation in India vis a vis other countries like USA ( ).
6. You have interest in the subject ( ).
7. You may choose the subject as your career option ( ).
8. The doctors are best able to apply the knowledge of the subject in medico legal investigations ( ).
9. Efficient utilization of the subject in medico legal investigations has potential to yield high quality medico legal investigations ( ).
10. There is lack of clinical application of the subject at present ( ).
11. The present application of the knowledge of the subject in medico legal investigations is adequate in India ( ).
12. You often dislike the subject as it deals with the dead bodies ( ).
13. You are discouraged to choose the subject as your carrier option as it involves legal cases and you are supposed to attend the courts ( ).
14. The interest about the subject can be generated among students ( ).
15. Students and general public are less aware about the utility and scope of the subject in medico legal investigations ( ).
16. A good teaching of the subject can affect your interest in the subject ( ).
17. The TV programmes like CID, discovery channel and movies casting detectives generate the interest about the subject ( ).

The overall rating to the utility of subject in the medico legal investigations in India [put a tick mark (✔)].

1-very useful, 2-somewhat useful, 3-can't say, 4-Not useful, 5-harmful

Name of the Participant: **Batch;** **Institute/Medical college:**

Figure 1: Questionnaire for Evaluation of perception of students about the subject of Forensic Medicine & Toxicology

Results

There was a total of 275 students who participated in the study. The item wise analysis (Tables 1, 2, 3, and 4) shows that 77.1% students strongly or somewhat agreed that they had heard about the subject before joining MBBS at AIIMS Bhopal while 16.7% strongly or somewhat had disagreed with it. 83.3% students have found the subject interesting while 6.5% found it as not interesting. A total of 85.9% students think that the subject has some utility in MBBS curriculum while 6.9% think it as of no utility. The 72% students think that the subject requires reframing in relation to the common practice while 4 % think that no change is required. The 69.1% students think that the subject is largely unexploited of its potential in medico legal investigations in India vis a vis other country like USA while 6.2% students disagree with it.

The 80.7% students perceive the subject as interesting and 10.1% as non-interesting while 9.1% say that they have no idea about it. When a question related with the subject as their career perspective in future was asked then only 14.2% agreed to opt it as their career option in future and 44.8% disagreed to it while 41.1% students express their responses as can't say anything.

Table 1: Responses to the study questionnaire by study group A

a	Strongly Agree		Somewhat agree		Neutral		Somewhat disagree		Strongly disagree		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Q1	52	54.2%	21	21.9%	9	9.4%	9	9.4%	5	5.2%	96	100.0%
Q2	47	49.0%	26	27.1%	20	20.8%	3	3.1%	0	0.0%	96	100.0%
Q3	61	63.5%	27	28.1%	7	7.3%	0	0.0%	1	1.0%	96	100.0%
Q4	31	32.3%	28	29.2%	36	37.5%	0	0.0%	1	1.0%	96	100.0%
Q5	39	40.6%	33	34.4%	16	16.7%	6	6.3%	2	2.1%	96	100.0%
Q6	41	42.7%	43	44.8%	9	9.4%	3	3.1%	0	0.0%	96	100.0%
Q7	10	10.4%	18	18.8%	51	53.1%	10	10.4%	7	7.3%	96	100.0%
Q8	35	36.5%	47	49.0%	9	9.4%	4	4.2%	1	1.0%	96	100.0%
Q9	71	74.0%	16	16.7%	8	8.3%	0	0.0%	1	1.0%	96	100.0%
Q10	15	15.6%	37	38.5%	28	29.2%	9	9.4%	7	7.3%	96	100.0%
Q11	4	4.2%	12	12.5%	33	34.4%	35	36.5%	12	12.5%	96	100.0%
Q12	4	4.2%	11	11.5%	4	4.2%	30	31.3%	47	49.0%	96	100.0%
Q13	17	17.7%	23	24.0%	11	11.5%	25	26.0%	20	20.8%	96	100.0%
Q14	46	47.9%	36	37.5%	13	13.5%	1	1.0%	0	0.0%	96	100.0%
Q15	41	42.7%	38	39.6%	11	11.5%	6	6.3%	0	0.0%	96	100.0%
Q16	71	74.0%	19	19.8%	5	5.2%	0	0.0%	1	1.0%	96	100.0%
Q17	64	66.7%	25	26.0%	3	3.1%	3	3.1%	1	1.0%	96	100.0%

a. Group = No FMT exposure

Table 2: Responses to the study questionnaire by study group B

b	Strongly Agree		Somewhat agree		Neutral		Somewhat disagree		Strongly disagree		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Q1	48	54.5%	22	25.0%	5	5.7%	5	5.7%	8	9.1%	88	100.0%
Q2	41	46.6%	42	47.7%	4	4.5%	1	1.1%	0	0.0%	88	100.0%
Q3	49	55.7%	27	30.7%	3	3.4%	7	8.0%	2	2.3%	88	100.0%
Q4	29	33.0%	36	40.9%	17	19.3%	4	4.5%	2	2.3%	88	100.0%
Q5	30	34.1%	24	27.3%	31	35.2%	2	2.3%	1	1.1%	88	100.0%
Q6	27	30.7%	51	58.0%	6	6.8%	3	3.4%	1	1.1%	88	100.0%
Q7	3	3.4%	8	9.1%	39	44.3%	14	15.9%	24	27.3%	88	100.0%
Q8	45	51.1%	29	33.0%	6	6.8%	7	8.0%	1	1.1%	88	100.0%
Q9	69	78.4%	15	17.0%	4	4.5%	0	0.0%	0	0.0%	88	100.0%
Q10	13	14.8%	34	38.6%	23	26.1%	13	14.8%	5	5.7%	88	100.0%
Q11	6	6.8%	14	15.9%	35	39.8%	28	31.8%	5	5.7%	88	100.0%
Q12	6	6.8%1	25	28.4%	1	1.1%	21	23.9%	35	39.8%	88	100.0%
Q13	10	1.4%3	30	34.1%	11	12.5%	22	25.0%	15	17.0%	88	100.0%
Q14	33	7.5%2	40	45.5%	10	11.4%	2	2.3%	3	3.4%	88	100.0%
Q15	22	5.0%6	53	60.2%	10	11.4%	3	3.4%	0	0.0%	88	100.0%
Q16	60	8.2%5	21	23.9%	7	8.0%	0	0.0%	0	0.0%	88	100.0%
Q17	52	9.1%	32	36.4%	1	1.1%	2	2.3%	1	1.1%	88	100.0%

b. group = Studying FMT

Table 3: Responses to the study questionnaire by study group C

c	Strongly Agree		Somewhat agree		Neutral		Somewhat disagree		Strongly disagree		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Q1	49	53.8%	20	22.0%	3	3.3%	2	2.2%	17	18.7%	91	100.0%
Q2	37	40.7%	36	39.6%	5	5.5%	9	9.9%	4	4.4%	91	100.0%
Q3	34	37.4%	38	41.8%	10	11.0%	6	6.6%	3	3.3%	91	100.0%
Q4	37	40.7%	37	40.7%	13	14.3%	3	3.3%	1	1.1%	91	100.0%
Q5	41	45.1%	23	25.3%	21	23.1%	5	5.5%	1	1.1%	91	100.0%
Q6	25	27.5%	35	38.5%	10	11.0%	12	13.2%	9	9.9%	91	100.0%
Q7	0	0.0%	0	0.0%	23	25.3%	18	19.8%	50	54.9%	91	100.0%
Q8	27	29.7%	43	47.3%	12	13.2%	7	7.7%	2	2.2%	91	100.0%
Q9	67	73.6%	21	23.1%	3	3.3%	0	0.0%	0	0.0%	91	100.0%
Q10	34	37.4%	38	41.8%	9	9.9%	9	9.9%	1	1.1%1	91	100.0%
Q11	5	5.5%	12	13.2%	28	30.8%	30	33.0%	16	7.6%	91	100.0%
Q12	6	6.6%	20	22.0%	3	3.3%	27	29.7%	35	38.5%	91	100.0%
Q13	11	12.1%	29	31.9%	5	5.5%	25	27.5%	21	23.1%	91	100.0%
Q14	48	52.7%	31	34.1%	10	11.0%	1	1.1%	1	1.1%	91	100.0%
Q15	35	38.5%	37	40.7%	11	12.1%	6	6.6%	2	2.2%	91	100.0%
Q16	49	53.8%	20	22.0%	3	3.3%	2	2.2%	17	18.7%	91	100.0%
Q17	37	40.7%	36	39.6%	5	5.5%	9	9.9%	4	4.4%	91	100.0%

c. group = completed FMT UG

Table 4: Combined Responses by Study Group A, B & C

	Strongly Agree		Somewhat agree		Neutral		Somewhat disagree		Strongly disagree		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Q1	149	54.2%	63	22.9%	17	6.2%	16	5.8%	30	10.9%	275	100.0%
Q2	125	45.5%	104	37.8%	29	10.5%	13	4.7%	4	1.5%	275	100.0%
Q3	144	52.4%	92	33.5%	20	7.3%	13	4.7%	6	2.2%	275	100.0%
Q4	97	35.3%	101	36.7%	66	24.0%	7	2.5%	4	1.5%	275	100.0%
Q5	110	40.0%	80	29.1%	68	24.7%	13	4.7%	4	1.5%	275	100.0%
Q6	93	33.8%	129	46.9%	25	9.1%	18	6.5%	10	3.6%	275	100.0%
Q7	13	4.7%	26	9.5%	113	41.1%	42	15.3%	81	29.5%	275	100.0%
Q8	107	38.9%	119	43.3%	27	9.8%	18	6.5%	4	1.5%	275	100.0%
Q9	207	75.3%	52	18.9%	15	5.5%	0	0.0%	1	.4%	275	100.0%
Q10	62	22.5%	109	39.6%	60	21.8%	31	11.3%	13	4.7%	275	100.0%
Q11	15	5.5%	38	13.8%	96	34.9%	93	33.8%	33	12.0%	275	100.0%
Q12	16	5.8%	56	20.4%	8	2.9%	78	28.4%	117	42.5%	275	100.0%
Q13	38	13.8%	82	29.8%	27	9.8%	72	26.2%	56	20.4%	275	100.0%
Q14	127	46.2%	107	38.9%	33	12.0%	4	1.5%	4	1.5%	275	100.0%
Q15	98	35.6%	128	46.5%	32	11.6%	15	5.5%	2	.7%	275	100.0%
Q16	203	73.8%	57	20.7%	14	5.1%	0	0.0%	1	.4%	275	100.0%
Q17	177	64.4%	77	28.0%	9	3.3%	7	2.5%	5	1.8%	275	100.0%

Therefore, in this study a contradiction was found where despite of interest in the subject and finding subject as interesting and its utility most of them would not choose it as their career option in future.

The 82.2% students think that the doctors are best able to apply the knowledge of the subject in medico legal investigations however 62.1% think that there is lack of clinical application of the subject at present and 45.8% think that the present application of the subject in medico legal investigations is inadequate in India but 94.2% believe that the efficient utilisation of the subject can yield high quality medico legal investigations. The 26.2% of students agree that they dislike the subject because it deals with the dead bodies while 43.6% of them are discouraged to choose the subject as their career option because it deals with the legal cases and they are supposed to attend the court cases later on.

The 85.1% students agree that the interest about the subject can be generated among them while 82.1% agree that the students and the general public are less aware about the scope and utility of the subject in medico legal investigations. The 94.5% students agree that a good teaching of the subject can affect their interest in it while 92.4% believe that TV programmes like CID, discovery channel and, movies casting detectives generate the interest about the subject. The 77.46% students found the subject useful as per their responses on the overall rating of the subject (Figure 2).

The mean, standard deviation and P value were calculated for various questions in the survey and P value was found significant for total score in relation to A and C groups and for intrinsic interest in relation to A*C and B*C and for individual items in the survey for Q2 (B*C), Q3(A*C), Q6(A*C,B*C) ,Q7(A*B,A*C,B*C), Q10 (A*C,B*C) and Q12 (A*B) (Table 5, Figure 3).

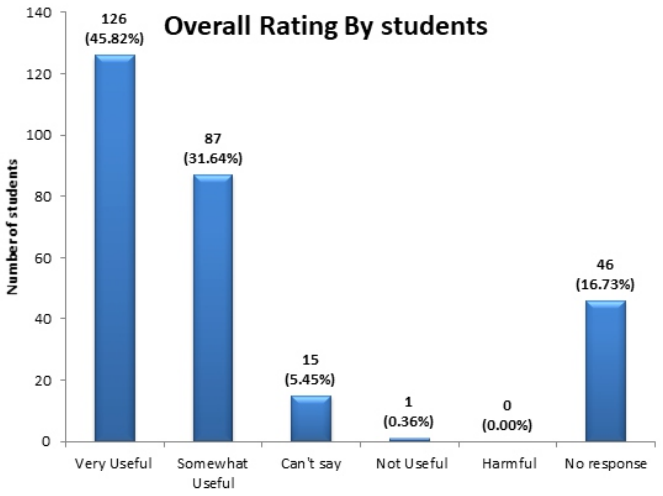


Figure2: Overall Rating of the subject by the students

Table 5: Descriptive statistics of the responses to each of the questions of the study questionnaire

	Group								p-value	Remark
	No FMT exposure (A)		Studying FMT (B)		Completed FMT UG (C)		Total			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Total Score	36.25	6.46	37.92	5.52	40.04	5.88	38.04	6.16	<0.001	A*C
Intrinsic-Interest	1.84	.50	2.03	.54	2.37	.62	2.07	.60	<0.001	A*C, B*C
Q2	1.8	.9	1.6	.6	2.0	1.1	1.8	.9	0.022	B*C
Q3	1.5	.7	1.7	1.0	2.0	1.0	1.7	.9	0.001	A*C
Q6	1.7	.8	1.9	.8	2.4	1.3	2.0	1.0	<0.001	A*C, B*C
Q7	2.9	1.0	3.5	1.1	4.3	.8	3.6	1.1	<0.001	A*B, A*C, B*C
Q16	1.3	.7	1.4	.6	1.2	.5	1.3	.6	0.156	
Extrinsic-Interest	1.60	.60	1.64	.53	1.64	.55	1.63	.56	0.875	
Q1	1.9	1.2	1.9	1.3	2.1	1.5	2.0	1.4	0.507	
Q9	1.4	.7	1.3	.5	1.3	.5	1.3	.6	0.429	
Q14	1.7	.7	1.9	.9	1.6	.8	1.7	.8	0.102	
Q17	1.5	.8	1.5	.7	1.5	.9	1.5	.8	0.849	
Intricacies of the subject	2.41	1.11	2.68	1.07	2.55	1.03	2.55	1.07	0.232	
Q12	1.91	1.17	2.39	1.43	2.29	1.35	2.19	1.33	0.033	A*B
Q13	2.92	1.43	2.98	1.32	2.82	1.41	2.91	1.39	0.759	
Scope of the subject	2.64	.36	2.65	.35	2.75	.36	2.68	.36	0.071	
Q4	2.1	.9	2.0	1.0	1.8	.9	2.0	.9	0.155	
Q5	4.05	1.01	3.91	.94	4.08	1.00	4.01	.99	0.471	
Q8	1.8	.8	1.8	1.0	2.1	1.0	1.9	.9	0.080	
Q10	3.46	1.09	3.42	1.09	4.04	.99	3.64	1.09	<0.001	A*C, B*C
Q11	2.59	1.00	2.86	.98	2.56	1.10	2.67	1.03	0.098	
Q15	1.8	.9	1.9	.7	1.9	1.0	1.9	.9	0.547	

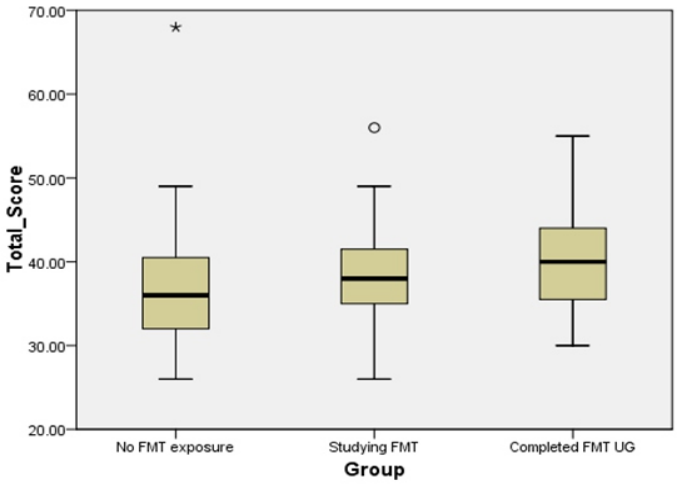


Figure 3: Box and Whisker Plot showing group wise distribution of total score

Discussion

In the present study 83.3 % students found it interesting in contrast to a study in which 43% students found pathology to be the most interesting subject followed by pharmacology (34%), Forensic medicine (17%) and Microbiology as least interesting (6%).[2] In another study conducted on the subject of anatomy, the 54.7% students found the subject as good and 34.6% as interesting while 31.1 % say that they may opt anatomy as a career option[3] in contrast to just 14.2% for Forensic medicine as career option and 80.7% have interest in the subject in the present study and 7.34% students as career option in another study.[4] In another study 68.5%[5] and 45.68%[12] students found the subject of pathology interesting and 40.9% willing to pursue career in it.[5] There is need to know what factors could help in understanding the subject better. In a study for 39.50% agreed that knowledge of Psychiatry helps in understanding Forensic medicine.[6] With regard to community medicine 55.4% students had positive attitude about the course.[7] The preference of the students for future career was found for clinical surgical (50.9%), clinical medical (45.3%), and basic medical (3.9%) sciences and reasons for that were personal interests, good income, intellectual challenge, and others as per a study.[8] Another study presents a positive attitude of students for basic sciences and the students believe that the learning experience for them can be improved significantly by better clinical integration of subjects.[9] 73.27% students said that they would not opt for community medicine as a career it comes to choosing the subject as a career choice the students seem to be reluctant to do so for various reasons such as the pay scale, prestige, fame and status in society.[10] Only 10.93% students were willing to consider pharmacology as one of the subject for post-graduation.[11] The percentage of students that considered pharmacology as a favoured subject and a choice for post-graduate studies was significantly lower ($p < 0.05$) compared with the percentage that did not, although the students that agreed were less than 30% of the total participants.[13] 96.5% of the students agreed that autopsy is necessary in medical education. 32.30% of the students were very uncomfortable on the first exposure to post-mortem examination[14] consistent with finding in present study where 26.2% dislike the subject because of this reason. A high proportion of study subjects considered that autopsy would result in visible disfigurement of the body. Involvement of police/court (92.1%), no use in knowing the cause of death/nature of death (88.6%) and autopsy delays funeral (83.4%) were the three top most causes responsible for autopsy refusal by family members or relatives of the deceased[15] consistent with the finding in present study where 82.1% agree that the students and the general public are less aware about the scope and utility of the subject in medico legal investigations. The predominant motivation for following forensics was the scientific interest (39.7%) and the fear of

death was more intense in students rejecting forensics. Feelings of fear, aversion and grief during the last day of autopsy seemed to be important negative predictors.[16]

Recommendations

1. There is need of a learner-oriented approach for teaching the students so that the needs of the students could be understood better and necessary reframing in the curriculum of the subject could be done.
2. The need-based approach as per the current perspectives, role and scope of the subject in different countries requires a fundamental change of the roles of Forensic experts.
3. More research and innovations are required to create sufficient interest, scope and role of the subject.
4. There is need for starting up of the practice of case-based discussion, Problem based learning and Concept based teaching, Clinical Toxicology and Clinical Forensic Medicine rather than just limiting them to the theory and texts.
5. Bigger role of Forensic specialists in emergency department and in dealing with medico legal aspect of clinical cases.
6. The existing faculty in the field of Forensic Medicine must inculcate and spread the positive aspects about the subject.
7. Extra incentives need to be given to the faculty, may be in form of remuneration per medicolegal case/ autopsy conducted. This might help in attracting good, academically inclined graduates in attracting sufficient size of the good students to achieve the status it truly deserves.
8. There is a need of career counselling and ensuring the students regarding job security and better future perspectives if they pursue the career in this subject.
9. The policymakers are supposed to widen the role of the practioners of this subject's various policies, especially those related with the criminal justice system.
10. The awareness level about the utility of the subject especially in criminal investigations in students and general public must be enhanced so that the associated social stigma about the subject that it deals with dead bodies and court cases could be removed.

Conclusion

With the growing importance of this field due to rise of the sophisticated crimes with modern weaponries by the criminals, its importance as a subject in the undergraduate curriculum should have increased, but in reality the opposite has happened in the recent past where the attempts were made to reduce the weightage of the subject despite of huge shortage of the practitioners in this field. Though the subject is an important and integral part of medical education, has remained a silent spectator to its ups and downs in the recent past. Having had its glory at times, playing pivotal role at places in aiding criminal justice, it has unfortunately failed to sustain the impetus and its importance. This could further strengthen the prevailing views among the mind of students that the Forensic Medicine and Toxicology, as a subject, is not of much importance for medical practice and has less scope and the students will not look to it as their career perspectives. The associated fear and stigma of dealing with dead bodies and court cases in the students have further demotivated the students for not opting it as career option even with the paradoxically high level of interest in the subject and finding the subject as interesting and useful. Therefore there is need to enhance the scope and role of the subject to get sufficient entry of the good students in this field to successfully face the future challenges of lack of sufficient number of forensic specialists and in dealing with the emerging medico legal issues and assisting the criminal justice system in a better way and to award the right stature to the subject as it does deserve. Limitation of the study is that it is based upon the responses expressed by the students of a single institution. Unavailability of comparison data due to lack of similar kind of the studies in the subject is another limitation.

Ethical clearance: A prior approval was obtained from the Institutional Ethics Committee

Conflict of interest: None to declare

Source of funding: None to declare

References

1. Sharma BR, Dasri H, Chavali KH.Teaching, training and practice of forensic medicine in india - an overview. J Indian Acad Forensic Med. 2005; 27 (4).
2. Goyal M, Bansal M, Gupta A, Yadav S. Perceptions and suggestions of 2nd professional MBBS students about their teaching and learning process: An analytical study. Natl J Integr Res Med. 2010; 1(4).
3. Biswas B, Ghosh TK, Chatterjee S. Assessment of Perception of New Entrant MBBS Students about Anatomy as a Medical Subject. Int J Rec Trends Sci Technol. 2014; 10(3), 538-540.
4. Shende S, Malani A, More S. Attitude towards Forensic Medicine as a career option: A Survey amongst Medical Students. Medico-Legal Update .2015; 15(1).
5. Shah AR, Shethwala ND, Parmar BH. Perception of undergraduate medical students towards the subject of pathology at one of the medical colleges of Gujarat, India. Int J Med Sci Public Health.

2014;3(7).

6. Pandey AK, Sapkota N, Nivedita. Medical Student's Perception about the Integrating Methods Of learning Medical Subjects And Importance Of Psychiatry In Pre-Clinical, Para-Clinical And Clinical Learning. J Psych Assoc Nepal. 2014;3(1).
7. Saleh AM. Perception of students about community medicine course in Hawler College of Medicine, Iraq. Zanco J. Med. Sci. 2015;19 (3).
8. Jha RK, Paudel KR, Shah DK, Sah AK, Basnet S, Sah P, Adhikari S. Subject preferences of first- and second-year medical students for their future specialization at Chitwan Medical College and Teaching Hospital, Chitwan, Nepal – a questionnaire-based study. Adv Med Educ Pract. 2015:6.
9. Gupta S, Gupta AK, Verma M, Kaur H, Kaur A, Singh K.The attitudes and perceptions of medical students towards basic science subjects during their clinical years: A cross-sectional survey. Int J Appl Basic Med Res. 2014; 4(1): 16–19.
10. Thakur AB, Upadhyay R, Wavare RR, Deshpande AR. Perception towards community medicine as a subject and career option among medical students in a medical college, indore, Madhya Pradesh. Natl J Community Med. 2016; 7(5).
11. Manjunath SM., Nagesh Raju G., Srinivas TR., Someswara G.M. A study on the evaluation of medical students perception and feedback of teaching-learning of pharmacology in a medical college. Int Arch Integ Med. 2015; 2(9): 102-110.
12. S. S. S. Quadri, Shyamala Srujana, S Mahesh, B. Bheeshma. Undergraduate medical students' feedback and perceptions on teaching learning methodology in Pathology at Government Medical College. Int Arch Integ Med. 2016; 3(7): 28-35.
13. Mahfoudh A.M., Abdulghani Redhwan, Al-Naggar A. Students' perceptions about learning pharmacology at a single private institute in Malaysia. J Taibah Univ Med Sci. 2015;10(1).
14. Jadav JC, Patel BN, Shah KA, Tandon RN. Knowledge and Attitude of Medical Students on Forensic Autopsy in Ahmedabad City. J Indian Acad Forensic Med. 2013;35(1).
15. Rathinam RD, Chopra M, Singh A, Bhardwaj A, Mithra P, Siddique A. Perceptions of relatives toward medico-legal investigation and forensic autopsy: A cross-sectional survey from rural Haryana. J Med Soc. 2013; 27:173-6
16. Papadodima, SA., Sergentanis, TN., Iliakis, RG. et al. Students who wish to specialize in forensic medicine vs. their fellow students: motivations, attitudes and reactions during autopsy practice. Adv Health Sci Educ. 2008;13: 535.

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 199-201
doi:10.5958/0974-0848.2020.00052.4

ORIGINAL ARTICLE

Medico-legal Profile of Hanging Cases in Rural Region of Maharashtra: An Autopsy Based Cross-sectional Study

Vitthal S. Karad, Vishwajeet G. Pawar, Shahshank S. Waghmare, Rajesh V. Kachare
Department of Forensic Medicine, SRTR Govt. Medical College, Ambajogai, Dist. Beed, Maharashtra, India

Abstract
Violent deaths resulting from asphyxia chiefly includes hanging. Hanging may be suicidal, homicidal or accidental in nature. Suicide by hanging is the most common, accidental hanging is less common and homicidal hanging is still less common. A retrospective study was conducted at mortuary of SRTR Government Medical College, Ambajogai, Dist. Beed, Maharashtra, India, between the period 1 January 2018 to 31 December 2018 on all cases of hanging brought for post mortem examination where the cause of death was attributed to hanging. Data was collected with help of police inquest, post-mortem notes and forensic science lab reports. Results were obtained after tabulating and analysing data. Maximum deaths were reported (20 cases i.e. 33.89%) in 21-30 age group followed by (11 cases i.e. 18.64%) 51-60 years age group. The ligature material most commonly used was rope (59.32%). Type of knots was, fixed in 27 (45.76%) cases. The position of knot was mostly cases on posterior aspect of neck in 21 (35.59%). Direction of ligature mark was oblique in 57 (96.61%) cases. Ligature mark was above the level of thyroid cartilage in 52 (88.13%) cases. Dribbling of saliva was present in 25 (42.37%) cases. Peri-ligature subcutaneous haemorrhages were present in 16 (27.11%) cases. Fractured hyoid bone was seen in 1 (01.69%) case only. Type of suspension was complete in 45 (76.27%) cases. Manner of hanging was suicide in 56 (94.91%) cases.

Keywords
Suicide; Asphyxia; Hanging; Medicolegal

Introduction

Asphyxia is defined as lack of oxygen in blood and tissues due to failure of function of lungs, leading to death .Conventionally the term asphyxia is applied to all conditions in which oxygen supply to blood and tissue has been reduced appreciably below the normal working level by any interference with respiration .In death from asphyxia oxygen usually falls below the minimum concentration necessary for continuation of life. [1] Hanging is a form of violent asphyxial death where death occurs due to prevention of entry of air in the lungs resulting from constriction of air passage at the level of neck by suspension of body with the help of ligature around it ,the constricting force being the weight of body as a whole or a part of it. [2]

Medico-legal questions likely to arise in case of hanging are mainly, whether the death was caused by hanging? Whether hanging was suicidal, homicidal or accidental. [3] Suicide by hanging is the most common, accidental hanging is less common and homicidal hanging is still less common. As a rule of thumb hanging is considered as suicidal unless proved otherwise. To arrive at conclusion, detailed external examination, internal examination, pattern of ligature mark over neck and analysis of samples, plays vital role. The present study aims towards analysing medicolegal pattern of hanging cases in this region.

Corresponding Author
Dr. Rajesh V. Kachare (Professor and Head)
E-mail:drkacharerajesh@gmail.com
Contact no. : 9422471377

Article History
Received: 22nd April, 2020; Revision received on: 10th August, 2020
Accepted: 28th August, 2020

Materials and Methods

The present retrospective study consists of hanging cases that were brought for post mortem examination at mortuary of SRTR Government Medical College, Ambajogai, Dist. Beed, Maharashtra, India. The study period was between 1 January 2018 to 31 December 2018. All cases of alleged history of hanging brought for autopsy examination and cause of death attributed to hanging were studied. This retrospective study of autopsies conducted between year 2018 is an attempt to know the medico-legal profile of hanging deaths at tertiary care center of rural region of Maharashtra. During this period there were total 462 post mortem conducted at the Centre, out of which 75 deaths were of asphyxial deaths, out of which 59 cases of hanging were done. After detailed examination of MLC papers, postmortem reports the cases were studied to know the medicolegal profile of hanging deaths with respect to ligature material, type and position of knot, particulars of ligature, external findings, internal findings, type of suspension, manner of death, etc. The medico-legal examination records and inquest papers were analyzed. The observations and analysis of the study is presented here. The data was tabulated according to specific characters and based on observations of tabulated data conclusion was made.

Results

The study was conducted on total 59 cases of alleged history of hanging that were brought to mortuary of SRTR Government Medical College, Ambajogai, Dist. Beed, Maharashtra, India for post mortem examination. The period of study was from 1st January 2018 to 31st December 2018. During this period total numbers of autopsy conducted were 462. The tables are self-explanatory and discussed below in detail.

Table 1: Distribution of study cases according age and sex

Age (years)	Male		Female		Total	
	N	%	N	%	N	%
11-20	5	(11.90%)	4	(23.52%)	9	15.25
21-30	9	(21.42%)	11	(64.70%)	20	33.89
31-40	8	(19.04%)	1	(05.88%)	9	15.25
41-50	6	(14.28%)	0	(00%)	6	10.16
51-60	10	(23.80%)	1	(05.88%)	11	18.64
>60	4	(09.52%)	0	(00%)	4	6.77
Total	42	(100%)	17	(100%)	59	100

Table 2: Type of ligature material used

Ligature material used	N	%
Jute Rope	23	38.98
Nylon rope	12	20.33
Sari	10	16.94
Gamja	6	10.16
Odhani	5	8.47
Shyal	1	1.69
Muffler	1	1.69
Wire	1	1.69

Table 3: External findings on the victims

Finding	N	%
Dribbling of Saliva present in	25	42.37
Cyanosis present in	23	38.98
Other injuries over neck present	4	6.77
Other injuries over body present	19	32.20

In this study, cases were divided in seven age groups. Maximum deaths were reported (20 cases ie. 33.89%) in 21-30 age group followed by (11 cases ie.18.64%) 51-60 years age group. Nine cases were from 11-20 year age group. Males committed suicide a little bit later, between 21 to 60 years. Among 59 cases of hanging, Rope was used as ligature material in 35 cases (59.32%) where Jute rope was used in 23 (38.98%) cases and Nylon rope 12 (20.33%) cases. Smooth & soft ligature material like Sari, Gamja, Odhani etc. in 21 (35.59%) cases. Among 59 cases of hanging, fixed knot was seen in 27 cases (45.76%) and running type of knot was present in 26 cases (44.06%). The position of knot was most commonly present on back of neck in 21(35.59%) cases. Direction of ligature mark was oblique in 57 (96.61%) cases. It was complete in 26 (44.04%), grooved in 42 (71.18%) and continuous in (93.22%). It was above thyroid cartilage in 52 (88.13%) cases.

Table 4: Internal findings of the victims

Findings	N	%
Peri-ligature Subcutaneous hemorrhage	16	27.11
Hemorrhage in salivary gland/muscle/thyroid cartilage	2	3.38
Fracture of Hyoid bone	1	1.69

Discussion

In this study, cases were divided in seven age groups. Maximum deaths were reported (20 cases ie. 33.89%) in 21-30 age group followed by (11 cases ie.18.64%) 51-60 years age group. Nine cases were from 11-20 year age group (Table 1). Similar finding were noted by Sharija et al.[4] She noted male preponderance in that particular age group her study, but overall female preponderance was there in the younger age groups. Males committed suicide a little bit later, between 21 to 60 years. Waghmare et al.[5] also noted that, most commonly affected age group was between 21 to 30 years. Reason for that was productive younger age group are commonly vulnerable. Samantha et al.[6] also mentioned that age range of the victims from 11 – 40 years, where victims were under increased pressures and burdens of life. Reddy et al.[7] states that, asphyxial deaths were more in age group of 21–30 years (34.93%) followed by 11-20 years (20.10%) and 31–40 years (17.80%) respectively. The study conducted at our hospital and author's study at respective place shows co-relation between the age groups affected.

Among 59 cases of hanging, Rope was used as ligature material in 35 cases (59.32%) where Jute rope was used in 23 (38.98%) cases and Nylon rope 12 (20.33%) cases. Smooth & soft ligature material like Sari, Gamja, Odhani etc. in 21 (35.59%) cases. (Table 2) similar findings were mentioned by Waghmare et al[5] & Samhanta et al[6] that it was readily available material nearby for victims. Among 59 cases of hanging, fixed knot was seen in 27 cases (45.76%) and running type of knot was present in 26 cases (44.06%). The position of knot was most commonly

present on back of neck in 21(35.59%) cases . It is a well-accepted fact that the ligature mark of hanging and strangulation are not found at same level. Authors like Modi[3] and Karmakar R N[9] have reported that, hanging mark is situated higher in the neck usually above the laryngeal prominence. Jason et al.[10] have reported that, position of mark of hanging depends on how the device was fixed and the suspension point. Similar findings were mentioned by Sharija et al.[4]

Direction of ligature mark was oblique in 57 (96.61%) cases. It was complete in 26 (44.04%), grooved in 42 (71.18%) and continuous in (93.22%). It was above thyroid cartilage in 52 (88.13%) cases. Similar findings were noted by Reddy KSN.[11] He mentioned that, mark of hanging was situated above the level of thyroid cartilage, between larynx and chin in 80% cases. It may be situated at the level of thyroid cartilage in about 15% cases and below the level of thyroid cartilage in about 5% cases, especially in partial suspension. Momin et al.[12] mentioned that, in all 90 cases (100%) of hanging, direction of the ligature mark was oblique. Sharma et al.[13] noted that, ligature mark was complete in 15 (17%), obliquely placed in 89 (98%) cases. Dribbling of saliva was present in 25 (42.37%) of cases; similar findings were mentioned by Samanta et al.[6], Mohammed Musaib M.[14]

Peri-ligature subcutaneous hemorrhages were present in 27.11% cases, similar findings were observed by Mohammed Musaib M[14] and Kumar et al.[15] Fracture of hyoid bone was present in 1 (1.69%) of case only. Yadav et al.[16] also noted, fracture of hyoid bone in only 1.6% cases (3 out of 186 cases). Feigin[17] also found fracture of hyoid bone only in 3.2% cases. Type of suspension was complete in 76.27% cases. However, Waghmare et al.[5] found that, in almost all 60 (100%) cases, type of suspension was complete. Manner of hanging was suicide in 94.91%, accidental hanging in 1 (01.69%) case. In 56 cases of hanging, on the basis of circumstances of death and post-mortem findings the manner of death was suicidal. In our study, a case of accidental ligature hanging was observed, where victim caught in Thresher agricultural machine, similar case of accidental hanging was observed by Zine et al.[18]

Conclusion

The number of suicidal hanging cases is increasing day by day. Male predominance in the age group was maximum in 21-30 years of age. Easily available ligature material like rope and smooth and soft ligature material like sari, gamja, odhani was used for hanging. Hanging was always suicidal unless proved otherwise. Hanging was diagnosed mostly by particulars of ligature mark. Dribbling of saliva was sure sign of death by hanging but it is not always present. Thorough internal examination of neck, layer by layer is must in all cases of hanging to arrive at correct diagnosis, especially in doubtful cases. However to conclude, study was carried out at rural population and period of study duration was only one year, attempt was made to include all possible factors for confirmation of death due to hanging. More studies related to hanging in large group population and duration is required as well as false histories by relatives and many loop holes for confirmation of diagnosis can be solved if possible crime scenes were organised in doubtful cases.

Ethical clearance: A prior approval was obtained from the Institutional Ethics Committee

Conflict of interest: None to declare

Source of funding: None to declare

References

1. Nageshkumar G Rao. Textbook of Forensic Medicine and Toxicology. Jaypee Publications, New delhi. 2000. 157.
2. R.N.Karmakar. Forensic Medicine and Toxicology, 5 th edition,Academic Publishers,181,184.
3. Modi. A Textbook of Medical Jurisprudence and Toxicology. 25th edition. LexisNexis, 2016:494-498.
4. Mohammed Musaib M. A Study of Gross Postmortem Findings in Cases of Hanging and ligature strangulation, JIAFM Jan-March 2013; 35(1): 63-65.
5. Sadikhusen G.Momin, Hari Mohan Mangal. Pattern of Ligature Mark in cases of Compressed Neck in Rajkot Region:A prospective Study. JIAFM Jan-March 2012; 34(1): 40-43.
6. B.R.Sharma, D. Harish, Virendra Pal Singh. Ligature Mark On Neck:How Informative?. JIAFM 27(1),ISSN 0971-0973. 2005: 10-15.
7. Abhisek Yadav,Manish Kumath,Sumit Tellewar. Study Of Fracture Of Hyoid Bone in Hanging Cases. JIAFM,2014; 35(3): 239-241.
8. Samanta A.K, Nayak. S.R. Newer trends in hanging death. Journal of Indian Academy of Forensic Medicine. 2012; 34 (1): 37 – 39.
9. Reddy KSN. The Essential of Forensic Medicine & Toxicology, Published by K. Suguna Devi, Hyderabad, (2000) 19th ed. 283-295.
10. Jason PJ, Anthony B, William S. Forensic Medicine-Clinical and Pathological Aspects, Greenwich Medical Media Ltd, London, 2003; 1st ed.266-269.
11. Zine K. U., Tandle R. M., Varma N. M., Jambure M. P. Accidental Ligature Strangulation with Avulsion of Scalp. Journal Indian Academy Forensic Medicine. July-Sept 2011; 33(3):267 – 268.
12. Feigin G. Frequency of neck organ fractures in hanging. Am J. of For Med & Path. 1999; 20(2):128-130.
13. Pradeep Kumar G., Manoj Kumar M, Shanavaz B. “Rope Burns: A feature of Antemortem Hanging”. Journal of Karnataka Medico-legal Society, 2002; 11 (2): 25-26.
14. Waghmare P B, Chikhalkar BG, Nanandkar S D. Analysis of asphyxial deaths due to hanging JIAFM ,2014: 36(4); 343-45
15. Sharija S, Sreekumari K, Geetha O. Epidemiological profile of suicide by hanging in southern parts of Kerala. An autopsy based study. JIAFM, 2011; 33(3): 237-40.
16. Reddy S, Kumar R, Rudramurthy. Asphyxial deaths at district hospital, Tumkur, A retrospective study. JIAFM (2012); 34(2):146-47.

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 202-206
doi:10.5958/0974-0848.2020.00053.6

ORIGINAL ARTICLE

Autopsy audit of fatal suicidal burns: A retrospective study in South India

Siddhartha Das[1], Vinod Ashok Chaudhari[1], Swaroop Kumar Sahu[2], Gerard Pradeep Devnath[1], Ankit Chandra[3]
1 Department of Forensic Medicine and Toxicology, Jawaharlal Institute of Postgraduate Medical Education & Research, Pondicherry, India
2 Department of Preventive & Social Medicine, Jawaharlal Institute of Postgraduate Medical Education & Research, Pondicherry, India
3 Center for Community Medicine, All India Institute of Medical Sciences, New Delhi, India

Abstract
Suicide is an important cause of death globally. Burns is the commonly employed method for Suicidal deaths. Burns is common in Asian countries and India had the maximum cases of suicidal burns with the highest fatality rate. In the South India particularly Tamil Nadu and Pondicherry had high rate of suicides. India has the highest hospital admission of cases due to suicidal burns. Autopsy based study will help to collect important data on deaths due to suicidal burns. This study mainly focuses on various aspects of fatal suicidal burns, reasons for committing suicide by burns and socio-demographic factors associated with it. It is a record based retrospective study of fatal suicidal burns from January 2010 to December 2014 in a tertiary hospital in South India. We reviewed 3996 medicolegal autopsy case records and analyzed 459 fatal suicidal burns. Deidentified data were collected in anonymous data proforma. A total of 459 (38%) fatal suicidal burns were studied out of 1205 fatal suicides. The majority of victims were females (67.9%) as compared to males (32.1%). the mean age was 29.9 years (female – 27.9years, male – 34.2years). Common age group was 21-30 years (n=221, 48.14%). Family problems (n=185, 40.3%) and financial problems (n=32, 6.9%) were the main reason for suicide among both sexes and most of the victims were married. The victims were from rural locality (n=364, 79.3%) and kerosene (n=436, 94.98%) was the commonly used accelerant. The common time of the incident of burns was 12.00 to 06.00 pm (n=155, 33.7%). Three hundred ninety-eight cases (86.71%) had above 50% of burn TBSA with a median survival period of 184 hours. Most of the victims were female, from the rural areas, family problems were the common reason for fatal suicidal burns. Median burn TBSA was also higher. Data generated will be helpful for planning awareness and interventional programs to prevent suicidal burns.

Keywords
Suicide; Burns; Self-immolation; Total body surface area; Reason for suicide

Introduction

Every 40th second one person is dying of suicide. About eight lakh people die every year due to suicide. Globally, suicide comprises the second prominent cause of death among the 15-29-year age group. Low- and middle-income countries (LMIC) encompass 78% of suicides observed in 2015 and death due to suicide is 1.4% of all deaths worldwide.[1] Self-harm accounts for 5.4% of all deaths and it is 10th most common cause of death.[2] As per the National crime record bureau of India rate of suicide in India is 10.2 and a total number of suicides is 1,34,516 in year 2018.[3] Death due to burns is a significant public health problem. Suicidal death by burn is common in Asian countries as compared to Western countries.[4] Annually 265,000 fire-related deaths occur globally. Half of the death occurs in the WHO South-East Asia Region. Among 70 lakh burn injuries in India, 1.4 lakh people died, and 2.4 lakh people had a disability. Similar rates observed for burns in females and males compared to other injury patterns which were higher in males than females. Burns are the fifth most common cause of non-fatal injuries among children of 1-9 years. Infants have maximum death rates from burns compared to other age groups. Burns cause disability, disfigurements, and emotional trauma.[5] Eleven million people required treatment for burns in 2004. Burns is the fourth common cause of all injuries. Three lakh people die every year in the World due to burns and fires. About 90% burns deaths observed in low- and middle-income countries and they lack preventive programs and quality of treatment.[6]

In India, high burns rate observed in young women; while in Europe, men in the mid-aged groups are more affected. Suicidal burns had 65% mortality rate worldwide.[7] In 1998, India was burns was classified among the 15 leading causes of death. High mortality in young married women from burns has already become an alarming and contentious medical problem in rural India.[8] The epidemiology, causes, and intervention strategies are different in higher- and lower-income countries.[9] Laloë studied fifty-five studies of deliberate self-harm (DSB) and found maximum cases of suicidal burns with the highest fatality rate in India. India has the highest admission to the hospital due to suicidal burns.[10] Worldwide, admissions to burn centers was due to self-immolation (0.4% to 40%).[11]

As per the National crime record bureau of India, burns were the third most common method of suicide and the rate of fatal suicidal burns was 5.3% in 2018. In Tamil Nadu and

Corresponding Author
Dr. Vinod Ashok Chaudhari (Associate Professor)
Email: drvinodchaudhari@gmail.com
Mobile: +918940483914

Article History
Received: 13th March, 2020; Revision received on: 29th July, 2020
Accepted: 1st August, 2020

Pondicherry, the rate of suicide is 18.4 and 33.8, respectively; and also, being the highest among the other states.[3] To plan an intervention to prevent suicidal deaths, it is vital to know the common reasons for suicide and the socio-demographic profiles of the cases. In India, very few autopsy-based studies have reported the reasons and profile of fatal suicidal burns. Therefore, we undertook this study to known the relative reasons for committing fatal suicidal burns and the socio-demographic profile of these cases.

Materials and Methods

The present investigation was a record based retrospective study. It was conducted in a tertiary hospital (located in Pondicherry), After taking clearance from the Ethical committee and Medical Superintendent, we extracted the autopsy records from the Department of Forensic Medicine, JIPMER conducted between January 2010 to December 2014. We screened 3996 medicolegal autopsy case records and found 459 cases of fatal suicidal burns. Data was extracted under the following variables – age, gender, marital status, occupation, residence, the reason of suicide, time of injury, time of death, and burn total body surface area (TBSA). Two authors independently entered the data in the data extraction sheet and any discrepancy was resolved through consensus.

Data analysis: Data was entered in MS Excel and analysis was done in STATA 13.0. Descriptive analysis was for a sociodemographic profile, the reason of suicide**.** We reported median survival time (hours) according various subgroups of TBSA of burns. We plotted the Kaplan Meier graph using the time from injury to time of death. A Log-rank test was performed to find any statistical difference in the median survival time in various subgroups of TBSA of burns.

Results

A total of 459 (38%) fatal suicidal burns were studied out of 1205 fatal suicides over 5 years. We found a reduction in cases of fatal suicidal burns in 2014 compared to 2010 (Figure 1). These 459 cases (11.48%) were out of 3996 medicolegal autopsies during the study period. Out of 459 cases, the majority were females (n=312, 67.9%) and were from the age group of 21-30 years (48.1%, n=221). Female cases in the age group 21-30 years were 2.6 times compared to males (Table 1). The mean age was 29.9 years (female 27.9 years, male 34.2years). Most of the cases were from rural areas (n=364, 79.3%), compared to urban area (n=50, 10.89%) and semi-urban area (n=45, 9.8%). In our study**,** married cases (n=345, 75.16%) were more than unmarried cases (n=112, 24.40%). The most common accelerant was kerosene (n=436, 94.98%) followed by petrol (n=10, 2.17%) and in 13 cases accelerant was not known.

The most common reason for suicide was a family problem among both the sex. The second common reason for suicide in females was harassment for dowry and domestic violence. In male, the second common reason for suicide was a financial problem (Table 2). We couldn't ascertain the reason for suicide in 6.1% of cases. In our study, most of the cases (n=384, 83.66%) were booked under 174 Criminal Procedure Code (CrPC); 75 cases (16.3%) were booked under 174 (3) (CrPC) and 498 (A) Indian Penal Code (IPC).

Common occupation of the cases was housewife (36.1%) followed by labourers (16.3%) (Table 3). The common time of incident of burns was 12.00 pm to 06.00 pm (33.76 %) (Table 4). The place of incident of burns was inside the house (n=453, 98.69) and outside the house (n=6, 1.30%). Three hundred ninety-eight cases (86.71%) were above 50% of burns TBSA. The median survival time in hours (n=459) was 184 hrs (IQR 84 – 278) and the median TBSA percentage of burn (n=459) was 85% (IQR 65 – 95). There was no significant difference between the median survival time among various groups of percentage of burns TBSA (p-value – 0.496) (Table 5 & Figure 2).

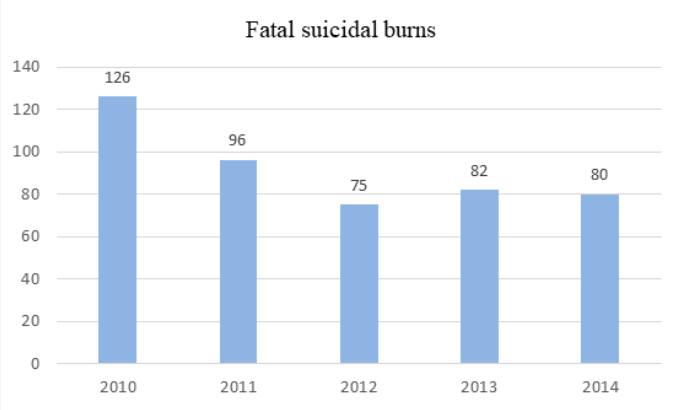


Figure 1: Number of cases of fatal suicidal burns from 2010 to 2014.

Table 1: Age and sex wise distribution of fatal suicidal burn cases

Age group (years)	Male cases	Female cases	Total cases (%)
11-20	13	69	82 (17.86%)
21-30	61	160	221 (48.14%)
31-40	35	53	88 (19.17%)
41-50	24	21	45 (9.80%)
51-60	12	7	19 (4.13%)
>60	2	2	4 (0.87%)
Total	147	312	459 (100%)

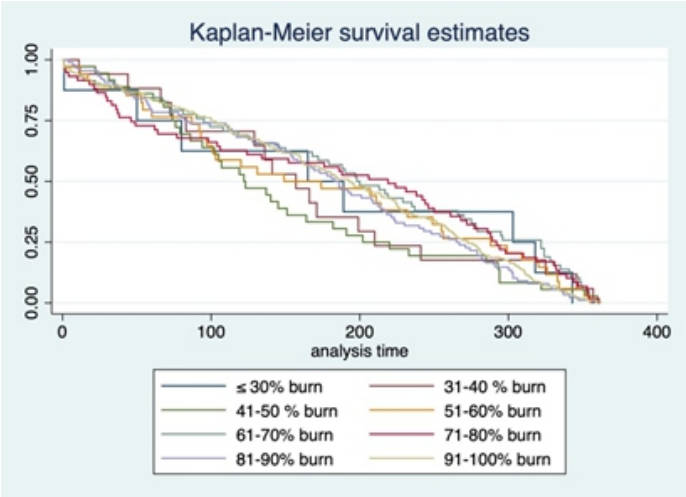


Figure 2: Kaplan Meier graph showing survival estimates for various percentages of burns TBSA

Table 2: Distribution of reason for suicide

Reason for suicide	Males	Females	Total
Family problems	56	129	185(40.3%)
Harassment for dowry and domestic violence	0	61	61 (13.2%)
Chronic illness	23	35	58 (12.6%)
Psychiatric illness	23	30	53 (11.5%)
Financial problem	28	4	32 (6.9%)
Academic failure	3	24	27 (5.8%)
Not documented	12	16	28 (6.1%)
Romantic failure	2	13	15 (3.2%)
Total	147	312	459 (100%)

Table 3: Distribution of cases as per occupation

Occupation	No. of cases (%)
Skilled worker	19 (4.1%)
Agriculture workers	58 (12.6%)
Labourers	75 (16.3%)
Housewife	166 (36.1%)
Unemployed	45 (9.8%)
Fisherman	16 (3.4%)
Professional	12 (2.6%)
Student	67 (14.5%)
Other	1 (0.2%)
Total	459 (100%)

Table 4: Time of incidence of burns

Time of incidence	No. of cases (%)
12.00 am to 06.00 am	47 (10.2%)
06.00 am to 12.00 pm	115 (25%)
12.00 pm to 06.00 pm	155 (33.7%)
06.00 pm to 12.00 am	142 (30.9%)
Total	459 (100%)

Table 5: Burns total body surface area (TBSA) and median survival time in hours

TBSA	Number (%)	Median survival time (in hours)
≤ 30	8 (1.74%)	165
31 -40	17 (3.7%)	157
41 -50	36 (7.84%)	122
51 -60	34 (7.4%)	149
61 -70	58 (12.63%)	198
71 -80	59 (12.85%)	219
81 -90	88 (19.17%)	183
91 -100	159 (34.64%)	193

Discussion

Batra (Central India) observed 942 deaths (23.3%) were due to burns; and the mortality rate of 15.1 per year per 100,000 population.[8] Ambade et al. (Central India) studied that death due to burns accounted for 21.6% out of the total medicolegal deaths. Accidental death (75%) due to burns was common than suicidal and homicidal burns.[12] Bain et al. (Central India) common manner of burns was accident (93.3%) followed by suicide (5.8%) and homicide (0.9%).[13] In Iran the incidence of suicidal burns was 6.51 and 2.32/100,000 person-years for two provinces.[14] The study of Singh et al. (North India) showed that accidental burns were seen in 80% cases, suicidal burns (16.2%) and homicidal burns (4.1%).[15] Kumar et al. (South India) studied 94.1% victim of the flame burns followed by scalds (2.8%) and electrical burns (2.5%). They observed 11.5% of suicidal burns deaths.[16] Rao et al. (South India) studied 70% suicidal, 25% accidental, 3% homicidal and 2% non-classifiable cases of burns.[17] Laloe et al. (Sri Lanka) studied self-immolation admission cases were mostly Tamils followed by Muslims.[18] Ahmadi et al. (Iran) revealed that 27% of suicide cases were due to self-immolation.[19] In our study 459 (38%) fatal suicidal burns were out of 1205 suicide during the study period.

In higher-income countries, self-immolation is uncommon and the majority cases are male. In lower-income countries, self-

immolation is higher, and the majority of cases are female.[9] Laloë observed that suicidal burn cases were grossly 10 years older in Europe than in Asia. In western countries male victims are generally higher, and Middle East and the Indian sub-continent female victims are more.[10] Batra revealed that most of the victims (71.9%) belonged to a young age (21-40 years). Young married women from rural India had high mortality due to burns and 80.8 % were females out of all burn deaths.[8] Burns fatality was commonly seen in females (74.2%) and the male-female ratio was 1:2.9. Most of the victims were between 11-40 years with a peak at 21-30 years (47.1%).[12] Female (66.8%) outnumbered male (38.2%) out of all burn patients and the median age of patients was 25 years.[13] Self-inflicted burns were commonly seen female.[14] Singh et al. observed death due to burns in the age group 21-40 years (67 %). Female victims (61%) were more common in all age groups except in the extreme age groups. The mean age of subjects was 26.8 years and 67% were young (21-40 years). The most of females (99%) and males (76%) died due to flame burns.[15]

Kumar et al. observed that the majority of deaths (78.5%) were seen in 11-40 years and more common in females (74.8%).[16] In our study, 82.5% cases were seen in age groups 11-40. Laloe et al. observed maximum victims were females (79%) and 72% were in the age-group of 15–34 years.[18] Ahmadi et al. showed that the mean age of self-immolation cases was 29 years. Out of all cases, female accounted 71%.[19] Castana et al. studied that the mean age of the patients was 58 years.[20] Kumar et al. revealed female predominance was seen in suicidal burns and peak age were 30-39 years.[21] Shkrum et al. observed male to female ratio of victims was 26:6 and the mean age was 38 years.[22] Wagle et al. observed the majority of cases were below 35 years, unemployed. Females were more than males in suicidal burns and accidental burns.[23] Sukhai et al. observed the mean age of self-immolators was 31.2 years (range 16–76, SD 11.7).[24] In our study, the most common age group was 21-30 years and it was similar to other studies.[8,15,16,18,19] Female also outnumbered male in our study and it was concordance with other studies.[8-10,12,13,15,16,18,19,21,23]

Females were associated with a higher risk of open fire cooking, unsafe cookstoves, loose clothing. Self-directed or interpersonal violence are the major factor in burns. Adult females and children were vulnerable to burns.[5] As per Peck, the most common causes of suicidal burns were the domestic problems, family disputes, and unemployment.[7] However family problems and financial problems were the leading cause in or study. The study of Batra[8] showed that the common reason for suicidal burns in married women was torture by in-laws (32.1%) however only 13.2% of cases of deaths due to dowry harassments and domestic violence were reported in our study. Our study was conducted in the Southern part of India where dowry harassments and domestic violence were less as compared to the Northern part of India.

Common psychiatric disorder was depression followed by bipolar disorder and alcohol abuse.[20] In other study, self-immolation was more commonly seen with a mental illness or substance abuse in higher-income countries.[9] Laloë identified three groups of victims as psychiatric patients seen in Western and Middle-Eastern countries. The second group committing DSB for personal reasons observed in India, Sri Lanka, Papua-New Guinea, and Zimbabwe. Third group committing DSB for politically motivated seen in India and South Korea.[10] Common co-morbidities of suicidal behaviours were depression and anxiety disorders. Patients with self-immolation suffered significantly larger burns.[21] Half suicidal cases had the psychiatric illness and the reason behind choosing the self-immolation method was uncertain.[22] Rao et al. studied that reason for suicide was psychiatric disorders (23%), physical illness (15%), and marital and interpersonal problems (51%).[17] Most of the patients with suicidal intent were part of a joint family. They had tense life events and also, they suffered larger burns as compared accidental burns.[23] But in our study psychiatric illness was the fourth common reason for suicide.

Most of the victims had marital problems.[18] Ahmadi et al. observed that risk factor for the self-immolation was unemployment.[19] Academic failures were the third leading cause of death in females which was a new finding in our study that was not reflected by previous investigators. In our study, we highlighted relevant sections of the law, but there were no other studies that highlight relevant sections of law.

Most of the victims were married (82.4%).[8] In another study, 45% of victims were single/divorced and 55% were unemployed (55%).[20] Married (79.9%) outnumbered unmarried ones in burning. Kerosene was the main causative factor for burns.[12] Kerosene was the most common accelerant (76%) used in burns.[15] Kerosene was used more (94.98%) in our study because of easy availability through public distribution system for cooking. Castana et al. observed that 8 victims set fire their clothing and 4 victims used a liquid accelerant on their clothes.[20] Flame (80.1%) was the most common cause, traditional Indian stove (28.8%), kerosene lamp (26.7%), hot liquid (12.2%) and kerosene stove (10.4%) were common causes.[13]

Most of the burn cases (62%) were urban areas.[15] In another study, 75.0% of the victims were from rural areas.[8] Study in Iran showed that the self-immolation rate was higher in the rural areas.[19] Most of the burn patients (71.3%) were from rural areas.[13] The commonplace of burns was the kitchen (69.3%) and sari was the commonest vehicle of burns.[12] Study of Bain et al. showed that home (96%) was the most the commonplace of burns and kitchen (54.8%) was the most among these cases.[13] In our study more cases were reported from rural area and place of incidence was the house. In female peak incidence of burns was observed from 5.01 a.m. to 11 a.m. (38%), and during the same time period least incidence was observed for males. In male

peak incidence, 10.3% was seen from 11.01 p.m. and 5 a.m.[15] In our study the time of incidence was 12.00 pm to 6.00 pm and its reason could be staying alone in the home when the rest of the family members were outside the home for work.

Deaths due to burns commonly seen within one week (77%) of the incident and septicemia were the common cause of death (55%).[15] The average burn TBSA was 40.4% (range, 5-91%).[20] Singh et al. observed that 88% of patients had burn injury above 50%. The majority of the patient (77%) died within one week of burns and out of that 15% died within 12 hours.[15] In 92.5% cases burn TBSA was above 40%. The majority of deaths occurred within a week (69.87%) and most of the victims died because of septicemia (50.9%). The median burn TBSA was 48% and the upper part of the body mainly affected.[18] TBSA burns ranged from 1% to 100% and the median TBSA was 40.0%.[13] As per Sukhai et al., the mean burn surface area was 63.3% (range 15–96, SD 21.0).[24] In our study, the median survival period is 184 hours and the median above 50% burn TBSA was 85%. Median TBSA of burns was similar to previous studies.[15,18]

Conclusion

In our study, fatal suicidal burns were commonly observed among the age group of 21-30 years, female, married, housewives and in rural areas. Family problem was the most common reason for fatal suicidal burns. Academic failure was a new reason for suicide among females. Time of incident was commonly seen from 12.00 pm to 06.00 pm and kerosene was the most common accelerant used. The median burn TBSA was 85% and the median survival time was 184 hrs. There was no significant difference between the median survival time among the subgroups of TBSA of burns. The findings from this study can be useful in planning awareness and intervention to prevent fatal suicidal burns.

Ethical clearance: A prior approval was obtained from the Institutional Ethics Committee

Conflict of interest: None to declare

Source of funding: None to declare

References

1. Suicide data. World health organization. Accessed on 01.08.18. Available at: http://www.who.int/mental_health/prevention/suicide/suicideprevent/en/
2. Causes of premature death compare to those in other locations. The Institute for Health Metrics and Evaluation (IHME). Accessed on 01.08.18. Available at: http://www.healthdata.org/india
3. Suicide in India. National Crime Record Bureau, Ministry of Home Affairs. Accessed 05 March 2020. Available from: http://ncrb.gov.in/StatPublications/ADSI/ADSI2018/chapter-2%20suicides.pdf
4. Mohanty MK, Arun M, Monteiro FN, Palimar V. Self-inflicted burns fatalities in Manipal, India. Med Sci Law. 2005 ;45(1):27-30.
5. Burns. National health portal of India. Accessed on 03.08.18. Available at: https://www.nhp.gov.in/disease/skin/burns
6. Peck MD. Epidemiology of burns throughout the world. Part I: Distribution and risk factors. Burns. 2011;37(7):1087-100.
7. Peck MD. Epidemiology of burns throughout the World. Part II: intentional burns in adults. Burns. 2012;38(5):630-7.
8. Batra AK. Burn mortality: recent trends and sociocultural determinants in rural India. Burns. 2003;29(3):270-5.
9. Poeschla B, Combs H, Livingstone S, Romm S, Klein MB. Self-immolation: socioeconomic, cultural and psychiatric patterns. Burns. 2011;37(6):1049-57.
10. Laloë V. Patterns of deliberate self-burning in various parts of the world: A review. Burns. 2004;30(3):207-15.
11. Ahmadi A, Ytterstad B. Prevention of self-immolation by community-based intervention. Burns. 2007;33(8):1032-40.
12. Ambade VN, Godbole HV. Study of burn deaths in Nagpur, Central India. Burns. 2006;32(7):902-8.
13. Bain J, Lal S, Baghel VS, Yedalwar V, Gupta R, Singh AK. Decadorial of a burn center in Central India. J Nat Sc Biol Med. 2014;5(1):116.
14. Saadat M, Zendeh-Boodi Z. Correlation between incidences of self-inflicted burns and means of inbreeding coefficients, an ecologic study. Ann Epidemiol. 2006;16(9):708-11.
15. Singh D, Singh A, Sharma AK, Sodhi L. Burn mortality in Chandigarh zone: 25 years autopsy experience from a tertiary care hospital of India. Burns. 1998;24(2):150-6.
16. Kumar V, Mohanty MK, Kanth S. Fatal burns in Manipal area: a 10 year study. J Forensic Leg Med. 2007;14(1):3-6.
17. Rao AV, Mahendran N, Gopalakrishnan C, Reddy TK, Prabhakar ER, Swaminathnan R, Belinda C, Andal G, Baskaran S, Prahee R, Kumar N. One hundred female burns cases: A study in suicidology. Indian J Psychiatry. 1989;31(1):43-50.
18. Laloe V, Ganesan M. Self-immolation a common suicidal behaviour in eastern Sri Lanka. Burns. 2002;28(5):475-80.
19. Ahmadi A, Mohammadi R, Stavrinos D, Almasi A, Schwebel DC. Self-immolation in Iran. J Burn Care Res. 2008;29(3):451-60.
20. Castana O, Kourakos P, Moutafidis M, Stampolidis N, Triantafyllou V, Pallantzas A, Filippa E, Alexandropoulos C. Outcomes of patients who commit suicide by burning. Ann Burns Fire Disasters. 2013;26(1):36-39.
21. Kumar S, Verma AK, Singh US, Singh R. Autopsy audit of intentional burns inflicted by self or by others in north India-5 year snapshot. J Forensic Leg Med. 2015;35:29-32.
22. Shkrum MJ, Johnston KA. Fire and suicide: a three-year study of self-immolation deaths. J Forensic Sci. 1992;37(1):208-21.
23. Wagle SA, Wagle AC, Apte JS. Patients with suicidal burns and accidental burns: a comparative study of socio-demographic profile in India. Burns. 1999;25(2):158-61.
24. Sukhai A, Harris C, Moorad RG, Dada MA. Suicide by self-immolation in Durban, South Africa: a five-year retrospective review. Am J Forensic Med Pathol. 2002;23(3):295-8.

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 207-210
doi:10.5958/0974-0848.2020.00054.8

ORIGINAL ARTICLE

Retrospective Analysis of Pattern of Injuries in Medicolegal Cases

Kishor Kumar Badiadka[1], K Leena Pramod[1], Hashim Achummantakath[1], AG Balakrishna[2]
1 Department of Forensic Medicine and Toxicology, Yenepoya Medical College, Yenepoya (Deemed to be University), Mangaluru, Karnataka, India
2 Department of Community Medicine, Yenepoya Medical College, Yenepoya (Deemed to be University), Mangaluru, Karnataka, India

Abstract
The present research aims to highlight the pattern of different types of injuries sustained by the victims of medico legal cases visiting a tertiary care hospital in Deralakatte, Mangalore, South India. The data was obtained from accident cum wound register maintained in the casualty for medico legal cases during 2012 – 2017. Total 2426 cases were analysed. The pattern of injuries sustained were categorised under road traffic accidents, assault, fall, thermal & workplace injuries. Abrasion was the most common type of injuries noted in road traffic accidents accounting for most of the injury related deaths (77%) during the study period. .

Keywords
Medicolegal case; Abrasion; Contusion; Laceration

Introduction

Injury is the destruction or damage to tissues by external force or violence, to the body and mind. Medicolegal cases like road traffic accident, assault, fall, working with industrial machine, animal attack, moist and dry heat results in physical injury. The usually observed injuries are abrasion, contusion, laceration, incision, fracture, burns and scalds. Depending upon the type of external force the pattern of injuries is different with or without external visible sign or even fatal internal injury.

The pattern of injuries is dependent on the height, weight, velocity, surface of contact, alignment and position of body at the time of impact. The elasticity and viscosity of tissue is also one of the major determining factors. The severity of injuries is dependent on the kinetic energy transferred to the body of the person at the time of impact.[1] The victims of medico legal cases usually report to the hospital for the treatment of injury. All the cases with external visible injuries are considered as medico legal cases unless otherwise proved beyond reasonable doubt and needs to be registered in the accident cum wound register or medico legal register and should be informed to the investigating authorities.

The pattern or distribution of these injuries may be helpful for investigation of case and even for prevention of mortality and morbidity. The review of literature showed various studies on medico legal cases describing the demographic profile, pattern, and its analyses.[2-5] Very few studies describe the pattern of injuries either region wise (head, neck, thorax, limbs etc.) or based on organ (liver, brain, heart, lungs etc.).[6] Previous studies dealing with medico legal cases have not given importance to detail description of pattern of injuries.[7] This study was conducted as there is a need to describe the pattern of injuries sustained externally by the victim as abrasion, contusion, laceration, incision, and fracture in different types of medico legal cases.

Corresponding Author
Dr. K. Leena Pramod (Assistant Professor)
Email: leens.pr73@gmail.com
Mobile: +91-9844550574

Article History
Received: 21st January, 2020; Revision received on: 22nd July, 2020
Accepted: 1st August, 2020

Material and Methods

The present study was carried out after getting ethical clearance from Institutional ethics committee in a tertiary care hospital in Deralakatte, Mangalore, situated in Dakshina Kannada district of coastal Karnataka, in South India. The present research is a retrospective analysis of the medico legal cases for a period of 5 years from April 2012 to March 2017. All the medico legal cases were included in the study. Medico legal cases such as Road traffic accident (two, three, &four wheeler, tractor, bicycle, pedestrian hit by vehicle) train accident. Fall in house, work place and while walking or running, animal attack, injury due to fire (dry heat or moist heat), assault in public or domestic. Toxicological case or poison cases (Pharmaceuticals, chemical and biological poisons) were not included in the present study. Data related to Unconscious or dead was excluded. A detailed injury profile was made after coding the data collected from medico legal register maintaining the confidentiality of patient. This was followed by analyses using SPSS 23 Version.

Results

Based on the nature and manner of force a total of 2426 medico-legal cases were studied and on the basis of their similarity and occurrence divided under 9 different categories with analyses of injuries as shown in Table 1. The road accidents were divided into 7 categories as shown in Table 2.

The mechanical Injuries from road accident (n=1682) showed highest percentage of Abrasion followed by laceration. Most of the injuries were noted in the two-wheeler accident (n=1127).

The most common injuries in two-wheeler accidents were abrasions (n=659) and lacerations (n=468). The pedestrian was the second most affected category in this study (n=293) with the most common injury being abrasions (103) and lacerations (87).

The frequency distribution of assault cases is shown in Table 3. Among all the assault cases, 3 cases were sexual assaults, while the others were physical assaults (N=288). Physical assaults were sub-divided as public assault (N=221) and domestic assaults (N=67) along with a single case of ragging. Injuries were noted in 194 cases out of the total 292 assault cases. Injuries are more in number when compared to the number of cases as multiple injuries have been reported in single case of MLC. More than 50% of the public assault cases reported without any injuries. The pattern of injuries observed in assault cases are shown in Table 4. Public assault cases showed laceration followed by abrasion and contusion while domestic assault cases showed contusion as most noted injury. The injury pattern showed increase cases of Laceration in comparison to Abrasion & contusion. Under the influence of alcohol four cases each were reported under public & domestic assault.

Fracture followed by Lacerated wound was the main injury seen in cases of fall (Table 5). Thermal injury showed 76.8% burns followed by 13.5% of scalds (Table 6). Lacerated wound was the most common work place injury (Table 7). Medico legal cases also included cases of Train accident (0.32%), water accident (0.4%), deliberate self-harm (0.86%) and animal attack (0.20%).

Table 1: Injury pattern in Medico-Legal cases

Incident	Total	Percentage	Abrasion	Contusion	Laceration	Incision
Road accident	1682	69.3	901	290	702	8
Fall from height	280	11.5	73	52	98	1
Train accident	8	0.3	3	2	5	0
Water Accident	9	0.4	1	1	0	0
Thermal Injuries	82	3.4	1	1	6	0
Assault	292	12.09	74	58	82	7
Deliberate self-harm	21	0.86	1	0	2	9
Animal attack	5	0.20	1	0	2	0
Workplace injury	47	1.93	5	1	41	2
Total	2426	100	1059	405	938	27

Table 2: Types of injuries in road accident cases

Type	Total	Percentage	Abrasion	Contusion	Laceration	Fracture	Incision	Regional Injuries
Two-wheeler	1127	68	659	188	468	346	5	124
Four-wheeler	191	11	75	41	78	57	1	23
Three-wheeler	139	8	59	23	60	47	1	8
Pedestrian hit	206	12	103	35	87	67	1	41
Bicycle	9	0.5	3	1	5	4	0	5
Tractor	10	0.5	2	2	4	0	8	1
Total	1682	100	901	290	702	521	16	202

Table 3: Frequency distribution of assault cases

Type of assault	Total No. of cases (percentage)	Injury Present (percentage)	Injury Absent (percentage)
Public assault	221 (75.6%)	153 (69.2%)	68 (30.7%)
Domestic Assault	67(23%)	40 (59.7%)	27(40.29%)
Sexual Assault	3 (1.0)	0	0
Ragging	1(0.3)	1(0.3)	0
Total	292	194 (66.4%)	95 (33.6%)

Table 4: Pattern of injuries in Assault

Pattern of injury	Total : 292	Public Assault		Domestic Assault	
	Total injuries in Assault	Yes	No	Yes	No
Abrasion	74	61	158	13	54
Contusion	58	39	180	19	48
Lacerated wound	80	66	153	14	53
Incised wound	7	7	212	0	67
Fracture	23	19	200	4	63
Regional injuries	17	15	204	2	65
Human bite mark	3	2	217	1	66

Table 5: Pattern of injuries in fall

Pattern of injury	Total: 280
Abrasion	73
Contusion	52
Lacerated wound	98
Incised wound	1
Fracture	118
Regional injuries	40

Table 6: Pattern of Thermal injuries

Thermal Injury	Total: 82
Burn	63 (76.8%)
scald	11 (13.5%)
Chemical Burn	1 (1.2%)
Electrical Burn	3 (3.7%)
No Injury	4 (4.8%)

Table 7: Work place injuries

Work place Injury	Total: 47
Abrasion	5
Contusion	1
Laceration	41
Incised Wound	0
Fracture	14

Discussion

A retrospective study was conducted for a period of five years at tertiary care medical college hospital situated in rural area of DK district, situated 10 km away from Mangalore city and on Kerala Karnataka border having two more tertiary care medical college hospital within the radius of 2 kilometres and is well connected by national, state highway road, river, sea and railway track. As the place of study is situated in a region having access to different educational institution (Universities, engineering college, Ayurveda, Homeopathy and Schools) the rate of road incidents is high involving teenagers driving two wheelers, followed by pedestrian hit, and assault by the public. Cases of assault reported from this area is also high as there is a mixed population of educated and uneducated people belonging to various religion and sect. A Total of 41 cases with different types of history were reported to the hospital either for treatment or as medico legal or both. The number of cases reported showed that the patients were well aware of medico legal case and their right for justice. The pattern of injuries in road traffic accident were studied under five main categories (Table 2) among them two wheeler accident showed the highest rate of incidents (68%) with majority of the victims belonging to 18-30 years category[8] followed by pedestrian hit (12.2%), four wheelers (11.3%),and three wheeler (8.2%) while the study done by Chowdhury and Singh,[7] Chandrappa,[3] Kumar et al.,[4] Malik[2] and Badiadkaet al.,[6] showed similarity to the present study in having highest number of road traffic accident cases the study done by Yadav and Singh[5] and Agarwal et al.[10] had highest rate of assault cases. The pattern of injury abrasion (43.6%), laceration (38.6), fracture (28.4), regional injury (10.8) was seen highest in two-wheeler followed by pedestrian hit while contusion was highest in two-wheeler followed by four wheelers. These findings were similar to study done by Prasad et al.,[11] Shetty and Tapse,[12] and Farooqui et al.,[13] with respect to abrasion but showed the second highest injury as fracture followed by contusion[12] while in Farrooqui et al.[13] the percentage of contusion and laceration were almost equal.

Injuries sustained by pedestrian showed abrasion (50%) followed by laceration (42.2%), fracture (32.5%) and regional injuries (19.9%). While study done by Mandal and Yadav on road traffic accident in pedestrian showed (28.9%) fracture, (26.3%) laceration, (23.2%) abrasion and (21.6%) contusion and also described the injuries region wise.[14] A combination of injuries was reported by Dulal and Khadka as abrasion & bruise followed by incised wound & lacerated wound.[15] Region wise description of injuries in the road traffic accident cases with emphasis on the internal injury was done by Dhillon et al.[16]

The percentage of assault cases reported in this study was 11.9% which was comparatively less than others. The assault cases reported to the hospital included both with and without injuries. Pattern of injuries in the public and domestic assault have been described in the present study. While the study done by other researchers mentioned physical assault, sexual assault, mechanical injuries, number of injuries in public and domestic assault but none of these studies described the injuries and its pattern.[2,4-6,9,10,17]

The present study described the external injuries in a case of fall, while Kumar and Srivastava described the primary impact injuries and fatal internal injuries,[1] other authors described fall as one of the medico legal category without elaborating the injuries.[3,4]

Cases of thermal injuries (3.3%) were studied as dry heat, moist heat, chemical and electrical burns, while Aggarwal et al. described thermal injury (3.8%) as burns/electric burns[10]. Choudhury and Singh reported thermal injuries (11.7%)[7] while Haridas and Pawale (5.7%) described burns as suicidal, accidental, from history.[9]

Work place injury constituted 1.9% of overall cases with laceration as the main injury as machines are heavy cutting blunt weapons, the other researchers have not mentioned this category[9] and those who have included mentioned it as factory or industrial accident without describing the injury.[5,17]

Limitations

Sexual assault, injury sustained by the cyclist, fire arm injury, injury sustained by train and water accident were very few in numbers to describe the pattern of injury and may also have been reported to the other medical colleges in Dakshina Kannada district.

Conclusion

The rate of road accident was high involving teenagers driving two wheelers, followed by pedestrian hit, and assault by the public. Highest cases of mortality were seen in two-wheeler followed by four wheelers. The pattern of these injuries differs depending on the types of medico legal cases. Abrasion was the most common type of injuries in two-wheeler followed by Pedestrian and four wheelers in road accident cases. Laceration followed by abrasion and contusion was commonly seen in cases of assault. Fracture followed by laceration and abrasion were the common injury in cases of fall.

Ethical clearance: A prior approval was obtained from the Institutional Ethics Committee

Conflict of interest: None to declare

Source of funding: None to declare

References

1. Kumar KJV, Srivasta AK. Pattern of Injuries in fall from height. J Indian Acad Forensic Med. 2013;35: 47-50.
2. Malik R, Atif I. An analysis of 3105 Medico legal cases at tertiary care hospital, Rawalpindi. Pak J Med Sci. 2017; 33(4): 926–930.
3. Chandrappa SA. Study pattern of medico-legal cases treated at a tertiary care hospital in central Karnataka. Indian J Forensic Community Med. 2015;2(4):193-197.
4. Kumar DR, Siddaramanna TC, Parate SV, Hemanthraj MN. Retrospective study of profile of medico-legal cases in Tumkur region, Karnataka. Int J Biomed Res.2015; 6(04):339-340.
5. Yadav A, Singh NK. Pattern of medico-legal cases in rural area of Faridabad, Haryana. J Indian Acad Forensic Med. 2013; 35(1): 60-62.
6. Badiadka KK, Pramod KL,Shenoy V. A Study of medico legal cases in a rural health hospital. Indian J Forensic Med Toxicol.2017; 11(2): 266-271.
7. Choudhury R, Singh N. A Retrospective one-year study of the medico-legal cases

in the emergency department of rural Institute of medical sciences, Saifai, Etawah. Medico-legal Update.2016;16 (2): 158- 162.
8. Garg V, Verma VK. Profile of Medicolegal Cases at Adesh Institute of Medical Sciences and Research, Bathinda, Punjab. J Indian Acad Forensic Med.2015;37(1):44-49.
9. Haridas SV, Pawale DA. A Retrospective study of pattern of clinical medico-legal cases registered at tertiary health care centre in Kolhapur District. J Forensic Med Sci Law.2014;23(2): 1-7.
10. Aggarwal KK, Kumar R, Sharma. Retrospective study of medico legal cases presenting inthe emergency of rajindra hospital Patiala in the year 2009. J Punjab Acad Forensic Med Toxicol. 2011;11(2): 77-80.
11. Prasad M, Kumar A, Prasad A, Kumar S, Goel N. Injury pattern among fatal road traffic accident cases at Indira gandhi institute of medical sciences mortuary. J Med Sci Clin Res.2019;7 (1): 712-715.
12. Shetty VB, Tapse SP. A Study of pattern and distribution of injuries in fatalroad traffic accidents in Bidar. J Karnataka Med Leg Soc.2017;26(1): 20-24.
13. Farooqui JM, Chavan KD, Bangal RS,Syed MM, Thacker PJ, Alam S, et al. Pattern of injury in fatal road traffic accidents in a rural area of western Maharashtra, India. Australas Med J. 2013; 6(9): 476–482.
14. Mandal BK, Yadav BN. Pattern and distribution of pedestrian injuries in fatal road traffic accidental cases in Dharan, Nepal. J Nat ScBiol Med. 2014; 5 (2): 320-323.
15. Dulal P, Khadka SB.Victims of road traffic crashes attending the emergency department of Kathmandu Medical College Teaching Hospital. Kathmandu Univ Med J. 2004; 2(8): 301-306.
16. Dhillon S, Kapila P, Sekhon H S. Pattern of injuries present in road traffic accident in Shimla hills, J Punjab Acad Forensic Med Toxicol.2007; 7(2) :50-53.
17. Jude UOCharles NC, Eboreme O A, Okoye C. Medico legal cases in an urban city in south southern Nigeria; a hospital-based study. J Dent Med Sci. 2017;16 (6):1-5.

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 211-213
doi:10.5958/0974-0848.2020.00055.X

ORIGINAL ARTICLE

Socio-Demographic Profile among Burn-Victims: A Study from a Tertiary Care Hospital, Agra

Vaibhav Sharma, Shailesh Kumar Gupta, Ajay Agrawal, Richa Gupta
Department of Forensic Medicine and toxicology, Sarojini Naidu Medical College, Agra, India

Abstract
Burns is a global public health problem, accounting for an estimated 1,80,000 deaths annually. In India, over 10 Lakh people are moderately or severely burnt every year. So the need to do socio-demographical profiling of these cases time to time so that it can be used in the prevention of such cases by knowing its trends in the area and improving treatment facilities. The present study is aimed to identify and compare the socio-demographical profile of patients presenting with burn injuries to the Emergency ward of S.N. Medical College, Agra. This study is a record-based cross-sectional study, conducted from January 2019 to December 2019. Data related to name, age, sex, marital status, place of residence, type of burn injury, was collected from records and were analysed to know the current trends of burn injuries in the region. Out of a total 26346 patients were admitted in the emergency department of S. N. Medical College, Agra during the period from January 2019 to December 2019. Out of which a total of 141 victims of burn injuries were admitted in the Emergency ward, and their medico legal examination was done. Most of the burn victims belonged to age group of 21-40, married, female, of rural area. Most of the burn cases were from flame or dry heat. .

Keywords
Burns; Trend; Medico-legal examination

Introduction

Fire is one of most amazing creation of mankind, as it serves as tool of evolution helping men in allowing to eat cooked food, providing protection in wild, helping in working in the dark.

But this amazing tool also works as a disaster when it is not handled properly, as it causes mass disasters like Australian bush fire happened (2019-2020) involving 46 million acres (72000 square miles) of land , destroying over 5900 buildings and killing at least 34 people along with unimaginable damage to environment. [1]

Burns are a global public health problem, accounting for an estimated 1,80,000 deaths annually. The majority of these occur in low- and middle-income countries and almost two thirds occur in the WHO African and South-East Asia regions. In 2004, nearly 11 million people worldwide were burned severely enough to require medical attention. In India, over 10 Lakh people are moderately or severely burnt every year. [2]

Burns can be divided on the basis of causes into category of flame, scalding, contact, radiant heat, chemical, electric and microwave etc. Burn from dry heat is more common than other type of burn injury. Burn from dry heat may be caused by high temperature applied to the body surface by conduction or radiation. [3]

On socio-demographic studies of burn injuries it is found that it occurs predominantly in females, and in age group of 21-40 years (4-9) although in these studies, ratio of female to male burn victims is found to be different in different demographical regions.

Materials and methods

The present study is a record-based cross sectional study conducted in Emergency ward of S.N. Medical College, Agra for the period from January 2019 to December 2019. Hospital records of all patients admitted in emergency ward were studied for information regarding reasons for admission. This was done by observing admission register and medicolegal records. All other medicolegal cases like physical assault, road traffic accident, gunshot injuries, hanging, strangulations, poisoning and insect bites etc. were excluded. All data was documented and statistically analysed to know the current trends of burn injuries in the region. Statistical analysis was used to find the interaction between the socio-demographic variables in association with pattern of burn injuries as average, percentage and ratio.

Results

A total of 26346 patients were admitted to emergency department of S. N. Medical College, Agra during period from January 2019 to December 2019. Out of which a total no. of 141 victims belonged to burn injuries. Rest of medicolegal cases are of physical assault, road traffic accident, poisoning, animal bites, hanging etc. are excluded.

Corresponding Author
Dr Vaibhav Sharma (Assistant Professor)
Email: drvaibhavsharma84@gmail.com
Mobile: +91-9045055649

Article History
Received: 1st April, 2020; Accepted: 21st August, 2020

Out of total 141 patients of burn injury, one patient was bought by police and rest of patients were brought by relatives or family members. But none of the patients were destitute (for whom incomplete socio-demographic details are available).

Out of 141 patients total 42 (29.7%) patients belong to < 20yrs age group, 80 (56.7 %) belong to 21-40yrs, 14(9.9%) belong to 41-60 years, while 5 patient (3.5%) belong to > 60yrs (Table 1). Forty six (32.6%) patients were male while 95 (67.4 %) were female (Table 1) The mean age of patients was 29 +/- 13.30 years, in which mean age of male and female patients was 30.26 +/- 14.64 and28.40 +/- 12.67 respectively.

While on further analysis (Table 1) all age groups showed female predominance with male-female ratio in age group of <20yr (1:2.5), 21-40yrs (1:1.96), 41-60yrs (1:1.8) and >60yrs (1:1.5).

Table 1: Age and Sex wise distribution of Burn victims

	0-20	21-40	41-60	61-80	Total
Male	12	27	5	2	46
Female	30	53	9	3	95
Total	42	80	14	5	141
Ratio (Male:Female)	1:2.5	1:1.96	1:1.8	1:1.5	1:2.06

On analysis of marital status of patients (Figure 1) affected population was found to be predominantly married 95(67.4%), while 45 were married although marital status of one patient was unknown. Out of 141 patients 87(61.7%) patients belong to rural area, 54(38.3%) to urban area, (Table 2). On the basis of cause of burn injuries, (Figure 2) most of patients injured due to flame/heat while in 5 patients burn injury was caused by electricity. On further analysis all patients of electric burn injury belong to urban region and male with age between 20 to 45.

On month-wise analysis of burn victims' maximum no. of burn cases were found in the month of March and minimum in the month of August.(Figure 3)

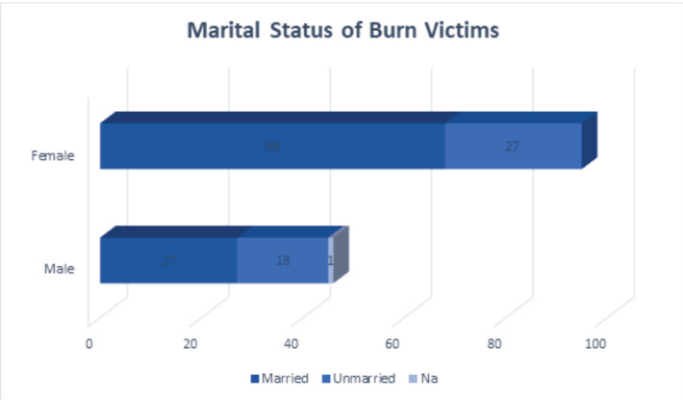


Figure 1: Marital status of patients

Table 2: Distribution of burn victims based on residential area

Type of residential area	No. of Burn Victims
Rural	87
Urban	54

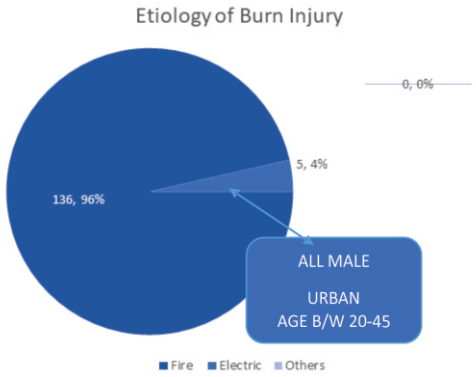


Figure 2: Etiology of burn injury

Figure 3: Month-wise distribution of burn victims

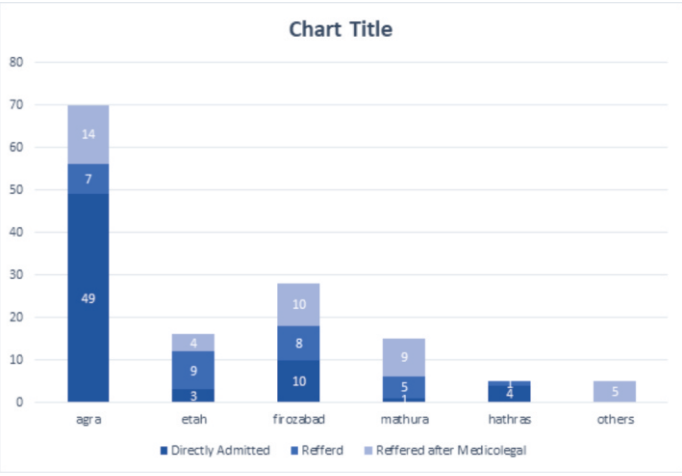


Figure 4: Area-wise prevalence of directly admitted, referred and referred after medicolegal cases

Discussion

On analysis of data of burn victims it's found that most of burn injuries are caused by dry Heat followed by electric burn similar to study conducted in Bhopal. [1]

Although in our study we gathered another information that all electric burn in Agra regions are middle age group male of urban area. Which means we can further reduce these incidences by educating those male population by educating them about use of protective equipment while dealing with electricity with the help of NGOs and Authorities.

It is also found that most of burn injuries occurs in female population of middle age group of rural areas. Although ratio of male and female ratio is different from other studies like it was very higher in studies conducted in Bhopal (2.5:1) and Kolkata (3:1) while it's found to be lower in studies done in Ajmer (1:1.2), Indore (1:1.22), (5,6,8,9),while in our study it is found to be 1:2.06 which means handling of flame or fire is mostly done by females in all region but their level of predominance in doing so is different in different regions.

Most of the cases admitted in Emergency ward are from Agra, but still large no. of cases coming from Firozabad, Etah, Mathura as referred although these districts have medical college/ tertiary care centres of their own. So we need to strengthen them and spread awareness about that in public, as in Burn cases time to start management (which is very critical in survival of patient) can be reduced.

In the study we also found that the number of cases are very low in July-August while they are very high in January to March months, which can help in planning for Administrative Authorities.

Conclusion

From the above results it is evident that government authorities and NGOs which are working for education of use of fire need to focus on middle age group married female population of rural area which will surely create an impact on reducing burden of burn injuries in the society.

Ethical clearance: A prior approval was obtained from the Institutional Ethics Committee

Conflict of interest: None to declare

Source of funding: None to declare

References

1. Centre for Disaster Philanthropy/Disaster/ 2019-2020 Australian bushfire/Impact, https://disasterphilanthropy.org/disaster/2019-australian-wildfires/
2. Organization WH. Burns: Fact sheet. Geneva: World Health Organization, 2020. Available from: https://www.who.int/en/news-room/fact-sheets/detail/burns
3. Pekka S, Knight B. The pathology of burns. In: Pekka S, Knight B, editors. Bernard Knight's Forensic Pathology. 3rd ed. New York: Oxford University Press Inc, 2004,page312-325
4. A Johry,R.K.Mathur,A.Srivastava, Study on Medicolegal aspect of Flame Burn Death, IRMPS,Vol-1,No.-4, 2015,Page 35-40
5. J Tomar, P K Mishra, M. R. Sane, Epidemiology and outcome of burn injuries- A prospective study, IJFCM, 2017;4(1):59-63
6. P K Mishra, J Tomar, D Saxena, Medicolegal aspect of Thermal burns - A prospective study, IJFCM, 2017;4(3):146-150
7. Dr. N. P. Zanjad, Dr. H. V. Godbole, Study of Fatal Burn Cases in Medico- Legal Autopsies, JIAFM, 2007 29 (3); ISSN: 0971- 0973
8. A Mazumder, A Patowary, A Study of Pattern of Burn Injury Cases, J Indian Acad Forensic Med. 2013, Vol. 35, No. 1
9. Dr. S Bandyopadhyay et al, Socio-Demographic Profile and Reported Circumstances of Death among Female Burn-Victims: Experience from a Tertiary Care Hospital, Kolkata, IOSR Journal of Dental and Medical Sciences (IOSR-JDMS), Volume 18, Issue 2 Ser. 8(, PP 56-59Nigeria; a hospital-based study. J Dent Med Sci. 2017;16 (6):1-5.

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 214-218
doi:10.5958/0974-0848.2020.00056.1

REVIEW ARTICLE

Right to Information Act: It's Applicability on Medico-legal cases and Postmortem Reports

Himanshi, Amit Patil, Avinash Kumar, Ashok Kumar Rastogi, Abhishek Parashar
Department of Forensic Medicine & Toxicology, All India Institute of Medical Sciences, Patna, Bihar, India

Abstract
The enactment of Right to Information Act (RTI), 2005 has presented a conflicting situation in relation to professional secrecy, right to privacy and right to information. Moreover, the situation becomes complicated when applicability of RTI Act encounters medicolegal reports and postmortem reports which are impliedly confidential in nature. Many a times doctors involved in managing and writing such reports often faces a dilemma regarding sharing of such reports under RTI Act 2005. There are different views as per the interpretation of RTI act regarding its applicability in medico-legal documents and post-mortem reports. As per Central Information Commission (CIC), Medico-legal Cases (MLCs) and Post-Mortem Reports (PMR) are indeed legal requirements in criminal cases and not prepared at the instance of the patient, but to record injuries inflicted on a person/deceased, to be used by courts in criminal proceedings and hence are not held in fiduciary relation with the patient and that refusal of information under Section 8(1) (e) is unsustainable. Contrastingly, different courts has directed that certified copy of PMR/MLR cannot be issued under RTI and is covered under the exemption of Section 8(1) (j) of RTI Act. Thus, its applicability varies as per the judgments pronounced by different judicial courts of India. This article intends to address contrasting views related to applicability of RTI Act to Medico-legal Reports and Post-Mortem Reports and an attempt is made to bring clarity in these matters.

Keywords
RTI Act; Medico-legal cases; Medicolegal reports; Postmortem reports; CIC; Appellate Authorities.

Introduction

The preamble of RTI Act 2005 says that it is an act to provide for setting out the practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority.[1] The objectives of this act is to contain corruption by empowering people, promoting transparency and accountability in the Government working system and make our democracy work for people in real sense. This Act is seen as a big step towards making the citizens informed about the activities of the Government.[2] Thus it could be said that this act provides Indian citizen the right to access public information under the control of authorities thereby promoting transparency and accountability.

The enactment of Right to Information Act (RTI), 2005 has presented a contrasting situation in relation to professional secrecy, right to privacy and right to information. Moreover, the situation becomes complicated when applicability of RTI Act encounters medicolegal reports and postmortem reports which are impliedly confidential in nature. Many a times doctors involved in managing and writing such reports often faces a dilemma regarding sharing of such reports under RTI Act 2005.

There are different views as per the interpretation of RTI Act is concerned in its applicability to seek information of medico-legal documents and post-mortem reports. As per Central Information Commission (CIC), Medico-legal Cases (MLCs) and Post-Mortem Reports (PMR) are indeed legal requirements in criminal cases and not prepared at the instance of the patient, but to record injuries inflicted on a person/deceased, to be used by courts in criminal proceedings and hence are not held in fiduciary relation with the patient and that refusal of information under Section 8(1) (e) is unsustainable. Contrastingly, different courts has directed that certified copy of PMR/MLR cannot be issued under RTI and is covered under the exemption of Section 8(1) (j) of RTI Act. Thus, its applicability vis-à-vis medicolegal and postmortem reports varies as per the judgments pronounced by different judicial courts of India. In order to address these issues and to seek clarifications we searched the available information on the subject matter on internet through google search engine for relevant articles and medicolegal manuals. Also, various judgments on this topic were searched on www.indiakanoon.org website and are cited in this article. This article intends to address this complex issue of applicability of RTI Act to Medico-legal Reports and Post-Mortem Reports with attempt to bring clarity in this matter.

Corresponding Author
Dr Amit Patil (Additional Professor and Head)
Email: dramp1976@gmail.com
Mobile: +91-9920193750

Article History
Received: 22nd March, 2020; Accepted: 11th August, 2020

Definitions under RTI Act 2005

As per the Act, it is pertaining to seek understand various terms

like record, information and right to information which has been defined as below:

"Sec. 2(i) of RTI Act, 2005 "record" includes –

(a) any document, manuscript and file;

(b) any microfilm, microfiche and facsimile copy of a document;

(c) any reproduction of image or images embodied in such microfilm (whether enlarged or not); and

(d) any other material produced by a computer or any other device"[2]

"2(f) "information" means any material in any form, including records, documents, memos, e-mails, opinions, advices, press releases, circulars, orders, logbooks, contracts, reports, papers, samples, models, data material held in any electronic form and information relating to any private body which can be accessed by a public authority under any other law for the time being in force."[2]

Medicolegal records and post-mortem reports may be termed as medical records stored in different formats and comes under the definition of information which can be sought under this Act.

Confidentiality and Professional Secrecy

The proposition is that a secret acquired by the doctor is the secret of the patient and not unreasonably of the doctor. The patient has prima facie right in law to necessitate that the secret shall not be uncovered to any outsider, and to seek redress if it is so unveiled, unless the doctor can show that there is some paramount reason which supersedes the patient's prima facie right.

A modem enunciation of Hippocratic Oath on confidentiality of the similar principle is found in the International Code of Medical Ethics,"A doctor shall preserve absolute secrecy on, all he knows about his patients because of the confidence entrusted in him". The confidential nature of the relationship between the patient and doctor does not end with the demise of the patient as per the Declaration of Geneva and the International Code of Medical Ethics.[3]

The nature of relationship between the doctor and his patient or victim or deceased in medicolegal or post-mortem cases is more of legal than therapeutic or diagnostic, as examination in such cases is done on the requisition of legal authorities. The findings and opinion mentioned in such reports should be treated as confidential with absolute secrecy and cannot be shared with any other person without the explicit consent of the concerned person who has requested such examination.

Exemptions to disclosure of information under RTI Act[2]

Section (8) of the RTI Act enlists some special instances when the authorities are exempted from disclosing information sought for. The exemptions under section 8 (1) is mentioned as below: Notwithstanding anything contained in this Act, there shall be no obligation to give any citizen, (b) information which has been expressly forbidden to be published by any court of law or tribunal or the disclosure of which may constitute contempt of court; (e) information available to a person in his fiduciary relationship, unless the competent authority is satisfied that the larger public interest warrants the disclosure of such information; (g) information, the disclosure of which would endanger the life or physical safety of any person or identify the source of information or assistance given in confidence for law enforcement or security purposes; (h) information which would impede the process of investigation or apprehension or prosecution of offenders; (j) information which relates to personal information the disclosure of which has no relationship to any public activity or interest."[2]

Therefore, u/s 8(1) (e) of RTI Act, exemption of information is available to a person in his "fiduciary relationship".[4] It guards personal information of person including public authority when it under the fiduciary relationship. Fiduciary relationship is basically a relation of trust between the fiduciary and beneficiary under which one party relies on the judgement and opinion of another.

According to the Advanced Law Lexicon Dictionary [5], fiduciary relationship means: "A relationship in which one person is under a duty to act for the benefit of the other on the matters within the scope of the relationship. Fiduciary relationship usually arise in one of the four situations (1) when one person places trust in the faithful integrity of another, who is a result gains superiority or influence over the first, (2) when one person assumes control and responsibility over another, (3) when one person has a duty to act or give advice to another on matters falling within the scope of the relationship, or (4) when there is specific relationship that has traditionally be recognized as involving fiduciary duties, as with a lawyer and a client, or a stockbroker and a customer." Doctor- patient relationship falls under this category.

Many information seekers get frustrated with the plea of fiduciary relationship. It is a relation of trust where one party provide information to other party and other party must secure the information therefore it is not pari passu with secrecy and confidentiality. Though, there is no accord between the two while giving the information that the information needs to remain safe, yet because of the trust shown by trustee, information needs to be kept invulnerable from the investigation of the public. It is to be kept in mind that the RTI

Act is introduced on disclosure being the standard, and refusal being the exception.[6] The question behind Section 8(1) (e) is to ensure the information since it is furnished in certainty and trust rested. It ensures that the assurance, trust and the privacy associated isn't sold out.[6]

Besides, under provision (h), if a FIR has been enlisted for a situation and investigation is in progress, the investigating officer can claim exemption on the ground that providing copy of PMR or MLR would obstruct the investigation and additionally apprehension or prosecution of offenders. Likewise, under Section 8(1)(g) exemption can be asserted where the divulgence of information may imperil the life and wellbeing of any individual (potential witnesses, victim etc.).[4]

Judicial Judgments related to right to information in MLCs and Post-mortem reports

Various judicial pronouncements have contrasting views on information sought under the act in relation to medicolegal and post-mortem reports/cases. Few of them are quoted below:

1. In Mr. Raj Kumar vs M/O Health & Family Welfare, 2009, the CIC stated under the RTI Act [7] that, "Medico legal cases (MLCs) are indeed legal requirements in criminal cases and not prepared at the instance of the patient but to record injuries inflicted on a person, to be used by courts in criminal proceedings and hence are not held in fiduciary relation with the patient and that refusal of information under Section 8(1)(e) is unsustainable."
2. In Mr. Satbir Singh vs Government of NCT of Delhi, 2014, [8] CIC stated that "Medico-legal reports are not entirely personal records."
3. In Delhi Administration vs. Gian Singh, [9] 1980, Delhi High Court accepted that, "Postmortem report & medico legal report are not substantive evidence. Therefore, it cannot be termed as public document as envisaged under sec. 74 IEA."
4. In Union of India through Director, Ministry of Personnel, PG & Pension vs. CIC, 2009, Delhi High Court[6] held under paragraph 87 stating, "If the disclosure of such information impedes the investigation or apprehension of the offender or prosecution of the offender, it can be denied. The said section does not provide blanket exemption, even if it is partial in nature or justified. Court explained that there shall be no disclosure of post-mortem reports when investigation is under progress. The MLC reports can be shared when that would not impede the process of investigation or prosecution".
5. In K. Tharush Moideen vs. Hasan Ambalam 2010, the Judges of Madras High court[10] in that case stated that, "the opinion of the medical officer contained in the postmortem was only to aid the investigating officer in investigation. The report cannot be held to be a record of medical officer of his official "act" for the use of public."
6. In Judgment by Delhi High Court'[11] Jan 2010, a three judge bench stated that, "medical details of an individual cannot be made public and cannot be given under RTI which is covered under the Exemption of Section 8(1)(j) of RTI Act as per various decisions of CIC."
7. As per "The State of U.P. vs. Raj Narain [12] (1975) 4 SCC 428", "One basic fact regarding the ownership of medico legal records, is that the medico legal documents, especially the post-mortem report belongs to the requestor i.e. the police and the same is held by the doctor in fiduciary relationship."
8. The Madras High Court[13], in The Government of Tamil Nadu ... vs Mrs. Muthulakshmi and the Joint, 2006 [Veerappan encounter], dismissed the petition filed by the wife of deceased for asking post-mortem report of his husband who was killed in an encounter under RTI.
9. In "Selvanathan @ Raghavan vs. State by Inspector of Police, Madras" full bench of Madras High Court[14] has held that: "At any rate, R.339 (of the Criminal Rules of Practice) does not postulate that the accused is entitled to copies at any stage. Held that accused are not entitled to certified copies of the Post-mortem certificate, requisition given by the police officers to the Medical Officer for conducting post-mortem and medically treating the injured, before the final report is forwarded to the Magistrate, as contemplated under S.173(2) of the Code".

Thus, from above judicial judgments it is safe to interpret that the court has refused to accept medicolegal and postmortem report as public document and hence cannot be made public through this act. Also, the court has categorically exempted to make these documents public considering them under the exemption clause of 8 (1) (j) RTI Act. These court judgements have made it clear that disclosure of information may be denied if it impedes the investigation of the offender or prosecution of the offender. The court further states that clarifies non-disclosure of post-mortem reports when investigation is under progress and these MLC reports can be shared if it does not impede the process of investigation or prosecution. The ownership of medicolegal reports lies with the requestor i.e., police and the doctor held them in fiduciary relationship.

Medicolegal manual vis-à-vis MLC and Post-mortem reports and RTI

The Manual of Health and Family Welfare, Government of Mizoram[15] mentions that, "Post-mortem report is considered to be classified item as such; the report cannot be disclosed to the public without the authority of 1st Class Magistrate. If affected party is asking for a record in road traffic accidents or where some issues of compensation or some relief is there, then attested photocopy of the record can be given to the victim or next of kin on written request. In cases, where injuries are produced as part of criminal offence then leakage of information before Police file a challan in the court of law, unauthorized leakage or communication is not permitted."

As per "Clause 24 of Medico-legal manual of Punjab" 1[6] & "Clause 25 of Medico-legal manual of Haryana 2012" 17, "A medico legal report or post mortem report given by an expert is confidential and not a public document. Copy of the PMR/MLR may, however, be given to authorized person after he/she submits written application and submitting prescribed fee with receipt enclosure addressed to the concerned Medical Officer/Medical Superintendent clearly stating his/her relationship with the patient/deceased person. Alternatively, the applicant shall produce order of the Court directing the Medical Officer concerned to provide him/her attested copy of the PMR/MLR. Requests by third party for copy of PMR/MLR under the RTI Act are not maintainable."

According to "Maharashtra Postmortem and Medicolegal Manual" [18] clause 12.19 states, "Medico-legal reports are confidential documents and cannot be supplied. The Interested parties may be asked to approach the Police authorities or the concerned Magistrate."

In Contrast, "Clause 29-32 of the Kerala Medicolegal Code"[19], "Postmortem certificate can be given to the legal heirs of the deceased (only after a NOC from the Investigating Officer) on a written requisition for the same. However, on a written requisition for the immediate issue of any medico-legal document except postmortem Report, from a Police or Judicial Officer, the immediate issue of such medicolegal document should be done by the Medical Officer on duty in that Institution and in temporary custody of such documents at that particular time. For Insurance claims authentication of postmortem report is given."

Thus, according to the excerpts from above referred medicolegal code/manual PMR/MLR are not public document and may be given to the legal heirs of the deceased or to the interested parties only after a no objection certificate from the Investigating Officer.

Conclusion

Any medico legal case record ought not be revealed to any unauthorized individual. Numerous instances have happened when the offenders have posed themselves like family members and have taken away the documents of the case and produced the same in the court after making modifications in the court in the wake of making adjustments in that which fit them. Medico legal report and postmortem reports are not public document. It ought to be handed over only to the police. Until, explicitly excluded/mentioned by the Hon'ble Court/police, to diffuse media pressure & public, the subtleties should not be made public. However, if necessary, the concerned party can get the duplicate of report from police or under the order of courts, which should be given in the wake of filling the charge sheet.[20] Consequently, the Medico-legal Report & Post-Mortem reports ought not be issued, except

1. with assent/consent of the patient's or lawful representative's,
2. when public intrigue supersedes the patient's own advantage,
3. when required by statute or law (e.g. notification of infectious diseases) or by lawful procedure (e.g. during court testimony) or
4. for the purposes of medical teaching, research or audit.[3]

Likewise, a convention pertaining to the disclosure of information should be made as that would fill in as the standard for autopsy surgeon practice acknowledged by the profession, while not legitimately bound, would probably be recognised by the courts.

Conflict of interest: None to declare

Source of funding: None to declare

References

1. Mayank. Role of RTI in Health by Mayank | Central Information Commission [Internet]. University Institute of Law and Management, Gurugram; [cited 2020 Jan 21]. Available from: https://cic.gov.in/sites/default/files/Role%20of%20RTI%20in%20Health%20by%20Mayank.pdf
2. RTI Act 2005 for Ministry of Health & FW | Ministry of Health and Family Welfare | GOI [Internet]. [cited 2020 Jan 15]. Available from: https://mohfw.gov.in/right-information-rti/rti-for-sub-ordinate-organisations-under-ministry-of-health-family-welfare/rti-act-2005-ministry-health-fw
3. Ong B-B. Confidentiality and death. Malays J Path. 1997 Dec 1;19(2):111–4.
4. Nair MRH. RTI v Medical Ethics: some questions arising from the recent decision of the Chief Information Commissioner under the RTI Act. Indian J Med Ethics [Internet]. 2015 Jul 1 [cited 2020 Jan

12]; Available from: http://ijme.in/articles/rti-v-medical-ethics-some-questions-arising-from-the-recent-decision-of-the-chief-information-commissioner-under-the-rti-act/

5. Ramanatha PA. Advanced Law Lexicon Dictionary. 5th ed. Lexix Nexis; 2016.
6. Sethi S. Fiduciary Relationship under Section 8(1) (e) of RTI Act, 2005 [Internet]. National Law University, Nagpur; 2018. Available from: https://cic.gov.in/sites/default/files/Safal%20Sethi.pdf
7. Medico-legal reports cannot be refused under the RTI Act. [cited 2020 Jan 12]; Available from: https://taxguru.in/corporate-law/medico-legal-reports-cannot-be-refused-under-the-rti-act.html
8. Shakdher R. MrSatbir Singh vs Government of NCT of Delhi on 25 November, 2014 [Internet]. [cited 2020 Jan 14]. Available from: https://indiankanoon.org/doc/58942485/
9. Rohatgi AB, Tulwar C. Delhi Administration vs Gian Singh on 13 October, 1980 [Internet]. [cited 2020 Jan 15]. Available from: https://indiankanoon.org/doc/630222/
10. K. Tharush Moideen vs Hasan Ambalam on 2 February 2010 [Internet]. [cited 2020 Jan 15]. Available from: https://indiankanoon.org/doc/396780/
11. Yadav M. RTI and Medicolegal Cases. J Indian Acad Forensic Med. 2013 Mar;35(1):4–6.
12. State of U.P vs Raj Narain & Ors on 24 January, 1975 [Internet]. [cited 2020 Jan 15]. Available from: https://indiankanoon.org/doc/438670/
13. Sathasivam P. Muthulakshmi vs State on 18 January, 2005 [Internet]. 2005 [cited 2020 Jan 15]. Available from: https://indiankanoon.org/doc/911371/
14. Selvanathan alias Raghavan and Others v State by Inspector of Police, G-5 Police Station, Madras and Others [Internet]. 1988 [cited 2020 Mar 18]. Available from: https://www.lawyerservices.in/Selvanathan-alias-Raghavan-and-Others-Versus-State-by-Inspector-of-Police-G-5-Police-Station-Madras-and-Others-1988-11-16
15. Mizoram Police Manual, 2005. Gov Mizoram. 2006 May 1;XXXV(109):457.
16. Punjab Medicolegal Manual [Internet]. Government of Punjab; 2018. Available from: http://pbhealth.gov.in/Punjab%20Medicolegal%20Manual%20jan30.pdf
17. Kumar A, Kumar M, Singh S, Rani Y. Haryana medico legal manual 2012: An appraisal. Int J Med Toxicol Leg Med. 2017;20:14–7.
18. Postmortem and Medicolegal Work [Internet]. Government of Maharashtra; [cited and assessed on 2020 Jan 27] Available from: http://www.mlam.in/pdf/forensicmedicineandscience/postmortemandmedicolegalwork.pdf
19. Kerala Medico-legal Code [Internet]. Government of Kerala; 2011 [cited on 2020 Jan 27]. Available from: https://www.yumpu.com/en/document/read/12971921/kerala-medico-legal-code arogyakeralam
20. Murty OP, Kohli A, Millo T, Rani M, Verma SK, Sikary AK, et al. Uniform Guidelines for Postmortem Work in India: Faculty Development on Standard Operative Procedures (SOP) in Forensic Medicine and Toxicology. J Forensic Med Toxicol. 2013;30, 1 & 2(January-December):137.

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 219-223
doi:10.5958/0974-0848.2020.00057.3

CASE REPORT

Bioinformatics as a Forensic Tool in Coronavirus Outbreak

Bandr Siraj Fakiha
Department of Medical Health services, Faculty of Health Sciences, Umm Al-Qura University, K.S.A

Abstract
The recent outbreak of the novel coronavirus has raised a lot of concerns on the effective strategies of diagnosing and managing such disease. As for governments and security agencies, the extent of the outbreak is a major concern regarding possible usage of bioweapons. As a result, a reflection on the existing forensic tools forms the basis of further research on the issue. Hence, an improvements on the application of bioinformatics in forensic investigations is a major area of concern for many medical and forensic researchers. This paper explores the advancements in bioinformatics as a forensic tool amid the developments in current novel coronavirus outbreak. Considering that there is limited resources to conduct a primary research on the novel coronavirus and the Covid-19 disease, a systematic review of the existing research is best suited for the research. Therefore, the research involves a review of the past research on bioinformatics and forensic investigations and its relations to the ongoing research on the novel coronavirus.

Keywords
Corona virus; Bioweapons; Bioinformatics

Introduction

The novel coronavirus (2019-nCoV) that was discovered in Wuhan, China in 2019 has increased the interest in research on pathogenic coronaviruses and how they can be diagnosed and managed as quickly as possible. This is on the grounds that the resulting disease (Covid-19) became pandemic after just about three months after the discovery of the novel coronavirus. The pandemic requires an abrupt reaction for readiness against this infection. For this reason, the use of bioinformatics as a forensic tool in the coronavirus outbreak is mandatory. For instance, bioinformatics analysis tools can be used to recognize the conceivable origin of the virus if it is used effectively with incorporation of modern computing technology. Moreover, bioinformatics can be used to determine the common host of a virus. Hence, effective use of bioinformatics tools that can quickly determine its origins of the novel coronavirus if bioinformatics are well integrated into the current forensic tools. It is additionally significant in distinguishing its acknowledged vaccine targets. Based on the most recent forensic analysis, it is believed that the novel 2019-nCoV is strongly connected to Severe Acute Respiratory Syndrome (SARS) coronavirus. Additionally, the novel coronavirus is identified with Middle East Respiratory Syndrome coronavirus (MERS) coronavirus to a lower degree. [1] From that perspective, data from past researches on the related viruses can be analyzed through forensic tools to determine the different aspects of its causes and the people involved in its development.

Forensic genetics are the most widely used form of bioinformatics analysis that are based on a comprehensive analysis of DNA-related information. In its relevant description in this case, forensic genetics is derived from a recent branch of the enormous tree as a result of the combination between criminology and medical research. Veljkovic et al. [2] depict that such information identifies with the qualification between forensic genetics and other forensic sciences that can be used in an investigation on the aspects of the novel coronavirus. Its historical advancement shows considerable hypothetical and technological improvements. In the past two decades, forensic genetics analytical tools have transformed into an expansive and free scientific are for which it is turning out to be increasingly difficult to distinguish from its predecessors. The development of present day social orders significantly widened the forensic structure by presenting new types of objectives, permitting space for avoidance, and controlling all the more prohibitively the criminal investigations associated with pathogens. [3] This implies a possibly forensic circumstance is the one for which at least two sides concede to the truth of the realities but differ on the causes or origin of viruses such as the coronavirus. In this manner, common cases are normal and they do not necessarily require courts to settle such as the current conflicts between several nations regarding the origin of the 2019-nCoV.

In terms of epidemiological investigation, microbial forensics are vital in deciding if a virus outbreak was normal or caused by humans accidentally or intentionally. Hence, microbial forensics is individually connected with virology, permitting examining and following disease outbreak elements. For the most part, such studies are concerned with the recognizable proof of the agent, the root characteristic causes, genetic evolution and variety, and conceivable transmission courses. [4] Some notable instances of the epidemiological investigations

Corresponding Author
Bandr Fakiha (Associate Professor)
Email: bfageeha@hotmail.com
Mobile: 00966505544693

Article History
Received: 16th April, 2020; Accepted: 7th August, 2020

are the 2009 Swine Flu Virus A (H1N1), the 2012 MERS-Cov, the 2013 Avian Influenza A virus (H7N9), the 2013 and 2015 West African Ebola Virus, and the Zika Virus outbreaks. [5] The use of microbial forensics in biocrimes additionally incorporate the subsequent transmitted diseases and social insurance misbehavior connected to the transmission of viral diseases. Additionally, this order is likewise used to determine instances of hospital-acquired infections or unexpected death. The human micro-biome is beginning to be a focal point of interest for recognizable proof purposes. [6] The rationale in this case is to follow human micro-biomes to enhance the utilization of human DNA that associate individuals with proof and conditions.

History of Inventive Forensic analysis tools in outbreaks

During the times of historical wars, use of bioweapons was utilized to perpetrate most extreme destruction to adversaries. For instance, bioweapons were utilized in type of by tainting tips of spears and arrows with fatal components such as venom. In past two centuries, there is evidence of documented of utilization of pathogenic agents to kill enemies. For example in the First and the Second World Wars and the Afghanistan War, there has been a proof of bioweapons usage. [7] These weapons included insects raised on laboratories as well as developed plague infected rodents. The bioweapons were then spread into the target areas and they would cause enormous harm. For instance, dangerous pathogens that cause typhoid, Bacillus anthracis, and cholera were utilized during the World War II. The weapons were used in different ways to assault foes such as through aerial bombs.

In past century, microbial forensics has become an autonomous forensic research and technology. It is through microbial forensics, that people have been able to tackle complex issues in the investigative studies of pandemics and epidemics. For example, the use of computer-based forensic analysis tools has been useful in connecting of pathogen to its conceivable source. Additionally, microbial forensics has resulted into the convergence of strain-level genome data that relates different processes with each other. Integration of computing into forensics became crucial with the improvement of DNA sequencing and automated protein after mid-1970s and through mid-1980s. [8] In 1995, there was the principal complete bacterial genome was discharged. Since then, microbial forensics tests fatal microbes, for example, viruses, microorganisms just as their poisons and elements. [9] The future improvement of microbial forensics depends on the steady development of the genomics, atomic biology, and nanotechnology suggest that there could be quicker and easier diagnosis and management of outbreaks such as the Covid-19 pandemic.

How Bioinformatics can be used Forensic Tool in the Coronavirus Outbreak

The investigation of infectious disease outbreaks is heavily dependent on statistical information that is interrelated and gleaned from different sources. Thusly, bioinformatics represent the best method to collect, analyze data and make conclusions. However, the capability of such data must be gathered utilizing various extraordinary, integral tools, and methodologies. These tools and techniques should be integrated to analyze of outbreaks which is as of now inadequate. Effective bioinformatics tools are created by a network of disease transmission experts, modelers, analysts, and bioinformaticians. [10] These tools execute classes and strategies for gathering, dealing with and figuring out outbreak data. These forensic analysis tools incorporate genuine and recreated outbreak datasets.

In light of the ever-present worry of medical professionals about epidemics of infectious diseases, there is the need for a straightforward entry and minimal effort of acquiring, creating, and spreading pathogenic living beings or biological poisons. This implies that bioterrorism movement should be viewed in the same as when confronting a disease outbreak. [11] Usage of whole-genome sequencing in coronavirus analysis encourages the quick and precise identification of deadliness of the components of a pathogen. Moreover, whole-genome sequencing can be utilized to distinguish the way of disease transmission in a population and give information on the plausible source. [12] From that point of view, whole-genome sequencing are being refined and progressed at a quick pace. They are significant in giving encouraging and higher objectives strategies for recognizing, analyzing, and grouping pathogenic life forms. In the event that these techniques for pathogen portrayal are appropriately applied, they will empower an improved general health reaction whether a disease outbreak was started by regular occasions or by incidental or purposeful human movement.

So as to contrast informational similar novel coronavirus and other related coronaviruses, a cross-spectra of the proteins from coronaviruses such as MERS-CoV and SARS-CoV should be compared. The cross-spectra contains just a single predominant pinnacle comparing to a particular recurrence. When looking at these viruses, the amplitudes in these the novel coronavirus cross-spectra have demonstrated to be essentially lower than in the other coronaviruses. In such manner, the S1 proteins from 2019-nCoV encodes regular information with the other coronaviruses. The S1 proteins from novel coronavirus are noteworthy all the more comparable with S1 those in the other coronaviruses. This proposes biological properties of 2019-nCoV are evidently increasingly like those of the different viruses. [13] Hence, use of bioinformatics cannot be avoid if the novel coronavirus is to be comprehensively known.

SARS-Co, MERS-CoV, and SARS-like CoV originating from bats, are ideal instances of the numerous ongoing virus revelations made through analysis of next-generation sequencing data. As demonstrated by Woo et al. 2018, [14] just a little piece of the few a large number of short-length sequence parts generated by next-generation sequencing tools, a considerable lot of which are relied upon to be of viral cause, can be analyzed with current strategies in bioinformatics. In any event, for notable (pathogenic) viruses, legitimate epidemiological analyses are turning out to be increasingly more troublesome because of the absence of bioinformatics devices that can deal with the huge and developing size of datasets. [15] The virogenesis will beat the most squeezing bioinformatics deterrents to utilizing next-generation sequencing. The procedure requires building up a software stage for end-clients with devices supported by novel calculations, models and bioinformatics strategies. [16] The speed and adaptability of the tools will make it conceivable to run analyses consistently for an assortment of subjects. For example, diagnostics, phylogeography, phylodynamics and transmission of medication opposition all rely upon the next-generation sequencing device. The instruments have been steered and fused in the numerous accessible bioinformatics pipelines and software programs utilized in the field. However, the puzzles encompassing 2019-nCoV are yet to be completely revealed.

In spite of the complexity of underlying data structure in bioinformatics systems, getting to information stored in data access objects is encouraged by countless access systems and techniques. Modern bioinformatics are based on solitary meta-data as well as the DNA sequences at hand. The data and information are acquired from given genes. In that regard, the data can be traced through the genetic network of the infected people as well as those who are considered to be more susceptible to such infections. Critically, decoupling the access to information and its transportability is what forensic analysis tools provide especially when they are based on bioinformatics. In such manner, future adjustments of the data structure do not straightforwardly impact on the content but rather the ease of access and its relevance to the data being sought after. [17] When considering the prospects of these kinds of bioinformatics, it is encouraging to believe that outbreaks such as the novel coronavirus will not be a major problems to all stakeholders of the medical field.

Current research has described the full-genome sequence of two SARS-CoV-2 strains detached from two patients analyzed in Italy. Discoveries were for the most part dependent on bioinformatics analysis, so more research facility concentrates on 2019-nCoV in cell and animal models are required. The sequences introduced are analyzed with regards to other accessible genome sequences from different research centers. The resulting data and information should therefore be shared with interested researchers. The analyzed genome-wide codon use designs in several 2019-nCoV secludes from 13 distinctive locations globally. The result of this investigation may help in understanding the hidden elements associated with the development of 2019-nCoV coronavirus and collaborations with their host. In that regard, the process might help in vaccine development techniques.

Reports have shown a relationship between SARS-CoV-2 infection and anosmia, recommending an adjustment not confined to the respiratory tract. However, that may likewise incorporate the olfactory tangible epithelium. Hence, a combination of these data and information through bioinformatics systems could be vital in determining the cause of the novel coronavirus. For instance, past investigation were conducted by generating RNA-seq libraries from human neuroepithelium. [18] The information was availed to the researching stakeholders through digitalized systems. To decide if explicit cell kinds of this chemosensory tissue may coexpress both of the virus passage genes, they analyzed a scRNA-seq dataset. [19] It was verified that sustentacular cells, which are in direct contact with the outside world and keep up the decency of olfactory tangible neurons, speaks to a prime contender for SARS-CoV-2 infection by means of the nose, and perhaps for 2019-nCoV-instigated anosmia. Therefore, bioinformatics are required in the process in determining the developments that led to the origin and spread of the coronavirus.

Synthesis and Conclusions

Discussions revolving around bioinformatics commonly focus on the advancement of new medications and customized medicine. In any case, the jobs are growing for this ground-breaking registering framework that represents considerable authority in gathering and analyzing data regarding outbreaks. What is more, one of those developing use cases is forensics – otherwise called crime discovery. As demonstrated by the ongoing research on the Covid-19 pandemic, coronaviruses will in general relate with different coronaviruses to make new kinds of coronaviruses. As suggested by Li et al. [20] it becomes much more complicated when distinguishing the new coronavirus from the already known ones. This is on grounds that they seem to sometimes deviate from the already known facts about coronaviruses yet they show substantial resemblance. For this reason, there is the need for extensive and intensive research on how the existing bioinformatics should be connected so that data can be shared easily and quickly among different medical research institutions. However, there have been issues of bureaucracy in light of the existing international relations such as those between the United States, China, and Russia.

In the process of biological data crime investigations, include DNA sequencing. In light of the repercussions of the current pandemic, many governments have been shocked by the extent to which biological weapons could harm the world. In that regard, bioinformatics can upgrade and speed results of forensic investigations of possible bioweapons than conventional strategies. [21] Additionally, those are not by any means the only applications of bioinformatics. For instance, bioinformatics can be crucial in determining the people behind a bioweapon or a bioterrorism attack. As such, whatever or any place releases another biological danger on humankind can possibly be distinguished and found with bioinformatics in record time. The development of bioinformatics systems are very important in such cases and the need for their improvements cannot be underestimated.

From analysis of people's reactions to the possible causes of Covid-19, not every person is that the novel coronavirus occurred in same course as the past coronaviruses incidences including MERS-CoV, SARS-Cov, and SARS-like CoV originating from bats. Some unproved theories insinuate that the novel coronavirus was manufactured in a laboratory in the Wuhan Institute. In that regard, they assert that the institution hosts a mysterious program that supports biological weapons. However, those claims are undeniably bound to focus on negligible occurrence, a paranoid fear. [22] Many foreign policies have quashed the spread of such information especially when the disease is still a major cause of fear around the world. Most importantly, any theories such be based on credible sources of information regarding the biological danger, figuring out how to fix or moderate the dangers, and possibly following it back to its roots to save lives.

As demonstrated by many researchers, bioinformatics will probably demonstrate significant in recognizing the starting point of both common and man-made biological dangers for a long time to come. Regardless, all biological dangers are right now analyzed and the outcomes checked over and over by substances around the globe to forestall slip-ups and discover life-sparing medicines. Data sharing and result approvals will proceed the world over until the virus is vanquished all over the place. The research data on the virus is highly active in many research centers and most of them are sharing information with the World Health Organization. Scientists around the globe work to affirm that the data and shared does not cost more human lives by ensuring that any tests involving human beings are well-researched and simulated. Hence, the prospects of development of the Covid-19 disease are still far from being considered a reality. Therefore, the collaboration of many research centers through a network of bioinformatics systems is not only important for the elimination of the disease but also as a basis for future handling of outbreaks.

Conflict of interest: None to declare

Source of funding: None to declare

References

1. Mao D, Zhou N, Zheng D et al. Guide to forensic pathology practice for death cases related to coronavirus disease 2019 (COVID-19) (Trial draft). Forensic Sci Res. 2020:1-7. doi:10.1080/20961790.2020.1744400
2. Veljkovic V, Segalés J, Paessler S. Use of the informational spectrum methodology for rapid biological analysis of the novel coronavirus 2019-nCoV: prediction of potential receptor, natural reservoir, tropism and therapeutic/vaccine target. F1000Res. 2020;9(52). doi:https://doi.org/10.12688/f1000research.22149.2
3. Li X, Yu J, Zhang Z et al. Network bioinformatics analysis provides insight into drug repurposing for COVID-2019. Preprints 2020. 2020. doi:https://doi.org/10.20944/preprints202003.0286.v1
4. Bokhari H. Exploitation of microbial forensics and nanotechnology for the monitoring of emerging pathogens. Crit Rev Microbiol. 2018;44(4):504-521. doi:10.1080/1040841x.2018.1444013
5. Woo P, Lau S, Chen Y et al. Rapid detection of MERS coronavirus-like viruses in bats: potential for tracking MERS coronavirus transmission and animal origin. Emerg Microbes Infect. 2018;7(1):1-7. doi:10.1038/s41426-017-0016-7
6. Jombart T, Aanensen D, Baguelin M et al. OutbreakTools: A new platform for disease outbreak analysis using the R software. Epidemics. 2014;7:28-34. doi:10.1016/j.epidem.2014.04.003
7. Pattnaik P, Jana A. Microbial Forensics: Applications in Bioterrorism. Environmental Forensics. 2005;6(2):197-204. doi:10.1080/15275920590952874
8. Cappuccio J, Falso M, Kashgarian M, Buchholz B. 14C Analysis of protein extracts from Bacillus spores. Forensic Sci Int. 2014;240:54-60. doi:10.1016/j.forsciint.2014.04.003
9. Arenas M, Pereira F, Oliveira M et al. Forensic genetics and genomics: Much more than just a human affair. PLoS Genet. 2017;13(9):e1006960. doi:10.1371/journal.pgen.1006960
10. Li X, Yu J, Zhang Z et al. Network bioinformatics analysis provides insight into drug repurposing for COVID-2019. Preprints 2020. 2020. doi:https://doi.org/10.20944/preprints202003.0286.v1
11. Pattnaik P, Jana A. Microbial Forensics: Applications in Bioterrorism. Environmental Forensics. 2005;6(2):197-204. doi:10.1080/15275920590952874
12. Gilchrist C, Turner S, Riley M, Petri Jr. W, Hewlett E. Whole-Genome Sequencing for Listeria Outbreak Surveillance. Microbe Magazine. 2016;11(2):58-58. doi:10.1128/microbe.11.58.2
13. Veljkovic V, Segalés J, Paessler S. Use of the informational spectrum methodology for rapid biological analysis of the novel coronavirus 2019-nCoV: prediction of potential receptor, natural reservoir, tropism and therapeutic/vaccine target. F1000Res. 2020;9(52). doi:https://doi.org/10.12688/f1000research.22149.2
14. Woo P, Lau S, Chen Y et al. Rapid detection of MERS coronavirus-like viruses in bats: potential for tracking MERS coronavirus transmission and animal origin. Emerg Microbes Infect. 2018;7(1):1-7. doi:10.1038/s41426-017-0016-7

15. Oliveira M, Amorim A. Microbial forensics: new breakthroughs and future prospects. Appl Microbiol Biotechnol. 2018;102(24):10377-10391. doi:10.1007/s00253-018-9414-6

16. Chen Q, Zhu J. Detecting virus-specific effects on post-infection temporal gene expression. BMC Bioinformatics. 2019;20(S3). doi:10.1186/s12859-019-2653-4

17. Charaya N. Microbial Forensic's - Microbes as a part of Forensic Investigation. Journal of Advanced Medical and Dental Sciences Research. 2016;4(4):32-37. doi:10.21276/jamdsr.2016.4.4.8

18. Woo P, Huang Y, Lau S, Yuen K. Coronavirus Genomics and Bioinformatics Analysis. Viruses. 2010;2(8):1804-1820. doi:10.3390/v2081803

19. Jombart T, Aanensen D, Baguelin M et al. OutbreakTools: A new platform for disease outbreak analysis using the R software. Epidemics. 2014;7:28-34. doi:10.1016/j.epidem.2014.04.003

20. Li X, Yu J, Zhang Z et al. Network bioinformatics analysis provides insight into drug repurposing for COVID-2019. Preprints 2020. 2020. doi:https://doi.org/10.20944/preprints202003.0286.v1

21. Fricke W, Rasko D, Ravel J. The Role of Genomics in the Identification, Prediction, and Prevention of Biological Threats. PLoS Biol. 2009;7(10):e1000217. doi:10.1371/journal.pbio.1000217

22. Li X, Yu J, Zhang Z et al. Network bioinformatics analysis provides insight into drug repurposing for COVID-2019. Preprints 2020. 2020. doi:https://doi.org/10.20944/preprints202003.0286.v1

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 224-226
doi:10.5958/0974-0848.2020.00058.5

CASE REPORT

Pushing the Envelope: A Unique Case of Successful Treatment of Diquat Poisoning with Multiorgan Dysfunction

George Varghese,[1] Navin Patil,[2] Shanti Gurung,[3] Shankar M Bakkannavar,[4] Karthik Rao,[5] Mohsin Nazeer[1]

1 Department of Forensic Medicine, VMMC & Safdarjung hospital, New Delhi, India
2 Associate Professor, Department of Pharmacology, Kasturba Medical College, Manipal, Karnataka, India
3 Lecturer, Universal College of Medical Sciences, Bhairahawa, Nepal
4 Associate Professor, Department of Forensic Medicine & Toxicology, Kasturba Medical College, Manipal, Karnataka, India
5 Associate Professor, Department of Medicine, KS Hegde Medical Academy, Mangalore, Karnataka, India

Abstract

Consumption of chemicals and toxins is one of the most common means of committing suicide. Ingestion of pesticides for commission of suicide is a common subtype of this. Pesticide poisoning cases continue to be the one of the most important therapeutic problems around the world. We report a case of suicidal diquat (1,1'-ethylene-2,2'- bipyridyldiylium) poisoning that presented itself with complications and multi-organ failure. The patient was riddled with a myriad of problems such as vomiting, diarrhoea, painful burning of the mouth, tongue oedema, somnolence, mydriasis, reduced light re-flexes, jaundice and hematuria. Timely hemoperfusion, intravenous N acetyl cysteine and transfusion of blood products to the patient prevented catastrophic haemorrhage and saved his life. The patient was successfully treated and fully recovered. In this paper the medical line of management was highlighted which was responsible for the recovery.

Keywords

Pesticide poisoning; Diquat; Multiorgan failure

Introduction

Suicidal poisoning cases due to pesticide ingestion are common around the world. The incidence of such cases are more in numbers in developing countries. Herbicides follow pesticides in terms of mortality and morbidity due to poisoning. Diquat (1,1'-ethylene-2,2'- bipyridyldiylium) and paraquat (1,1'-dimethyl-4,4' bipyridyldiylium) belong to herbicide group.[1] Though the acute toxicity is same in both the compounds, the incidence of diquat poisoning cases is less.[1] In some countries they are associated with high mortality rate.[2]

Diquat is a non-selective contact herbicide, a potent redox cycler which creates highly selective superoxide radicals leading to local as well as systemic effects.[3] The systemic manifestations include gastrointestinal mucosal ulceration, paralytic ileus, hypovolemic shock, acute renal failure, and coma.[4] It can lead to multiorgan failure including lungs, myocardium, liver, kidneys and gastrointestinal tracts.[3]

We present a case wherein an adult male with intentional consumption of diquat was presented with multiorgan failure was treated effectively in a tertiary care hospital.

Corresponding Author
Dr Shankar M Bakkannavar (Associate Professor)
Email: shankar.mb@manipal.edu
Mobile: +91-9110240992

Article History
Received: 29th March, 2020; Accepted: 11th August, 2020

Case Details

A 38-year-old male, agriculturist by occupation intentionally consumed approximately 60 ml of an herbicide came to the tertiary care teaching hospital for management. On arrival the patient was irritable, confused and disoriented. He also complained of abdominal pain, vomiting, diarrhea which were also associate with corrosive damage to the oral mucosa, leading to burning in the mouth and painful hemorrhagic ulceration along with edema of the tongue, somnolence, mydriasis and reduced light re-flexes. On subsequent day he showed signs of jaundice as well as hematuria.

On day 1: Physical examination of the victim of poisoning revealed slight increase in blood pressure (142/88 mmHg) with mean pressure of 126mmHg and normal heart rate being 70 beats/minute. Mucosal ulcerations and abdomen tenderness were treated with Oral Benzocaine with Pantoprazole. Total leucocyte count was elevated (23,700 cells/cu.mm.) along with dropped platelet count to 77,000 cells/cu.mm were treated with intravenous Ceftriaxone (2g/day). As Serum creatinine level on admission was 1.7mg/dL, Hemoperfusion was considered.

On day 2: The platelet count was reduced to 29000 cells/cu.mm and hemoglobin was 8.9g/DL. 4 units of blood were transfused and potassium supplements were provided which led to normalization of platelets, potassium and total leucocyte counts. N-Acetyl Cysteine (NAC) was administered as per the standard protocol for treatment of paracetamol poisoning (Initial loading dose of 150mg/kg over 60 minutes, 50 mg/kg over the next four hours and 100mg/kg over the next 16 hours).

On day 3: An episode of spontaneous hypoglycemia was

noticed. Platelet counts dropped again (54,000 cells/cu.mm.) Lactate dehydrogenase (LDH) level was 814U/L (normal range being 140-280 U/L). The patient was supported with parenteral glucose. Acute kidney injury, hypoglycemia, severe anemia and thrombocytopenia requiring transfusion were treated accordingly and the patient recovered.

At the time of discharge, serum creatinine 0.9 mg/dL, serum potassium 4.4 mEq/L, and platelet count showed 3,05,000 cells/cu.mm.

Discussion

Unintentional or intentional poisoning due to herbicides is common in Asia, the Pacific and Caribbean regions of the world.[4] Diquat (1,1'-ethylene-2,2'-bipyridilium) is a nonselective bipyridyl herbicide.[5] Incidences of diquat poisoning cases are less when compared to paraquat. When systemically absorbed, it has more severe toxic effects on central nervous system consisting of brain stem infarction (particularly pons) as reported in fatal cases.[6,7,8] As it does not selectively concentrate in lung, only causes mild, reversible injury to type I pneumatocytes and there is no evidence of progressive pulmonary fibrosis.[6,7] The clinical manifestations of diquat can be considered in the following three groups based on the amount of poison consumed as:[9]

Group 1: Mild poisoning (1g diquat ion ingested). In addition to gastrointestinal symptoms, evidence of renal impairment may develop. Recovery is invariable.

Group 2: Moderate-to-severe poisoning (1–12 g diquat ion ingested). Multiple organ dysfunction is frequent, and acute renal failure in particular is common but recovery occurs in some two-thirds of cases.

Group 3: Fulminant poisoning (>12 g diquat ion ingested). Multiple organ failure develops and death eventually occurs in all cases within 24–48 hours.

Diquat, like paraquat, is a potent redox cycler and its toxic effects depend on its ability to undergo a single electron addition to form a free radical. This occurs in the presence of NADPH and cytochrome P450 reductase. The diquat radical formed in this step is highly unstable and transfers an electron to molecular oxygen to form a superoxide anion radical, a highly reactive species. In this way, diquat is cycled in a continuous process of oxidation and reduction, hence the term redox cycling.[10]

The superoxide anion radicals produced from the redox cycling of diquat react with each other forming hydrogen peroxide and molecular oxygen, a reaction that may occur spontaneously or via the enzyme superoxide dismutase. Under normal circumstances, hydrogen per-oxide is detoxified by catalase and glutathione peroxidase, but when such protective mechanisms are over-whelmed, it is free to cause devastating effects on the cell.[10] In the presence of iron, the superoxide anion radical reacts with hydrogen peroxide generating the even more potent hydroxyl radical. The hydroxyl radical can attack the lipid chains of biological membranes initiating lipid peroxidation which causes membrane damage and ultimately cell death.[10] The oxidative stress induced by diquat is associated with the release of iron from hepatic ferritin and the depletion of reducing equivalents including glutathione and NADPH.

There is no specific antidote for diquat treatment.[11] N-acetyl cysteine, employed in the management, has been known to improve the condition.[12] It helps to improve the lung function, controls symptoms and reduces exacerbation rates by breaking disulphide bonds in mucoprotein complexes or by direct or indirect antioxidant effects. N-acetyl-L-cysteine (NAC) is a precursor of glutathione (GSH). Hoffer et al. in a study enhanced GSH content and prevention of paraquat induced cytotoxicity by incubating NAC with alveolar type-II alveolar cells.[13] Keeping this in mind, this patient was initiated on NAC therapy. NAC reduces serum malondialdehyde levels, thereby reducing superoxide production and increasing glutathione concentrations.[5] Studies have shown that liposomal NAC (L-NAC) is better than conventional NAC, as L-NAC has increased intracellular concentration due to liposomal delivery.[6]

Other treatment modalities like immunosuppression in paraquat poisoning using corticosteroids, cyclophosphamide have been tried, but their role has not been definitely established.[7]

Conclusion

The case highlights the importance of early and aggressive management in patients with diquat poisoning. Larger studies need to be undertaken to ascertain the role of high dose intravenous N acetyl cysteine in the management of diquat poisoning. This young adult survived only due to the timely hemoperfusion, intravenous N acetyl cysteine and transfusion of blood products preventing catastrophic haemorrhage. From a public health perspective, counselling and educating the farmers and people at risk of consuming paraquat is of paramount importance considering its potentially devastating effects.

Conflict of interest: None to declare

Source of funding: None to declare

References

1. Saeed SAM, Wilks MF, Coupe M. Acute diquat poisoning with intracerebral bleeding. Postgrad Med J 2001;77:329–332.
2. Elenga N, Merlin C, Le Guern R, Tchameni RK, Ducrot YM, Pradier M, Ntab B, Dinh-Van KA, Sobesky M, Mathieu D,

Dueymes JM, Egmann G, Kallel H, Mathieu-Nolf M. Clinical features and prognosis of paraquat poisoning in French Guiana: A review of 62 cases. Medicine (Baltimore). 2018;97(15): e9621. doi:10.1097/MD.0000000000 009621

3. Rayyan E, Savajiyani S, Uppalapu S. Diaquat toxicity: Multi-organ failure from Herbicide Ingestion. Am J Respir Crit Care Med 2018;197: A6902
4. Khosya S, Gothwal S. Two cases of paraquat poisoning from kota, rajasthan, India. Case Rep Crit Care. 2012; 2012:652146. doi:10.1155/2012/652146
5. Jones GM, Vale JA. Mechanisms of toxicity, clinical features, and management of diquat poisoning: a review. J Toxicol Clin Toxicol. 2000; 38(2):123-8.
6. Olson KR. Paraquat and diquat. Poisoning and drug overdose. 2nd ed. Norwalk: Appelton and Lange; 1994:245-246.
7. Vanholder R, Colardyn F, De Reuck J, Praet M, Lameire N, Ringoir S. Diquat intoxication: report of two cases and review of the literature. Am J Med. 1981;70(6):1267-1271.
8. Lam HF, Takezawa J, Gupta BN, van Stee EW. A comparison of the effects of paraquat and diquat on lung compliance, lung volumes and single breath diffusing capacity in the rat. Toxicology. 1980;18(2):111-123.
9. Wilks MF. Diquat: Diagnosis, Treatment and Prognosis of Poisoning. Fernhurst, Haslemere, Surrey: Zeneca Agrochemicals, 1994.
10. Niesink JM, de Vries J, Hollinger MA. Toxicology: Principles and Applications. Boca Raton: CRC Press, 1996.
11. Magalhães N, Carvalho F, Dinis-Oliveira RJ. Human and experimental toxicology of diquat poisoning: Toxicokinetics, mechanisms of toxicity, clinical features, and treatment. Hum Exp Toxicol. 2018; 37(11): 1131-1160.
12. Karthik Rao, Navin P, Handattu Manjunatha Hande, Sushil Kiran Kunder, A Avinash, Zeba Moopen, and George Varghese. Successful Management of Paraquat-Induced Multiorgan Dysfunction Syndrome with Intravenous N-Acetyl Cysteine. Res J of Pharm Bio Chem Sci. 2016; 7(1): 564-566.
13. Hoffer E, Baum Y, Tabak A, Taitelman U. N-acetylcysteine increases the glutathione content and protects rat alveolar type II cells against paraquat-induced cytotoxicity. Toxicol Lett 1996; 84: 7-12.

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 227-230
doi:10.5958/0974-0848.2020.00059.7

CASE REPORT

Arsenic – Not an Obsolete Homicidal Poison

Roshni Pillay[1], Anu Sasidharan[2], VV Pillay[3]
1 Aster Medcity, Cochin, Kerala
2 Department of Forensic Medicine & Toxicology, Amrita School of Medicine, Amrita Vishwa Vidyapeetham, Cochin, Kerala
3 Poison Control Centre, Department of Forensic Medicine & Toxicology, Amrita School of Medicine, Amrita Vishwa Vidyapeetham, Cochin, Kerala

Abstract
Arsenic has been one of the heavy metals with a notorious reputation as an ideal homicidal poison, with numerous high profile cases being reported in literature. It has also been a favourite with detective fiction writers who write stories on cases involving the use of poisons. However, over a period of time the popularity of arsenic began to wane in reality as well as in fiction; and other newer and more exotic poisons emerged. In recent times, cases of such homicidal attempts with this agent have become quite scarce in literature. It is in the midst of such a scenario that a shocking case of attempted murder with an arsenic compound came to light in a major corporate hospital of Cochin, involving a Keralite male working in Bengaluru city. Suspicions of systematic poisoning with arsenic trioxide through his food over a period of several days to weeks became a certainty on the basis of his gradually deteriorating health, medical evaluation, and subsequent laboratory investigations. While the case is yet to be resolved in the legal context, medically the patient is on the road to recovery, and this paper seeks to present the clinical unfolding of a case of arsenic poisoning with almost textbook characteristics in relation to symptomatology and laboratory findings.
This disturbing case serves to demonstrate the sinister fact that some poisons just do not fade into history, and physicians must always be alert to the possibility of them still being employed by people with a criminal bent of mind.

Keywords
Arsenic; Attempted homicide; Criminal poisoning; Heavy metal

Introduction

In India, though the general perception is that heavy metal poisoning is uncommon, the truth is the converse.[1] Heavy metal poisoning is a major cause of morbidity/mortality all over the world with India being no exception. Arsenic has had an outstanding reputation as an ideal homicidal poison, especially in the West, in the Victorian era. Several murders were said to have been accomplished with the help of this heavy metal, including the shocking case of Napoleon Bonaparte, though there are conflicting reports relating to this today.[2] However of late, the popularity of arsenic as a homicidal agent had declined due to legal restrictions on its sale, availability of sophisticated methods for its detection, and also perhaps due to emergence of better homicidal poisons. Today much of the reported research work on arsenic relate to environmental contamination,[3] and reports of murders are quite rare.[4] Since 1992, only two cases of intentional arsenic poisoning have been reported in the Western literature.[5,6] Arsenic trioxide, one of the commonest salts of this metal, can be administered to a victim without arousing suspicion because it is virtually tasteless and colourless. The only problem is the relative insolubility in common food or beverage items, and hot solutions (such as coffee or soup) are required for dissolving it.[1] Also, much of the dissolved arsenic often separates out as a gritty deposit once the solution cools. But if chronic administration to a victim is successful, the symptoms produced can be mistaken even by a qualified doctor for natural causes such as neurological disease or hepatorenal afflictions, while acute poisoning may be confused with gastroenteritis or cholera.

The case being reported is a rare presentation of homicidal chronic arsenic poisoning with almost textbook characteristics that escaped suspicion for quite some time.

Case Report

A 37 year old male, an Information Technology professional working in the city of Bengaluru, developed nausea, vomiting and loose stools immediately after dinner at home, on 15 April 2019. He was admitted at a local hospital and was managed conservatively. He was symptomless for the next one month. However, the same incident repeated one month later following dinner, though this time, the symptoms took much longer to resolve. He was again admitted to hospital. In addition to the earlier features, there was tingling and numbness of both hands. After two weeks he was discharged, but the sensory neuropathy of both hands and feet persisted for a month. By the end of July 2019, he began to notice skin changes on his palms and soles in the form of flaking, accompanied by a burning sensation over the feet. He became virtually bed bound due to difficulty in walking, and also had loss of appetite. He felt progressively

Corresponding Author
Dr. VV Pillay (Chief of Poison Control Centre, Professor & Head of Forensic Medicine & Toxicology)
E-mail : toxicology@aims.amrita.edu
Mobile: +91-9895282388

Article History
Received: 2nd April, 2020; Accepted: 13th August, 2020

weaker and had to be readmitted to the hospital.

This time, a detailed evaluation was done by the attending physician. The complete blood count showed evidence of leucopoenia and anaemia. Iron studies, folic acid and vitamin B_{12} levels were normal. ESR (erythrocyte sedimentation rate) was 15mm/hr and CRP (C-reactive protein) was 12mg/l. Renal, liver, and thyroid function tests, serum amylase and lipase, and electrolytes were all with normal ranges. ANA (antinuclear antibody) profile, C-ANCA (cytoplasmic antineutrophil cytoplasmic antibodies) and P-ANCA (perinuclear antineutrophil cytoplasmic antibodies) were also negative. Tissue transglutaminase immunoglobulin A (tTG-IgA) was assayed and showed up as negative. CECT (high-dose contrast-enhanced computed tomography) abdomen indicated peripancreatic oedema. NCV (nerve conduction velocity) revealed right deep peroneal neuropathy, primarily demyelinating in nature, with secondary axonal loss. MRI (magnetic resonance imaging) of the spine was normal. No oligoclonal bands were seen in the cerebrospinal fluid. Autoimmune encephalitis panel and paraneoplastic panel tests turned out to be negative.

Figure 1: Arsenic trioxide powder

The patient was diagnosed and managed as a possible case of Guillain–Barré syndrome (GBS) for five days with intravenous immunoglobulin (IV-IG) and was then discharged. But he showed no improvement at all, and subsequently presented to a major corporate hospital in Cochin on 5 September 2019.

Figure 2: Hyperkeratosis of skin over the palm of left hand

Figure 3: Hyperkeratosis of skin over the sole of left foot

Meanwhile he began to develop suspicion that his wife was somehow responsible for his problems as they had been experiencing serious marital problems for quite some time. The patient felt that his symptoms appeared to manifest only when he had food from his home. Subsequently he searched the entire house meticulously for the source of the poison and happened upon a bottle with white powder (Figure 1) among the kitchen waste. This white powder was tested in a laboratory in Bengaluru, and was identified as arsenic trioxide. The first author performed a detailed physical examination and recorded severe hyperkeratosis of palms and soles (Figure 2 and 3). The patient then consulted with the third author and got his blood

sample tested for arsenic. The toxicology report revealed high level of arsenic (63.36 mcg/L) confirming the diagnosis as chronic arsenic poisoning. He was started on chelation therapy with a combination of dimercaprol (British Anti Lewisite or BAL) and D-penicillamine following which his condition improved significantly (Figure 4). As there was no further exposure, his overall condition improved with supportive treatment. Meanwhile the patient made a complaint of deliberate poisoning against his wife to the police, which is currently being pursued.

Figure 4: Healing of the sole of left foot, following chelation therapy

Discussion

In the case being reported, attending physicians suspected various ailments as being responsible for the patient's deteriorating condition, until finally it began to dawn on the victim himself that he was being poisoned.

The usual fatal dose of arsenic trioxide is 200-300 mg; and the lethal dose following acute ingestion is 1-3 mg/kg.[1] However survival has been reported in an adult following ingestion of 54 grams of arsenic trioxide.[7] The amount of arsenic consumed was not able to be estimated in the present case. A blood level of less than 10 mcg/L is generally considered normal. In this case, the blood level was 63.36 mcg/L and the classical clinical features of chronic arsenic poisoning as mentioned in the literature[1] were clearly evident, such as hyperkeratosis of palms and soles, anorexia, weight loss, periodic diarrhoea, etc. There was also polyneuropathy mimicking GBS which has been a frequently confounding condition in the differential diagnosis.[8]

While many physicians today consider arsenic poisoning to be relatively uncommon in the form of accidental nature, leave alone homicidal, this case shows that the notorious Victorian poison is still very much around. A fact that has also been reinforced by some other reported cases.[9] Diagnosis is often tricky, but a high index of suspicion can enable this to be done with certainty, with the help of methodologies such as ICP-MS (inductively coupled plasma mass spectrometry) and ICP-AES (inductively coupled plasma atomic emission spectrometry) that are considered to be among the best methods for heavy metal analysis today.[10] In this case, ICP-MS was used, both on the suspicious white powder, as well as the blood sample, and helped to clinch the diagnosis. Hair samples were not tested for arsenic as there is much controversy today about its actual efficacy in arriving at the right diagnosis, because of confounding factors such as environmental exposure.[11] Urine screening for heavy metals is subject to high incidence of false positives/negatives.[12]

While treatment of chronic arsenic poisoning is best accomplished with chelation therapy utilising DMSA (dimercapto succinic acid), or DMPS (dimercapto propane sulfonic acid), in India BAL (British anti lewisite or dimercaprol) is usually employed because the former are not easily available. In the case being reported, a combination of BAL and D-penicillamine was used, as this is more effective.[13]

Conclusion

Arsenic is a heavy metal with a notorious reputation. Even though numerous cases have been reported in the past, its popularity has waned in recent years. But as this case report demonstrates, it has never really disappeared from the scene. The case highlights the importance of a high degree of suspicion every clinician must have when dealing with unusual presentations in daily practice.

Ethical clearance: A prior approval was obtained from the Institutional Ethics Committee

Conflict of interest: None to declare

Source of funding: None to declare

References

1. Pillay VV. Heavy Metals. In: Comprehensive Medical Toxicology. 3rd ed. Hyderabad: Paras Medical Publisher; 2018: 142-242.
2. James G Whorton. The Arsenic Century. 2011. Oxford University Press, United Kingdom.
3. Pillay VV, Sasidharan A, Arathy SL, Sundaram KR, Greeshma CR. Detection and estimation of arsenic and lead in coconut water – A Kerala study. Indian J Forensic Med Toxicol 2019; 13 (1): 19-24.
4. Poklis A. Arsenic poisoning: Acute or chronic? Suicide or murder? American J Forensic Med Pathol 1990; 11: 226-232.
5. Roy A. Old textbooks out of arsenic poisoning case. Sunday Telegraph 1995.
6. Heitland P, Koster HD. Comparison of different medical cases in urinary arsenic speciation by fast HPLC-ICP-MS. Int J Environ Health 2009: 212: 432-438.
7. Duenas-Laita A, Perez-Miranda M, Gonzalez-Lopez MA, Martín-Escudero JC, Ruiz-Mambrilla M, Blanco-Varela J. Acute arsenic poisoning. Lancet 2005; 365 (9475): 1982.
8. Bolliger CT, Zijl P, Louw JA. Multiple organ failure with the adult respiratory distress syndrome in homicidal arsenic poisoning. Respiration 1992; 59: 57-61.
9. Duncan A, Taylor A, Leese E, Allen S, Morton J, McAdam J. Homicidal arsenic poisoning. Ann Clin Biochem 2015; 52 (4): 310-515.
10. Moor C, Lymberopoulou T, Dietrich VJ. Determination of Heavy Metals in Soils, Sediments and Geological Materials by ICP-AES and ICP-MS. Mikrochim. Acta. 2001; 136(3): 123-128.
11. Katz SA. On the use of hair analysis for assessing arsenic intoxication. Int J Environ Res Public Health 2019; 16(6): 977.
12. Kales SN, Huyck KL, Goldman RH. Elevated urine arsenic: unspeciated results lead to unnecessary concern and further evaluations. J Analyt Toxicol 2006; 30: 80-85.
13. Kosnett MJ. The role of chelation in the treatment of arsenic and mercury poisoning. J Med Toxicol 2013; 9(4): 347-354.

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 231-233
doi:10.5958/0974-0848.2020.00060.3

CASE REPORT

Forensic Dental Evidence in a case of sexual assault and homicide of a minor girl in India: A Case Report

Hemlata Pandey, Harish M Pathak
Department of Forensic Medicine and Toxicology, Seth GS Medical College and KEM Hospital, Mumbai, India

Abstract
Forensic Odontology is that branch of dentistry which deals with evidence related to teeth and maxillo-facial region, pertaining to recognition, collection, evaluation, analysis, reporting and presentation of dental evidence. Bites, in the form of pattern injury are sources of physical evidence and owing to the presence of saliva which can be swabbed for DNA as per standard protocols of forensic examination, they are also a source of biological evidence. In this paper, a case of sexual assault and homicide of a minor girl, involving bite mark evidence is presented. Bite mark evidence, if analysed, must be handled with utmost sensitivity as skin is a dynamic tissue and the pattern is not always recorded with clarity. However, when the pattern of injury is clear and undistorted, it can prove to be crucial in such forensic investigations involving should crimes against women and children.

Keywords
Forensic Odontology; Dental evidence; Sexual assault; Bite mark analysis

Introduction

Forensic Odontology has been defined by various researchers through decades. It is, in essence, that branch of dentistry which deals with evidence related to teeth and maxillo-facial region, pertaining to recognition, collection, evaluation, analysis, reporting and presentation of dental evidence. Teeth have been used as weapons of violence since prehistoric times. Bite marks are commonly inflicted in cases of sexual assaults, child abuse, domestic violence, by an aggressive attacker, however, biting the attacker may be the only option available for defence by the victim. [1] However, Bites are sources of physical as well as biological evidence, owing to the presence of saliva which can be swabbed for DNA as per standard protocols of forensic examination.

Case Report

In this case report, a 14 year old orphan girl's body was found at her home by her younger sister. On post mortem examination by a team of 4 doctors including the gynaecologist, it was opined that the girl had been sexually assaulted and cause of death was by strangulation (using thread of petticoat which was found wrapped around her neck at the crime scene). In the course of investigation, it was later revealed that the younger sister of the deceased, was an eyewitness who had seen a 34 year old man known to the sisters at her home and had threatened her with similar consequences were she to tell anyone about the incident. Medical examiners, on autopsy, noted multiple bite marks on the body of the victim, for which the case was later referred to forensic odontologist for bite mark analysis.

Corresponding Author
Dr. Hemlata Pandey (Assistant Professor- Odontology Consultant)
Email address: drhemlata.pandey@kem.edu
Mobile No: +91 8879066856

Article History
Received: 7th April, 2020; Accepted: 24th July, 2020

Bite Mark Analysis

Abrasion of size approximately 2.8cm, semi-circular or 'C' in shape, reddish in colour, depression exhibiting linear pattern of teeth, was present over left cheek region, suggestive of a partial human bite mark representing biting patter of lower arch of biter's dentition exhibiting both class and individual characteristics (Figure 1). Partial bite mark was inflicted due to cloths on victim and hand of accused covering upper half of victim's left cheek. Two partial bite marks were present on the left breast which exhibited limited class or individual characteristics. Multiple bite marks were present on the right breast of the victim of which 3 were partial, exhibiting clear class characteristics and limited individual characteristics (Figure 2).

Complete dental examination of accused was followed by dental impressions to prepare casts. Dental examination of accused exhibited generalized attrition involving enamel, spacing with maxillary and mandibular anterior teeth, labial proclination as well as distal tilt with lower left lateral incisor, mild distal tilt with lower left central incisor (Figure 3).

On comparison with injury on left cheek of victim, the pattern of accused's teeth was consistent with class as well as individual characteristics observed on the pattern of injury. There was absence of any discrepancies between the two (Figure 4). On comparison with injuries present on the breasts of the victim, the pattern of accused's teeth was consistent with the class characteristics and limited individual characteristics were observed (Figure 5). There was absence of any discrepancy. It was concluded that bite mark injury present on

victim's left cheek was probably inflicted by the accused and there is less or rare likelihood for someone else to have created a bite mark in the same pattern. The bite mark injuries on breast exhibited limited individual characteristics and the possibility of accused having made those marks could not be ruled out as there were no discrepancies observed.

Figure 1: Bite mark injury present over left cheek of victim

Figure 2: Bite mark injuries present over right breast of victim

The positive DNA reports from clothes of victim, accused and swabs taken from the victim's body during autopsy, as well as evidence of strangulation, all provided ample proof to connect the accused with this crime. In relation to bite mark evidence, Additional Sessions Special Judge, Parbhani, Presided over by Dr. Y.G. Chaware: Special POCSO Case No.2/2014; State Vs. Irfan @ Afroz

"…. From her evidence, it is clear that the bite marks appearing on the body of the deceased are caused by the accused. Though she has given opinion that probably those bite marks are caused by the accused, her evidence cannot be discarded. Her evidence is sufficient to establish that the accused has committed rape on deceased and while committing the rape, he caused bite marks to the deceased. All the evidence of the prosecution is consistent and sufficient to prove that the accused has committed rape on deceased and also murder of deceased. The prosecution has proved offence beyond all reasonable doubts. No any circumstance on record creates any kind of doubt." [2]

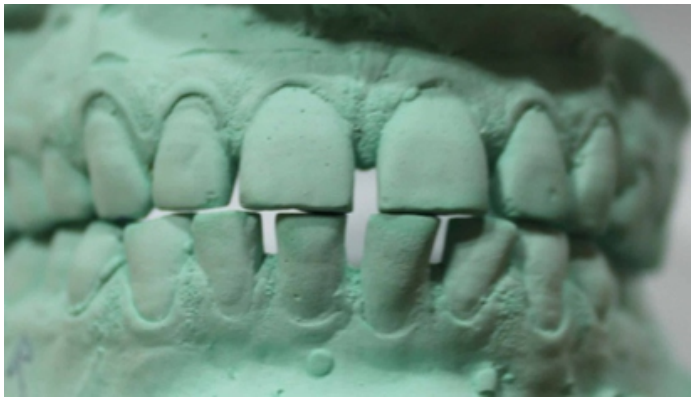


Figure 3: Dental casts of maxillary and mandibular arch of accused, fabricated with dental stone

Figure 4: Comparison of pattern of injury on victim's left cheek with incisal edges of lower arch of accused

Figure 5: Comparison of pattern of injury on victim's right breast with incisal edges of upper and lower arch of accused

Discussion

Human bite, generally, exhibit class characteristics such as a circular or elliptical pattern. Often 2 'C' or 'U' shaped arches are observed facing each other, separated at their bases representing the biting edges of upper and lower teeth impressed on the skin while biting. [3] The diameter of an adult human bite can range anywhere between 2.5 mm to 4.5 mm, and often a centralized area of bruising is observed within this circular pattern. In some cases, a partial bite mark may be visible with only an upper or a lower arch or upper and lower arch of left or right side. This may happen due to movement by victim and/or perpetrator or something like clothes partially covering the region of injury when it is being inflicted.

Individual characteristics of the biter's teeth in relation to the shape and size of the arch and each tooth, their pattern of arrangement like crowding or spacing, presence of diastema, rotations, tilting, supraeruption or infraeruption, fractured incisal edges, attrition, congenital malformations, any dental treatment, temporo-mandibular joint, deviation while mouth opening or closing, mobility, etc. render the pattern unique to that individual. [4] However, human skin, depending on the region of bite, maybe curved, flexible, undergoing inflammation, infected, distortable, and hence, it is pertinent that bite marks be evaluated by a qualified and experienced forensic odontologist. When the bite mark exhibits class and individual characteristics of the biter's dentition, clearly visible on the medium of bite like human skin, only then can they be analyzed and compared to the suspects in that case.

Photography of bite marks can be done by conventional or digital photography. Digital photography has become a more convenient form of evidence collection in the past decade. Distortion can be minimized during the process of photography and evidence collection, resolution of photographs should be high quality and orientation of injury in close-up photos should be perpendicular the surface of the lens of camera.

Conclusion

Bite mark analysis can provide crucial forensic evidence in cases of crimes against women and children. However, skin being a dynamic flexible tissue, bite marks are not always recorded clearly. It is advisable that bite mark analysis be conducted by a forensic odontologist qualified and experienced in this field; and that bite mark evidence can never replace DNA evidence or other primary evidences. Forensic odontology reports to Court of law or other legal agencies simply offering an opinion have little significance, therefore, inclusion of information as to why the conclusion or opinion was reached is essential. Studies also indicate that in a small but significant proportion of cases, there is still some tendency to reach conclusions that could be considered over-confident when considering the overall quality of the physical evidence offered.[5-8] Since digital methods are susceptible to loss of data or allegations of manipulation, it is pertinent that meticulous records be maintained by the testifying expert throughout the process. Bite mark analysis is one of the most demanding, complicated and sensitive part of forensic odontology work.

Conflict of interest: None to declare

Source of funding: None to declare

References

1. Sweet D, Pretty IA. A look at forensic dentistry − Part 2: teeth as weapons of violence − identification of bitemark perpetrators. Br Dent J 2001; 190(8): 415−418
2. Judgment: Special POCSO Case No.2/2014; State Vs. Irfan @ Afroz; Exh.No.80.In The Court Of Additional Sessions Judge, Special Judge, Parbhani. (Presided over by Dr. Y.G. Chaware)
3. Pretty, I. A. (2008). Forensic Dentistry: Bitemarks and Bite Injuries. Dental Update, 35(1), 48–61.
4. Krishan K, Kanchan T, Arun K. Dental Evidence in Forensic Identification – An Overview, Methodology and Present Status. Open Dent J. 2015; 9:250–6.
5. Pretty, I. A. (2008). Forensic Dentistry: 2. Bitemarks and Bite Injuries. Dental Update, 35(1), 48–61.
6. Page M, Taylor J, Blenkin M, Reality bites—A ten-year retrospective analysis of bitemark casework in Australia, Forensic Science International, 2012, 216:82-87
7. B.L. Garrett, P.J. Neufeld, Invalid forensic science and wrongful convictions, VA Law Rev. 95 (2009) 1–97
8. The Innocence Project, Available at: https://www.innocenceproject.org/ (Accessed on: 24th March 2019).

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 234-237
doi:10.5958/0974-0848.2020.00061.5

CASE REPORT

An archetypal case report of child abuse and neglect- a dentist's perspective

Suruchi Gupta, Rashi Srivastava, Sudhindra Baliga M, Nilima Thosar, Chinmay Ghavat
Department of Pediatric and Preventive Dentistry, Sharad Pawar Dental College, Sawangi (Meghe), Wardha-442004, Datta Meghe Institute of Medical Sciences (Deemed University), Maharashtra, India.

Abstract
Child abuse and neglect are a serious global problem. It is often in the form of physical, sexual, emotional or neglect in providing for the child's needs. In India, the number of cases registered for child abuse increased from 8,904 in the year 2014 to 14,913 in the year 2015 with more than half of the reported cases involving craniofacial trauma. In the present case report, a 10-year-old male child was physically and emotionally abused by a senior schoolmate in the boys' hostel. In addition, neglect on the part of the hostel authorities facilitated the abuse to cause more detrimental effects. The child reported with trauma and mental torture. With due management of the trauma and debilitating emotional effects on the patient and providing counselling to the child and the caregiver, the patient made a steady recovery. With this we can say that paediatric dentists come across children who may be victims and thus play a key role in detecting child abuse and neglect as well as providing empathetic and appropriate care to them.

Keywords
Child abuse; Craniofacial trauma; Mental torture

Introduction

In the year 1999, the World Health Organisation (WHO) defined 'child abuse' as a violation of the basic human rights of a child. This comprised of all types of physical, emotional ill treatment, sexual violence, neglect or negligent care, commercial or other abuse causing which causes actual harm or potential harm to the health, survival, development or dignity of the child pertaining to special relations, trust or power.[1]

'Child neglect' on the other hand is defined as (a) inattention or omission by the caregiver to provide for the child's health, education, emotional development, nutrition, shelter and safe living conditions (b) in the context of providing resources reasonably available to the family or caretakers; (c) and causing harm to the child's health or physical, mental, spiritual, moral or social development.[2]

'Child maltreatment' sometimes referred to as child abuse and neglect, includes all forms of physical and emotional ill-treatment, sexual abuse, neglect, and exploitation that results in actual or potential harm to the child's health, development or dignity.[3]

Owing to the adverse socioeconomic situations, large population base, poverty, illiteracy and poor access to health services.[4] Child abuse and neglect is a serious, widely prevalent public health problem in India.[5] Age group of 5-12 years was the most vulnerable group exposed to child maltreatment according to a 2007 survey conducted by the ministry of women and child development. It discovered that among them almost 50% were abused physically and most of them were boys.[6]

Doctors and health care professionals are often the primary point of contact for maltreated and abused children.[7] They play a vital role in detecting child abuse and neglect, deliver immediate and long term care and support to these children.[8]

On the basis of this information and through the report of a case of child maltreatment, the aim of this paper is to provide elements that may assist dentists, especially paediatric dentists, in the diagnosis and management of child abuse cases.

Case Report

A 10 year old male patient was brought to the Pediatric dentistry OPD at Sharad Pawar Dental College and Hospital, Sawangi (M), Wardha by his parents with a chief complaint of an oral ulcer and problems in swallowing with discharge since two days. A detailed history was recorded and a thorough examination was done. Apart from oral ulceration, on examination, lacerations were noted on the left mastoid region and over the face and neck. (Figure1) Lacerations and healing scars were also seen on both the extremities. (Figure2) On intra-oral examination, a large solitary ulcer was noted on the soft palate region measuring approximately 3-4 mm in diameter with sloughing, erythema and indurations. (Figure3) With such lesions, a provisional diagnosis of child neglect was considered. The parents were then questioned separately with the child in the other room about a version of the events that had taken place and lead to such grievous injuries.

Behavioural indicators which led to suspicion included

Corresponding Author
Dr. Suruchi Gupta (Post-graduate student)
Email Id: suruchichiya.1993@gmail.com
Phone no: 9923158847

Article History
Received: 15th April, 2020; Accepted: 3rd August, 2020

withdrawn stance, stoic appearance, avoiding eye contact and conversation, and inconsistent explanations with the pattern of injury.

With the given data and the inspector findings, following discrepancies were noted:

Question	Child's Response	Parent's Response
Mechanism of the injury	Injury from Bedpost	Injury at school by schoolmates
Timing of the injury	2 days ago	Repeated injuries since months

With time invested in gaining confidence and trust of the child, effective communication was established to 1) Obtain information and 2) Confirming the suspicion.[5] This revealed the following information:

Injury	Alleged Cause	Actual Cause
Left Mastoid	Bedpost	Belt trauma
Neck, hands and feet	-	Nail and wire marks
Soft Palate	-	Toothbrush trauma by the senior

With all the data due recorded, the case was diagnosed to be of child abuse and neglect. The abuse was perpetuated by the patient's senior schoolmate.

The first step in the management was effective documentation and reporting which was carried out by thorough examination, questioning and counselling of the patient and family. This was followed by a complaint against the accused schoolmate to the school Principal. A treatment plan was formulated after consultation with the Department of Oral and Maxillofacial Surgery.

The treatment plan derived was

PHASE I: Counselling,

PHASE II: Conservative management with Anti-inflammatory and Antibiotic Therapy

PHASE III: Surgical - Suturing of ulcer under General Anaesthesia

PHASE IV: Periodic recall and review.

In the Follow up, 1 month later, the patient developed infection in the mastoid region which was operated surgically. There was a follow up taken on the punishment of the guilty, where the accused was found to be expelled from the school. At the 3 month follow up, the child reported with healed lesions and a positive, cheerful and interactive personality. (Figure 4 and Figure 5)

Figure 1: Lacerations noted on the left mastoid region and over the face and neck

Figure 2: Lacerations and healing scars seen on both the extremities

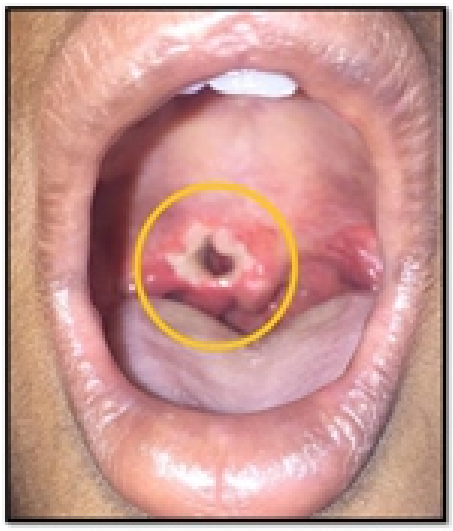


Figure 3: Intra-oral large solitary ulcer noted on the soft palate region

Figure 4: Healing Noted Intra-orally

Figure 5: A positive, cheerful and interactive change in personality of the child

Discussion

Child abuse can consist of various types i.e. physical, emotional, sexual, whereas child neglect can be physical or emotional in nature.[9] Their effects range from disrupted neuro-development leading to social, emotional, cognitive impairment which again could cause adoption of deleterious habits manifesting in disease, disability, social problems and even result in early death.[10] The abused and neglected children are often left with scars which affect them physically and psychologically, but they are the emotional scars that leave the child with life-long effects which damage the child's sense of self and the flexibility to create healthy relationships and performance at homework or school.[11-13]

Diagnosing such cases is of vital importance and a full body evaluation is necessary to confirm such cases as seen in the present case wherein multiple lesions were noted all over the body. Also, The oral cavity can be a focal point for physical violence due to its essential role in communication and nutrition.[14,15].

However, many dentists lack the training to interpret suspicious cases and report them.[16,17]

The defined roles of a Pediatric and Preventive Dentist include, Identification, Intervention, Management, Recording and Reporting which were all fulfilled in the present case.[18,19] Based on various case reports and protocols on the management of a case of abuse. The following plan of action was derived. Once it was established that the case was not that of domestic abuse, medical management was carried out to care for the injuries which were not life threatening. Since strict action was carried out by the authorities at school, no further action was carried out on our part. The patient and his family were counselled periodically and kept under monitoring.

The first ever documented case of child abuse was that of Mary Ellen Wilson in 1874 and this case led to the formation of New York Society for the Prevention of Cruelty to Children.[20]

Post that different jurisdiction developed their own stance towards mandatory reporting of such incidences. In 1974, the Child Abuse Prevention and Treatment Act came into existence in the United States.[21] In India, however, no laws or acts have been made yet with respect to physical abuse of children and there is an urgent need for strict laws and punishment to the abusers and protect the children from such maltreatments.[22]

Conclusion

It is essential for dentists to team up among themselves for prevention, recognition, and management of this condition and the urgent implementation of protective measures for the victim, along with sufficient follow-up in each case, in order to avoid the repetition of physical or sexual abuse in children of vulnerable age.[23,24]

Conflict of interest: None to declare

Source of funding: None to declare

References

1. World Health Organisation. Report of the consultation on child abuse prevention (WHO/HSC/PVI/99.1). Geneva(Switzerland): World Health Organisation, 1999.
2. Report of the Consultation on Child Abuse Prevention, 29–31 March 1999, WHO, Geneva. World Health Organization, 1999 (document WHO/HSC/PVI/99.1).

3. Gonzalez D, Bethencourt Mirabal A, McCall JD. Child Abuse and Neglect. [Updated 2019 Nov 29]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK459146
4. Southall D, MacDonald R. Protecting children from abuse: a neglected but crucial priority for the international child health agenda. Paediatrics and International Child Health. 2013;33(4):199-206
5. Rajeev Seth. Child abuse and neglect in India. Indian J Pediatr. 2015;82:707-714.
6. Kacker Loveleen, Vardan Srinivas, Kumar P. Study on Child Abuse: India 2007 Ministry of Women and Child Development, Government of India, 2007
7. Becker DB, Needleman HI, Kotelchuck M. Child abuse and dentistry: orofacial trauma and its recognition by dentists. J Am Dent Assoc. 1978;97:24–8.
8. Kemoli AM, Mavindu M. Child abuse: a classic case report with literature review. Contemp Clin Dent. 2014;5:256–9)
9. Jeffrey A. Dean. Mcdonald and Avery's Dentistry for the Child and Adolescent. 10th Ed. Elsevier;2016:110-119.
10. Muthu and Sivakumar. Pediatric Dentistry:Principles and Practice. 2nd Ed. Elsevier;2011:519-528.
11. Trope M. Root resorption due to dental trauma. Endod Topics. 2002;1:79–100.
12. Putnam FW. Ten-year research update review: Child sexual abuse. J Am Acad Child Adolesc Psychiatry. 2003;42:269–78.
13. Glasser M, Kolvin I, Campbell D, Glasser A, Leitch I, Farrelly S. Cycle of child sexual abuse: Links between being a victim and becoming a perpetrator. Br J Psychiatry. 2001;179:482–94)
14. Ambrose JB. Orofacial signs of child abuse and neglect: A dental perspective. Pediatrician. 1989;16:188–92 ;
15. Vadiakas G, Roberts MW, Dilley DC. Child abuse and neglect: Ethical and legal issues for dentistry. J Mass Dent Soc. 1991;40:13–5.
16. Vidhale G, Godhane AV, Jaiswal K, Barai M, Naphde M, Patil P. Role of Dentist in Child Abuse and Neglect: An Indian Perspective. Int J Dent Med Res 2015;1(6):224-225.
17. Souza-Acevedo M, Leao M, Brito A, Possebon AP, Domingues J, Demarco FF, et al. Child maltreatment: a survey of dentists in southern Brazil. Braz Oral Res 2011;26:5-1117.
18. Hinchliffe J. Forensic Odontology, Part 5. Br Dent J. 2011;210:423–8.
19. Mathur S, Chopra R. Combating child abuse: the role of a dentist. Oral Health Prev Dent. 2013;11:243–50.
20. Regoli, Hewitt, DeLisi, Robert M., John D., Matt (2014). Delinquency in Society (9th ed.). Burlington, MA: Jones & Bartlett Learning. p. 7. ISBN 978-1-4496-4549-6. The 1874 case of Mary Ellen Wilson is generally regarded as the first documented child abuse case in the United States.
21. Committee on Child Maltreatment Research, Policy, and Practice for the Next Decade: Phase II; Board on Children, Youth, and Families; Committee on Law and Justice; Institute of Medicine; National Research Council; Petersen AC, Joseph J, Feit M, editors. New Directions in Child Abuse and Neglect Research. Washington (DC): National Academies Press (US); 2014 Mar 25. 8, Child Abuse and Neglect Policy. Available from: https://www.ncbi.nlm.nih.gov/books/NBK195993/
22. Choudhry V., Dayal R., Pilla, D., Kalokhe A. S., Beier K., & Patel V. Child sexual abuse in India: A systematic review. PLOS ONE. 2018; 13(10), e0205086. doi:10.1371/journal.pone.0205086
23. Shastri P. Children at greater risk of abuse reveals NCRB data. The Times of India; 2014 Jul 7. Available from: http://timesofindia.indiatimes.com/india/Children-at-greater-risk-of-abuse-reveals-NCRB-data/articleshow/37920725.cms
24. Bathia SK, Maguire SA, Chadwick BL, Hunter ML, Harris JC, Tempest V. Characteristics of child dental neglect: a systematic review. J Dent. 2014;42:229–39.

J Indian Acad Forensic Med. 2020 Jul-Sep; 42(3): 238-239
doi:10.5958/0974-0848.2020.00062.7

PERSPECTIVE

Persistence of spermatozoa in the lower genitourinary tract after elapsed time: Should the guidelines be reframed?

Charu Sharma,[1] Raghvendra Singh Shekhawat,[2] Varuna Vyas,[3] Pratibha Singh,[1] Sudeep Khera[4]

1 Department of Obstetrics & Gynecology, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India
2 Department of Forensic Medicine and Toxicology, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India
3 Department of Paediatrics, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India
4 Department of Pathology, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India

Abstract

The finding of the persistence of spermatozoa or its remnants in the lower genitourinary tract of victims of sexual violence after elapsed time is a matter of great concern for forensic investigations. The guidelines followed in India and many parts of the world prescribe collection of such samples only if the presentation of the case is within 72 hours of the incidence of sexual crime. We encountered such a case in which the spermatozoa were retrieved from the vaginal samples after seven days of a possible act of sexual crime. It is suggested that samples of urine should be collected in cases of sexual crimes. The delayed collection of samples from the genitourinary tract of the victims can be useful for forensic investigation.

Keywords

Child sexual abuse; Government regulations; Forensic science; Spermatozoa persistence

Child Sexual Abuse (CSA) is an issue of significant socio-cultural, political, legal and ethical concerns in India as well as different parts of the world. Various studies across India have reported a high incidence of CSA.[1,2] The occurrences of CSA are more prevalent in India, then perceived. The fact may be attributed to lower socioeconomic status, overcrowding, social stigmas and myths related to CSA. In India, the cases of CSA is dealt under The Protection of Children from Sexual Offences (POCSO) Act, 2012. The examination of victims of sexual abuse has to be conducted as per the medico-legal guidelines issued by the Ministry of Health and family welfare, Government of India.[3] The guidelines also define the samples to be collected from the victims and the duration to which the samples should be collected.

We here want to highlight a case of a 14-year-old girl, who came to the pediatric outpatient department for follow up of juvenile systemic arthropathy. She was advised urine routine microscopy in her disease workup. Incidentally, when she came for follow up after seven days, her urine microscopy report suggested field full of intact spermatozoa.

She denied any history of sexual intercourse or sexual violence. In the subsequent course of detailed examination, the hymen was found to be torn. However, there were no signs of recent injury over the vulva, vagina or perineum. A vaginal and vulval swab was taken and sent to the pathologist for the presence of spermatozoa. The swabs were taken on the seventh day of collection of the urine sample. The child, as well as the relatives, gave consent for medico-legal examination but were reluctant for any legal proceedings. However, the case was reported to the police as per the provisions of the POCSO Act, and the child was subjected to medico-legal examination. Further, the swab report also came positive for spermatozoa. The histopathologist reported the presence of remnants of spermatozoa in the vaginal swabs.

Although, looking for the presence of DNA of the perpetrator forms the cornerstone of sexual crimes, the expectation of finding spermatozoa or its remnants forms a crucial part of forensic investigation in such cases. This becomes more pertinent in scenario of developing countries where facilities of DNA profiling are not available readily. The criminological literature is pervaded with literature about the facts about the persistence of spermatozoa in the genitourinary tract for prolonged periods.[4] Morrison observed sperm persistence of 9 days in vaginal samples from patients at a venereal disease clinic.[5]

In contrast, Casey et al. reported that proportions of spermatozoa in the vagina and anus declines significantly after 48 hours since intercourse.[6] Other studies also concluded that sperm persists no longer than seven days in the vagina after an act of sexual intercourse. The forensic literature has described the persistence of spermatozoa in the lower genitourinary tract of women until 17-19 days. However, these studies constituted self-reported data and were not designed in a desired scientific way.[4]

Interestingly, guidelines by many jurisdictions and World Health Organization doesn't support the collection of samples for spermatozoa if the TSI (time since intercourse) is more than 72 hours.[6,7,8] A contrary study recommends that swab collection

Corresponding Author
Dr Charu Sharma (Associate Professor)
Email: sharma.charu651@gmail.com
Mobile: +91-7063956215

Article History
Received: 19th August, 2020; Accepted: 20th September, 2020

from prepubertal victims of sexual abuse is unnecessary.[9] In India, the guidelines issued by the Ministry of Health and Child welfare has the same stand, which implies that if the duration of an incident of a penetrative sexual act is more than three days, swabs for the presence of spermatozoa need not be collected.[3] Moreover, the guidelines do not include urine examination for detection of spermatozoa. We are of the opinion that in cases of children who are reluctant in the examination or who are not giving consent for examination, at least a urine sample can be taken as a part of the forensic evidence. Various authors have stressed the importance of the urine sample in cases of sexual violence.[10,11]

In this case, the incidental discovery of spermatozoa in urine sample formed the basis of reporting the case to the law-enforcing agencies. Our case adds to the existing literature and gives an essential message that urine examination should be added to the steps of forensic evidence collection in sexual violence cases and that swabs should be taken even if the time since intercourse has elapsed more then 72 hours.

Conflict of interest: None to declare

Source of funding: None to declare

References

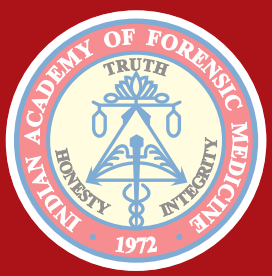
1. Choudhry V, Dayal R, Pillai D, Kalokhe AS, Beier K, Patel V. Child sexual abuse in India: A systematic review. PloS one. 2018;13(10):e0205086-e.
2. Dayal R, Kalokhe AS, Choudhry V, Pillai D, Beier K, Patel V. Ethical and definitional considerations in research on child sexual violence in India. BMC Public Health. 2018;18(1):1144-.
3. Guidelines & Protocols Medico-legal care for survivors/victims of Sexual Violence [Internet]. 2014 [cited 19/05/2020]. Available from: https://main.mohfw.gov.in/sites/default/files/953522324.pdf.
4. DiFrancesco J, Richards E. Persistence of spermatozoa: lessons learned from going to the sources. Sci Justice. 2018;58(3):244-7.
5. Morrison AI. Persistence of spermatozoa in the vagina and cervix. Br J Vener Dis. 1972;48(2):141-3.
6. Casey DG, Domijan K, MacNeill S, Rizet D, O'Connell D, Ryan J. The Persistence of Sperm and the Development of Time Since Intercourse (TSI) Guidelines in Sexual Assault Cases at Forensic Science Ireland, Dublin, Ireland. J Forensic Sci. 2017;62(3):585-92.
7. WHO Department of Gender Women and Health. Guidelines for medico-legal care for victims of sexual violence. Department of Gender Women and Health Geneva2003 [Available from: https://apps.who.int/iris/bitstream/handle/10665/42788/924154628X.pdf;jsessionid=A3990FCA3373531B3F3016EB7092F8F5?sequence=1.
8. U.S. Department of Justice Office on Violence Against Women. A National Protocol for Sexual Assault Medical Forensic Examinations 2013 [2:[Available from: https://nicic.gov/national-protocol-sexual-assault-medical-forensic-examinations-adultsadolescents-second-edition.
9. Christian CW, Lavelle JM, De Jong AR, Loiselle J, Brenner L, Joffe M. Forensic Evidence Findings in Prepubertal Victims of Sexual Assault. Pediatrics. 2000;106(1):100-4.
10. Joki-Erkkilä M, Tuomisto S, Seppänen M, Huhtala H, Ahola A, Karhunen PJ. Urine specimen collection following consensual intercourse - A forensic evidence collection method for Y-DNA and spermatozoa. J Forensic Leg Med. 2016;37:50-4.
11. Smith DA, Webb LG, Fennell AI, Nathan EA, Bassindale CA, Phillips MA. Early evidence kits in sexual assault: an observational study of spermatozoa detection in urine and other forensic specimens. Forensic Sci Med Pathol. 2014;10(3):336-43.

NOTES:

Acknowledging the Editors and Joint Editors of Journal of Indian Academy of Forensic Medicine

Governing Council	Editor	Joint Editor
1972-1976	Dr. Bishnu Kumar	Dr. Heeresh Chandra
1976-1978	Dr. Heeresh Chandra	Dr. D R Kothari
1979-1981	Dr. Heeresh Chandra	Dr. D S Badkur
1981-1984	Dr. K K Mishra	Dr. D K Satpathy
1984-1986	-	-
1986-1988	Dr. Heeresh Chandra	-
1988-1990	Dr. R S Prasad	Dr. Nageshkumar G Rao
1990-1994	Dr. Nageshkumar G Rao	Dr. J Gargi
1994-1996	Dr. S K S Singhal	Dr. P K Ghosh
1996-1998	Dr. Dalbir Singh	Dr. A S Thind
1998-2000	Dr. Dalbir Singh	Dr. A S Thind
2000-2002	Dr. B Shantakumar	Dr. Dalbir Singh
2002-2004	Dr. Indrajit Ray	Dr. A S Thind
2004-2006	Dr. R K Gorea	Dr. A S Thind
2006-2008	Dr. Mukesh Yadav	Dr. D S Bhullar
2008-2010	Dr. C B Jani	Dr. P Harikrishna
2010-2013	Dr. Mukesh Yadav	Dr. Akash Deep Aggarwal
2013-2016	Dr. Mukesh Yadav	Dr. Akash Deep Aggarwal
2016-2019	Dr. Dasari Harish	Dr. Manish Nigam
2019-till date	Dr. Tanuj Kanchan	Dr. Manish Nigam

JIAFM


INDIAN ACADEMY OF FORENSIC MEDICINE
TRUTH
HONESTY
INTEGRITY
1972