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Editor

Dr. Manish Nigam

Professor & Head

Department of Forensic Medicine and Toxicology

Government Medical College, Vidisha, Madhya Pradesh

Email : editorjiafm2022@gmail.com



Joint Editor

Dr. Siddhartha Das

Professor

Department of Forensic Medicine and Toxicology

JIPMER, Puducherry

Email : jointeditor.jiafm2022@gmail.com

Appointed as Support System in Editorial Team



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AIIMS Nagpur

Email : drmarsane@gmail.com



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Department of Forensic Medicine and Toxicology

Government Medical College, Vidisha, Madhya Pradesh

Email : drnspatel30@gmail.com



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Editorial Office

Dr. Manish Nigam

Department of Forensic Medicine and Toxicology
ABV Government Medical College, Vidisha, (M.P.)

Mobile: +91-9826213412

E-mail: editorjiafm2022@gmail.com

Account details

Name : Indian Academy of Forensic Medicine

A/c. : 327101000763

IFSC : ICIC0003271

Branch : Bhopal Bawadiya Kala

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From Editor's Desk**Respected seniors and dear colleagues,**

Wish you all a very happy winter. It's the time to say '**good bye year 2023**'. Passing year have brought laurels to life and many successful moments by our persistent hard work and good wishes of the people surrounding us, while at the same time we all have faced few unfortunate events of disgraceful incidence which would be so, due to the past karmic account. My personal belief is that, joyful moments always supersede those of sorrow and for a healthy life, we should always remember those charming moments, which have given us pleasure, bliss and ecstasy, instead of remembering very few hard and unfortunate events.

With this, we have now published all 4 issues of volume 45 JIAFM year 2023 and have completed 2nd year of our editorial board. I as editor express my happiness and pride, doing our best so far and would like to continue doing better in the coming years. We are receiving good number of articles, not only from national but also international authors while the number of Subscriptions are also increasing and this has helped us to be more confident about ourselves.

Website for JIAFM '<https://jiafm.in>' is doing good and we have started receiving many articles through its submission portal, from various authors who must have started getting regular updates on successful submission etc. Though acceptance, or review processes along with a payment is still carried out through our official email. The best part of this new website is a section of archives, in which the articles have been uploaded separately in JATS (XML) format, where **authors can retrieve their published articles free of cost**. Search engines can display the article of relevance to the authors, based on keywords. The subscribers can place orders through this website.

Dr. Siddhartha Das as Joint Editor; **Dr. Mandar Sane**; **Dr. Narendra Patel** as Associate editors; **Dr. Vivek Chouksey** as Assistant editors; **Dr. Vishal Seán Baveja** for proof reading; **Dr Richa Nigam** as Research and Statistical Editor; and **Mr. Chain Singh Lodhi** as the technical editor, have been supporting me throughout the journey of bringing up JIAFM volume 45 (4). We are continuously trying hard by putting our efforts, to upgrade at every step.

For improving the no of citation from JIAFM and somehow increase the impact factor, we are regularly requesting the authors to cite the articles of JIAFM in the references of their article for which they are getting an upper hand in publication and many authors have started doing it. We have also applied for **indexing JIAFM in DOAJ**, which will take some more time till then we will be providing all the documents to them as and when asked. This is entirely a new beginning and a new experience for us, and shortcomings are bound to come, which we all would be happy to receive from you through our official email ID (editorjiafm2022@gmail.com), or can call me directly, which we will try to resolve with time.

I give my sincere thanks to all the **authors** who showed patience while waiting for their turn to come after lengthy review process before publication. I honestly thank our **reviewers**, without whom we would not have come up with a quality issue as was desired. They supported with sufficient reasons and detailed suggestions for the authors so that authors could improvise, revise, or resubmit their work accordingly. Last but not the least, I thank all the readers for their cooperation and continued support in the year 2023.

Best wishes!

Sincerely



Prof. Dr. Manish Nigam
(M.D. LL.M.)
Chief Editor

Journal of Indian Academy of Forensic Medicine (JIAFM)
E-mail: editorjiafm2022@gmail.com

Editorial office:
Department of Forensic Medicine
ABV Govt. Medical College, Vidisha (M.P.) 464001

EDITORIAL**My Experiences as Forensic Specialist in ICRC and as Regional Delegate in India****Derek Congram, PhD**

It is a great honour for me to be invited to join the editorial board of the Journal of the Indian Academy of Forensic Medicine as an international advisor. I am new to India and very excited to learn about this country so rich in cultural history, rising so quickly technologically – as reflected in the great work and research by the forensic sciences community - and in global influence.

Working for the International Committee of the Red Cross (ICRC), I have the privilege of travelling to different countries and interact with some of the world's leading experts in forensic science. At the same time, the ICRC's core mandate means that our staff are usually stationed in countries that are negatively impacted by armed conflicts, such as Syria, Yemen, and Ukraine. In these contexts, there is a negative correlation between the increasing need for Forensic Science infrastructure, personnel, and services and the possibility of delivering these services. Almost invariably, conflict and mass fatality events overwhelm Forensic services, force people – including Forensic personnel – to flee for their lives and destroy infrastructure. When a country is involved in armed conflict or after a disaster, its focus quickly shifts to saving lives. Medical professionals familiar with triage understand this well; however, the need for Forensic services is never greater than when the country is confronted with a situation of conflict or disaster. This contradiction results in my colleagues and I being witness to state-of-the-art facilities that employ the most advanced technology according to well-defined standard operating procedures in accredited laboratories in resource-rich places. Furthermore, we visit morgues without running water or refrigeration, mortuaries with doctors without Forensic training, and cemeteries with workers trying to manage a never-ending flow of bodies. One of the benefits of being in India is being closer to the wisdom of the father of the nation, who asked us to “[r]ecall the face of the poorest and weakest man you have seen and ask yourself if this step you contemplate is going to be any use to him.” I think of this when I see luxury labs in peaceful places. I say this not to spite these, but rather to remind us about the inequality that Forensic scientists are subjected to, and how we can use our profession to fight against what Gandhi-ji called the greatest form of violence: poverty. The resource contrasts between places are severe. We are continually aware of how much work there is to do in conflict contexts, but we are also reminded that there are people outside of our organization who are well-positioned to work together with us to support those who are in need.

My doctoral research was inspired by a resource-poor environment. The name of that place, however, might surprise you: Spain. How can a western European country be considered resource-poor? A magnification of a subsector in Spain and a review of its modern history, illuminate the situation. An estimated 150,000 people involuntarily disappeared during the Spanish civil war (1936-1939) and postwar violence (Preston 2012). For different reasons, there were never any investigations

of the majority of these disappearances. While researching in Spain from 2006 to 2009, I often found myself in a field with a shovel, pick, and archaeological trowel, surrounded by volunteers, sometimes including forensic scientists and often being led by families of the disappeared; elderly men and women were on a mission to find their siblings or parents, whose bodies had been dumped in roadside ditches and buried in unmarked mass graves. These people became Forensic investigators, financed by private donations and using rudimentary excavation tools. Even with this, though, the skeletons of 10,000 of the disappeared have been found between 2010 and 2020 (Herrasti 2020). My research used Geographic Information Science to conduct spatial analysis and predictive modelling to home in on higher probability locations where graves might be found (Congram 2013). Scientific identification of those exhumed, however, has been lagging.

On 5 October 2022, the Spanish Senate passed a law that will, among other things, provide for a DNA data bank to identify and resolve some of these cases (Jones 2022). The government of Spain is responding positively to its humanitarian obligation to alleviate the suffering of the victims of the war, even after so many years.

As I think about the possibilities here in India, naturally I think about the country's role as a leader, with the capacity to mentor colleagues in neighbouring countries to develop Forensic infrastructure, expertise, and prepare to manage the dead from disasters in a dignified way. I see this reflected in the news of the National Forensic Sciences University (NFSU) supporting the development of Forensic services in Uganda, Rwanda, and Namibia, among others. In 2018, the ICRC established a partnership with NFSU in the form of the International Centre for Humanitarian Forensics (ICHF). The ICHF aims to be a space for sustainable teaching, professional training, capacity building, and consulting related to humanitarian applications of Forensic science. The centre combines the great Forensic expertise that already exists in India with that of the ICRC, which can be used to help others in the region and further abroad.

In the little time that I have been in India, however, I have also seen the interest to develop and improve Forensic services within India: for example, foster collaboration among different institutes, improve education and incorporate different disciplines such as Forensic odontology and anthropology, to better prepare for the management of the dead, following disasters, and to establish bioethics guidelines regarding consent for the acquisition and use of the dead in research. As in many countries where I have worked (including my native country), the medicolegal system is not national, and so resources, practice, and standards vary from place to place. This can be an obstacle for investigators when, for example, people migrate across local or regional borders and then unexpectedly die. The positive

identification of the dead and their return for dignified funerary rituals can depend on the capacity of their families to contact the authorities in another jurisdiction. I think that this disconnectivity is changing, though. In my time at NFSU, I have met public officials from different states who spend weeks or even months training there before returning to their home institutions to put

into practice what they have learned.

I am excited to be able to observe the developments of Forensic science in India and surrounding countries and I am equally excited to read about the great research and work in this journal that is a critical part of this development.



Derek Congram, PhD
Forensic Specialist

The editorial was written by Dr Derek when he was working as forensic specialist International Committee of the Red Cross and was in the regional delegation for India, Nepal, Bhutan & Maldives; Co-Head International Centre for Humanitarian Forensics National, Forensic Sciences University (NFSU) Gujarat, placed in New Delhi, India. Now he has left the country having finished his assignment in India, but his experiences need to be shared with our readers related to status of mortuary in India abroad and also his work with ICRC during his stay in India.

ORIGINAL ARTICLE

An Autopsy Based Study on Pattern of Fatal Injuries in Fall from Height

Lakshmy S,¹ Kachare RV,² Pawar VG,³ Pardeshi AR.⁴

Junior Resident,¹ Professor & Head,² Associate Professor,³ Junior Resident.⁴

1-4. Department of Forensic Medicine & Toxicology, Swami Ramanand Teerth Government Rural Medical College, Ambajogai.

Abstract:

Falls are the second most common cause of injury-associated mortality after traffic accidents. The present study aims to find out the pattern of injuries among the victims of fall from height. This prospective observational study was conducted among victims of fall from height at SRTR Government Medical College morgue during the period of July 2020 to July 2022. All medico-legal cases involving head injury, advanced decomposed bodies, intracranial haemorrhage, infarctions, lesions as a result of natural disease. Various data were collected. A total of 996 autopsies were performed during the study period out of which 48 (4.82%) were cases of fall from height. Among them 30 (62.5%) were male and 18 (37.5%) victims were female. Most of the victims were day labourer or construction workers 16 (33.33%). Most deaths occurred during day time 35 (72.92%) with highest mortality is due to accidental falls 31 (64.58%). Ages of maximum victims were between 31-40 years (37.5%). All the victims had multiple abrasions and bruises in their body, followed by intra cranial haemorrhage 42 (87.5%), laceration 34 (70.84%) and others. In skull, linear fracture was the commonest one 26 (54.17%). Temporal bone was the commonest bone to fracture 25 (52.08%) and most of the victims 17 (35.42%) had subdural haemorrhage. Most common cause of death is due to major injuries over head 36 (75%). Strategies designed to prevent these falls should have a substantial effect.

Keywords: Fall from height; Minor injuries; Major injuries.

Introduction:

Falls are the second most common cause of injury-associated mortality after traffic accidents.¹ A fall is defined as an injury to a person that occurs after landing on the ground after falling from a higher place, such as a ladder, scaffold, building, roof, or other elevated place or work area.² Factors determining serious and fatal injuries in a fall depends on distance of the fall, the characteristics of landing surface, orientation on falling, and whether the fall was direct or broken.³

The skull, brain, spinal cord and extremities are the most commonly injured systems. Falls from first/second stories are more frequently nonfatal, but falls from more than twenty feet have historically been triaged to trauma centres. But even low-level falls can cause serious head injuries and death.^{4,5}

Objectives: The objective of this study was to find out the pattern of injuries among the victims of fall from height.

Materials and Methods:

This prospective observational study was conducted among the victims of fall from height at SRTR Govt. Medical College and Hospital morgue during the period of July 2020 to July 2022. Various data of the victim were collected from inquest reports. Specific points regarding injuries were noted during autopsy

examinations. The data was analysed. IEC approval from ethics committee of the college has been taken and study has been started. No conflict of interest and no financial or source of funding utilised or taken from any other source.

Result:

A total 996 autopsies were performed during the study period out of which 48 (4.82%) cases were of fall from height. Among them 30 (62.5%) were male and 18 (37.5%) victims were female. Most of the victims were day labourer or construction workers 16 (33.33%) (Table-I). Considering timing, highest incidents occurred during day time 35 (72.92%) and 13 (27.08%) at night. The highest mortality is due to accidental falls 31 (64.58%). Ages of maximum victims were between 31-40 years (37.5%). All the victims had multiple abrasions and bruises all over the body, followed by intra-cranial haemorrhage 42 (87.5%), laceration 34 (70.84%), fracture of skull bone 30 (62.5%), injury to long bones of upper limbs 20 (41.67%), injury to long bones of lower limbs 28 (58.33%), injury to abdominal organs like liver, spleen, kidney 21 (43.75%), fracture of pelvis 17 (35.42%) (Table-II). In skull bones linear fracture was the commonest one 26 (54.17%) (Table-III), Temporal bone was the commonest bone to fracture 25 (52.08%) (Table-IV) and most of the victims 17 (35.42%) had subdural haemorrhage (Table-V). Most common injuries responsible for death was injuries over head 36 (75%) followed by injuries over thoracic region 21 (22.92%), abdominal region 21 (43.75%) and due to fracture of long bones 33 (68.75%) (Table-VI).

Discussion:

Injury due to fall from height remain a significant cause of morbidity and mortality in our day to day life. Fatalities occur

Corresponding Author

Dr. Rajesh Vijaykumar Kachare
Email : drkachareraajesh@gmail.com
Mobile No.: +91 94224 71377

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Table 1. Type of victims by profession (n=48).

Type of victims by profession	Total number of victims			Total Percentage (%)
	Male	Female	Total	
Day wagers/ construction workers	13	3	16	33.33
Students	4	3	7	14.58
House wife	0	8	8	16.67
Farmers	9	2	11	22.92
Children (<10yrs)	2	1	3	6.25
Others	2	1	3	6.25
Total	30	18	48	100

Table 2. Variation of types of injuries among victims (n=48).

Types of injuries	Number of victims	Percentage %
Multiple abrasions	48	100
Contusions	48	100
Intracranial injuries	42	87.5
Laceration	34	70.84
Skull fractures	30	62.5
Fracture of upper limb	20	41.67
Fracture of lower limb	28	58.33
Fracture of vertebra	6	12.5
Fracture of ribs	8	16.67
Injury to abdominal organs	21	43.75
Pelvic fracture	17	35.42

*same victims had multiple types of injury.

Table 3. Types of skull fracture (n=48).

Types of skull fracture	Number of victims	Percentage %
Linear/ Fissured fracture	26	54.17
Comminuted fracture	23	47.92
Diastatic fracture	9	18.75
Depressed fracture	10	20.83
Ring fracture	12	25
No fracture skull	18	37.5

*same victims had multiple types of injury.

primarily when a person fall from greater than two stories or when the head of the victim hits a hard surface. This includes falls from roof tops, windows, and balconies.³⁻⁵ In an Indian study, falls from height comprised the highest number of deaths among workplace accidents and the majority of these falls were from construction sites.⁶ In this study, most of the victims were day labourers or construction workers 16 (33.33%) followed by house wife 08 (16.67%), farmers 11 (22.92%), students 07 (14.58%), children and others 03 (6.25%). Considering timing highest incidents occurred during day time 35 (72.92%) and 13 (27.08%) at night.

Males are predominantly the earning members in our society context. Generally, men are exposed to trauma and falls more often than women because boys are more active than girls at early ages and more men are physical labourers than women.^{7,8} In this study 30 (62.5%) were male and 18 (37.5%) victims were female. Now a day a number of high rise buildings are being constructed in Ambajogai City and nearby places and being a rural area building safety codes are not always properly followed. This indicates the significance of highest number of victims as construction workers. Falling from roof top and buildings are usually considered accidental in nature. But sometimes due to familial disharmony, financial issues, failure in examination,

Table 4. Location of skull fracture in different cranial bone (n=48).

Skull bones	Number of victims	Percentage %
Frontal bone	16	33.33
Parietal bone	20	41.67
Occipital bone	6	12.5
Temporal bone	25	52.08
Anterior cranial fossa	7	14.58
Middle cranial fossa	9	18.75
Posterior cranial fossa	13	27.08
No fracture skull	18	37.5

*same victims had multiple types of injury.

Table 5. Different types of intracranial haemorrhage (n=48).

Intracranial haemorrhages	Number of victims	Percentage %
Extradural haemorrhage (EDH)	6	12.5
Subdural haemorrhage (SDH)	17	35.42
Subarachnoid haemorrhage (SAH)	12	25
Intracerebral haemorrhages	7	14.58

*same victims had multiple types of injury.

Table 6. Major body region injured leading to death (n=48).

Major body part involved (Major injuries)		Number of victims	Percentage (%)	Percentage in Total %
Head (total=36)	Skull fracture	30	62.5	75
	Intracranial injuries	42	87.5	
Thorax (total=11)	Rib fracture	8	16.6	22.92
	Lung injury	6	12.5	
	Pneumothorax	3	6.25	
	Hemo-thorax	6	12.5	
Abdomen (total=21)	Heart injury	2	4.17	43.75
	Injury to liver	10	20.83	
	Injury to spleen	16	33.33	
	Injury to kidneys	8	16.6	
Fracture of long bones (total= 33)	Hemo-peritoneum	20	41.66	68.75
	Fracture of upper limb	20	41.66	
	Fracture of lower limb	28	58.33	

*same victims had multiple types of injury.

emotional blackout after refusal by lovers, drug addiction also leads to suicidal cases as these sites are commonly used to commit suicide. Homicidal cases are also not rare. Circumstantial evidences of some cases occurred during night indicates towards homicidal activities. In this study, most of the victims died due to accidental fall 31 (64.58%) followed by suicidal fall 10 (20.84%), homicide 05 (10.42%) and 02 (4.16%) were undetermined.

The Indian construction industry is the second largest contributor to the nation's economy. While the industry is set to pick pace in the coming years, the government has also established regulation how construction workers are supported. They include:

- The Fatal Accidents Act, 1885.
- The Workmen's Compensation Act, 1923.
- The Factories Act, 1948.
- The Employees State Insurance Act, 1948.
- The Central Labour (Regulation & Abolition) Act, 1970.
- Building & Other Construction Workers (Regulation of Employment and Conditions of Services) Act, 1996.
- Building & Other Construction Workers Welfare Cess Act, 1996.
- Building & Other Construction Workers (Regulation of

Employment and Conditions of Services) Central Rules, 1998.

- The National Building Code of India, 2005.

The falls from greater heights tend to cluster in the summer months, presumably because windows are more likely to be open and children are more likely to be playing on fire escapes, roofs, and balconies.^{4,9,10} Falls in the elderly tend to occur with activities of daily living. In England falls account for 29% of injury deaths among adults aged 65 yrs and older. Older adults are five times more likely to be hospitalized due to falls than to injuries from other causes.¹¹

Overall in this study, 58.34% (28 cases) of the patients were between 20 to 40 years old, the age group which is the most active and mostly exposed to involved to trauma. Older individuals, especially those over 60 years old, lose their ability to balance, which causes more falls.¹² Host factors such as poor muscle tone, vision problems, medication use and sedentary lifestyle are the biggest contributors to ground-level and stair falls, but environmental components such as poor lighting and no handrails may increase the frequency. Factors contributing to falls from heights include faulty equipment, such as ladders and scaffold structures, and human factors, such as intoxication and inattention.

In this study all the victims had multiple abrasion and bruise in their body which was minor in nature and not a definitive cause for death. Head trauma and severe loss of blood that leads to shock was the most common cause responsible for death due to blunt traumatic injury. In this study, the major cause responsible for death was head injury 36 (75%) in the form of skull bone fracture 30 (62.5%) and intracranial haemorrhages 42 (87.5%), followed by thoracic injury 11 (29.92%) in the form of fracture ribs 8 (16.67%), lung 6 (12.5%) and heart 2 (4.17%) injuries, pneumo-thorax 3 (6.25%) and hemo-thorax 6 (12.5%), abdominal injuries 21 (43.75%) in the form of injuries to liver 10 (20.83%), spleen 16 (33.33%), kidneys 08 (16.6%) and hemo-peritoneum 20 (41.66%), long bone fractures 33 (68.75%) including upper 20 (41.66%) and lower 28 (58.33%) limbs.

Musemeche et al. and Meller et al. noted that, fractures of radius, ulna and femur were the most common injuries.^{13,14} Velecek et al. and Lehman et al. in their study pointed out that, rib, spine, pelvis and calcaneus fractures were much less common among children than among adults. Because children tend to use their arms to protect their heads and they have relatively flexible bones.^{15,16} Meller et al. and Lehman et al. noted that, multiple fractures and cranio-cerebral trauma were common, especially in those cases resulted from falls from greater heights. Abdominal and chest injuries were relatively uncommon in low height falls but they are more frequent in fatal falls from greater heights.^{14,16} In this study, occurrence of major injuries were less in children as compared to adult population.

The nature of the surface onto which the victim falls and the degree to which the fall is broken on the way down modify the pattern and severity of injuries. Children younger than three years are much less likely to have serious injuries than older children who fall the same distance because younger children have more fat and cartilage and less muscle mass than older children, they

better dissipate the energy transferred by the fall.¹⁷

Same victims had multiple types of skull fractures like linear, comminuted, depressed, diastatic and others. Force required to cause fracture depends on area of the skull struck, thickness of the skull, scalp and hair and direction of impact. In this study among skull bones linear fracture was the commonest one 26 (54.17%) and temporal bone was the commonest bone to fracture 25 (52.08%). Skull fracture can occur if the moving head directly strikes an object like in case of fall from height, it can be the hard ground. The linear fracture can also occur on opposite side by contre-coup if the head moves and its movement is suddenly arrested by coming in contact with a hard surface. In most cases of fall from height head strikes by forcible contact with broad resisting surface like the concrete or tarred ground resulting in the liner fracture. The thinnest area in our skull is temporal bone (4mm), followed by frontal bone (6mm), parietal bone (10mm) and occipital bone (15 mm). A force of 400- 600 pound per square inch is required to fracture a skull covered by cushion of hair and scalp. However a fall from three foot height will produce impact energy of 35 foot pound, causing two linear fracture or mosaic fracture. This indicates the predominance of different fractures, where the victims of fall from height are thrown with great impact.^{18,19}

This study have shown that most of the victims 17 (35.42%) had subdural haemorrhage. Subdural haemorrhage is due to vascular injury, especially the bridging veins, where the head rapidly decelerates because of impact to a firm, underlying surface. Subdural haemorrhages most commonly occur in old ages and children due to fall on ground by accidents, whereas subarachnoid haemorrhages were most common pattern in intra cranial haemorrhage in RTA. Extra-dural haemorrhages were more common in 20-40 years of age and occurred mostly due to Road Traffic Accident (RTA) or hit by any other object.²⁰ Acute extra-dural haemorrhage is generally due to rupture of middle meningeal artery as a result of fracture at 'pterion', an H-shaped formation of sutures on the side of skull representing the junction of four skull bones. ie. frontal, parietal, temporal & greater wing of sphenoid.

The majority of traumatic deaths occurred in pre-hospital setting; on-scene or during transport and the leading cause of death is poly-trauma. The incidence of pre-hospital mortality is great among overall trauma related deaths. So, pre-hospital medicine and trauma prevention programs are significant factors to reduce traumatic deaths.²¹

Conclusion:

As from the above study, we can arrive at a conclusion that most of the victims who died due to fall from height were construction site workers and death was accidental in nature and were preventable. Employers need to better access job sites and invest in safety equipment that secures a worker. This includes both securing the worker to a safety line and provide safety helmet. It is important that, all scaffolding jobs should be carried out by trained professionals who are knowledgeable about the specialized safety equipment. This also includes the maximum amount of load they carry while working on scaffolds. Scaffolding should be designed so as to offer a solid footing for

workers, be completely planked and away from any dangerous power lines. It is necessary that employers choose to work with the most suited ladder systems associated with the site of work. Workers should also be regularly trained about new ladder systems. Most construction workers in India come from rural areas looking for jobs. They are inexperienced and lack training in using safety gear. It is necessary that workers are chosen properly and that all are given the necessary training before being put on the job. Most times, workers aren't informed or are knowledgeable about the health and safety risks they are put to in construction sites. It is necessary that they are able to read and understand Material Safety Data Sheets and are prepared for the same. Implement safety programs to ensure that workers understand the risk and are well prepared to face the challenges without risking their life or health.

Discouraging or prohibiting children from playing on fire escapes, roofs, and balconies, especially those that are not adequately fenced with vertical bars and encourage the use of ground-level safe play areas, such as public parks and playgrounds can reduce the number of incidents. At the same time modernization of physical environment and strict maintenance of safety procedure can protect the vulnerable personnel and reduce economical burden.

Triage must be done accurately at the accident location and critical patients should be referred to trauma centres quickly. This can reduce the mortality and morbidity due to falls from height.

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ORIGINAL ARTICLE

Morphology of Lip Prints in Ethnic Meitei Subjects : A Preliminary Analysis of Patterns and Sexual Variation

Haricharan A,¹ Memchoubi PH,² Devi SE,³ Salam S,⁴ Devi TM.⁵

Post Graduate trainees,^{1,4} Professor,² Senior Resident,³ Professor and Head.⁵

1-5. Department of Forensic Medicine and Toxicology, Regional Institute of Medical Sciences, Imphal

Abstract:

Lip prints are individualistic and can be helpful in verifying a person's presence at the crime scene. This cross sectional study aims to classify lip prints in ethnic Meitei population and determine whether sex differences exist. Estimated sample size is 250. Lip prints of 137 females and 113 males were obtained using dark-colored lipstick and cellophane tape. Lip prints were analyzed using a magnifying lens and classified according to the Suzuki and Tsuchihashi classification. The upper and lower lips of males and upper lips of females revealed Type II to be the predominant pattern, accounting for 19%, 13.8% and 22% of all occurrences, respectively. In females, a Type I pattern was the most frequent in the lower lips (22%). These differences were statically significant ($p < 0.001$). A correlation analysis, with Spearman's rank order correlation (ρ), was used. The strength of the linear relationship between the lip patterns for the upper and lower lips (right and left sides) and sex was analyzed. We found a medium correlation value (from 0.030 to 0.412) with statistical significance ($p < 0.005$) for upper right lip and lower left lip with the exception of the upper left lip (correlation value = 0.092, $p = 0.147$ &) and lower right lip (correlation value = 0.030, $p = 0.642$). This study corroborates the hypothesis that lip prints may be useful in sex determination.

Keywords: Identification; Lip prints; Cheiloscropy; Sexual dimorphism.

Introduction:

Identification is the determination of the individuality of a person based on certain physical characteristics which are unique to him/her.¹ However, identification is not a problem when the whole body is available. The problem arises when we are dealing with only some parts of the body or some trace evidences available at the crime scene like lip prints, fingerprints, etc. The reliability of fingerprints is well established. Lip prints are also individualistic and can be helpful in verifying a person's presence at the crime scene.²

Lip prints or Cheiloscropy is the study of elevations and depressions on the labial mucosa called sulci labiorum and are constant during a person's lifetime.^{3,4} The creases on the vermilion border of the lips, and the raised reddish areas outlined by these creases are similar to the furrows and ridges of the skin. These creases are also called grooves, furrows, wrinkles, and valleys and are useful in Identification.⁵

The present study will chart out the different types of lip prints in a sample of Meitei population and examine the feasibility of its application as an identification tool.

Materials and Methods:

The present work is a cross-sectional study. The study was conducted in the Department of Forensic Medicine and

Toxicology of a tertiary health care center in North-East India. Study participants were ethnic Meitei subjects which is the majority group in the region.

The estimated sample size is 250 based on a previous study.⁵ Lip prints of 137 females and 113 males were analyzed. Ethnic Meitei subjects above 18 years of age and with normal lips without any congenital deformity were included. Subjects allergic to cosmetics, or with disease or trauma to the lips and unwilling subjects were excluded from the study.

After obtaining institutional ethics committee clearance, informed consent was taken from the eligible participants and data collection was started.

The materials used were Elle 18 lipsticks, a brush, cellophane tape, A4 size bond paper, a pencil for labeling, and magnifying lens (10xs).

For recording the lip prints, lipstick was gently and evenly applied on lips using a brush. Subjects were asked to gently rub their lips for the equal spreading of the lipstick. An impression was taken on folded bond paper and then cellophane tape was pasted over it to preserve it as a permanent record. The lipsticks were then wiped off with tissue paper or cloth. Analysis was done with the help of a magnifying lens.

Suzuki & Tsuchihashi's³ classification of lip prints was used for analysis as shown in Figure 1. The most common pattern of lip prints in males and females was assessed. For personal identification, the lip was divided into four quadrants by a horizontal line that divides the upper lip from the lower lip and a median vertical line that divides lips into right and left halves; right upper as the first quadrant, left upper as the second quadrant, left lower as the third quadrant, and right lower as the fourth quadrant. The lip prints were classified into particular types

Corresponding Author

Memchoubi Phanjobam

Email : mem010177@gmail.com

Mobile No. : +91-9612811931

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depending upon the predominant pattern.

Suzuki and Tsuchihashi's³ classification categorized lip prints into: Type I - complete vertical groove, Type I' - incomplete vertical groove, Type II - branched groove, Type III - intersected groove, Type IV - reticular pattern, Type V - irregular, undetermined (Figure 1). The determination of the pattern depends on the numerical superiority of the properties of the lines in each area.

In the second study stage, variations were determined following the recommendations from other study results⁶⁻⁸ to verify whether other population data can be applied to the Meitei subjects and both lips were classified as follows:

- » If Type I, I' pattern is dominant, then the subject is female.
- » Type I and II patterns are dominant: female.
- » Type III pattern present: male.
- » Type IV showing varied patterns: male.
- » The classification "undecided" was used when the lip print couldn't fit any of the above criteria.

Data entry was done using windows based statistical package for social sciences [SPSS] version 21.0 (Armonk NY: IBM Corp). A Pearson's Chi-square (X^2) test was used to compare qualitative data and determine statistical significance. The level of statistical significance was set at $p < 0.05$. A correlation analysis, with Spearman's rank order correlation (ρ), was used to assess the strength of the linear relationship between the lip patterns for the upper and lower lips (right and left sides) and sex.

Results:

A total of 113 males and 137 females were studied. Subjects' ages ranged from 18 to 78 years (Table 1). It was found that a Type II pattern was the most common and was present in 31.5% of

Table 1. Age and sex distribution of the study participants (n=250).

Age in group (years)	Sex		Total	Percent
	Male	Female		
18-28	54	79	133	53.2
29-38	11	10	21	8.4
39-48	29	19	48	19.2
49-58	12	17	29	11.6
59-68	7	0	7	2.8
>68	0	12	12	4.8
Total	113	137	250	100

Table 2. Total Lip pattern distribution (n).

Type	n	Percent
I	180	18
II	215	21.5
III	315	31.5
IV	223	22.3
V	14	1.4
	49	4.9

Table 3. Lip pattern distribution in upper lip (n).

Type	n	Percent
I	100	20
II	77	14.8
III	205	41
IV	99	19.8
V	1	0.2
	18	3.6

subjects, followed by Types III, II, and I (22.3.0%, 21.5%, and 18%, respectively). The least common patterns were Types V and IV, each represented by 4.9% and 1.4 % of the sample (Table 2).

The upper lip showed a predominance of Type II pattern (41%), followed by Type I (20%), Type III (19.8 %), Type II (14.8 %), Type V (3.6%), and Type IV (0.2%) (Table 3). The data differed from those seen on the lower lip, where a Type II pattern was more predominant (27.6%), followed by Type III (24.8%), Type II (22.8%), Type I (16 %), Type V (6.2%), and Type IV (2.6%) (Table 4).

A Type II lip print pattern was the most predominant in males and females and accounted for 16.4% and 15.5% of occurrences (Table 5).

The distribution of lip-print patterns in different areas of the lips and their correlation with sex can be seen in Table 6. In this table, the upper and lower lips of males and upper lips of females revealed Type II to be the predominant pattern, accounting for 19%, 13.8% and 22% of all occurrences, respectively. In females, a Type I pattern was the most frequent in the lower lips (22%). These differences were statistically significant ($p < 0.001$). A correlation analysis, with Spearman's rank order correlation (ρ), was used to assess the strength of the linear relationship between the lip patterns for the upper and lower lips (right and left sides) and sex. We found a medium correlation value (from 0.030 to 0.412) with statistical significance ($p < 0.005$) for upper right lip and lower left lip with the exception of the upper left lip (correlation value = 0.092, $p = 0.147$) and lower right lip (correlation value = 0.030, $p = 0.642$).

Table 4. Lip pattern distribution in lower lip (n).

Type	n	Percent
I	80	16
II	138	27.6
III	114	22.8
IV	124	24.8
V	13	2.6
	31	6.2

Table 5. Lip pattern distribution according to sex (%).

Type	Male	Female
I	6.2	11.8
II	11.4	10.1
III	16.4	15.5
IV	8.9	13.4
V	0.2	1.2
	2.1	2.8

Table 6. Distribution of lip-print patterns in different areas of the lips of males and females (n).

Type	Sex	URL	ALL	LRL	ALL	Total	Total UL	Total LL
Type I	Male	19	36	3	4	62	55	7
	Female	26	19	19	54	118	45	73
Type II	Male	36	11	34	33	114	47	67
	Female	14	16	25	46	101	30	71
Type III	Male	55	40	27	42	164	95	69
	Female	28	82	33	12	155	110	45
Type IV	Male	1	23	31	34	89	24	65
	Female	58	17	35	24	134	75	59
Type V	Male	0	1	1	0	2	1	1
	Female	0	0	12	0	12	0	12
Type V	Male	2	2	17	0	21	4	17
	Female	11	3	13	1	28	14	14

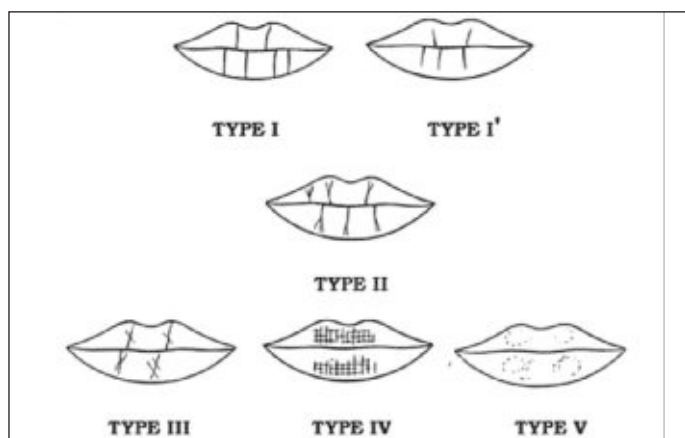


Figure 1. Suzuki and Tsushihashi's classification : (a) Type I, (b) Type I', (c) Type II, (d) Type III, (e) Type IV, (f) Type V.

Discussion :

Lip prints in a crime scene investigation could be an important trace evidence and can directly link a person to a specific place if found on material objects at the crime scene.⁹

Lipsticks are complex substances, which have in their constitution, several compounds, oils or waxes. The color of the lipsticks is due to organic inks and inorganic pigments.¹⁰ The vermilion border of the lips has minor salivary and sebaceous glands, which, together with the moisturizing done by the tongue, lead to the possibility of the existence of latent lip prints.¹¹ Noncolored lip prints were the kind of lip prints used with persistent lipsticks.¹² Another important aspect of the lip-print analysis is DNA analysis. In fact DNA detection could be done even in latent lip prints. For instance, Castell et al.¹³ stated that the genetic profile of the person could be derived from his lip print.

Investigation done by the classification proposed by Suzuki and Tsuchihashi was selected because this is the most widely used classification system.³ This classification has a clear description of nearly all of the commonly encountered lip patterns and is easy to interpret. Its resemblance to the dental formula is also familiar to a forensic specialists.¹⁴ They also suggested that the central part of the upper lip shows better groove pattern compared to other areas.¹² Therefore, we recorded lip print patterns on upper middle quadrant zone.¹⁵

Numerous factors like thinned lips, inverted lips, more prominence on either the middle or lateral part of the lips, excessive curvature of the lips, faint groove pattern on the lips can affect the quality of the lip print recording.¹⁶ Thus, we did a physical examination of the subject's lips before selecting for the study.

The present study showed the predominant lip print pattern among participants was Type II followed by Type III. Results obtained is in accordance with Durbacula et al.¹⁷ where the workers found a predominant lip print pattern in Indians as Type II.

Sivapathasundharam et al.¹⁸ conducted a study on 200 Indo-Dravidian subjects from Chennai and found that the Type III pattern was the predominant and Type IV the least commonly

occurring. This is also partially similar with our finding where type III is the second common pattern among the subjects. Koneru et al.¹⁹ analyzed lip prints of Tibeto- Burman (which is racially close to the Meiteis) population of 30 subjects in the age group of 18-21 years and found that predominant patterns were Type I, Type I', which is quite different from our findings. This may be due to the difference in the sample selection and size as our sample is much larger and consists of various age ranges.

Kapoor and Badiye²⁰ also showed a contrasting result from ours in that the predominant pattern in an Indian sample population of 200 persons was type I. This could be attributed to the fact that different locations involve different races with different genetic features.

However, the most prevalent lip print for each gender was not the same in every study, suggesting the possibility of specific population standards for sex determination through lip prints.⁶⁻⁸ In our sample, the upper and lower lips of males and upper lips of females revealed Type II to be the predominant pattern, accounting for 19%, 13.8% and 22% of all occurrences, respectively. In females, a Type I pattern was the most frequent in the lower lips (22%). These differences were statistically significant ($p < 0.001$). Considering the correlation between the different patterns of lip prints and gender in other studies,^{6,8} Type I, I' patterns were dominant in males, and Type I and II patterns were dominant in females. This somewhat differs from our study in which, Type I, III, IV, V predominantly were seen in females and Type II, I' are predominantly seen in males.

Also, a study in Dakahlia (Egypt) showed that the prevalent pattern in both sexes was type I negating the correlation between lip pattern and sex.²¹

Prabhu et al.¹⁶ showed in their study that there is no correlation between lip pattern and gender as pattern V was predominant in both sexes. However, this is not the case in our study which exhibits significant sexual dimorphism between the upper and lower lips and between the upper right and lower left quadrants of the lips.

The present investigation reveals that Type II pattern was more common in both males and females. However, sexual dimorphism is seen in the patterns present in the upper and the lower lips and in the upper right and lower left quadrants of the lips and is clearly shown in Table 6. The presence of sexual dimorphism has also been verified by other authors.⁶⁻⁸

In our study, we found that the difference between the upper and lower lips between males and females was statistically significant ($p < 0.001$). Not only this, when the upper and the lower lips were divided into right and the left halves, we found a medium correlation value (from 0.030 to 0.412) with statistical significance ($p < 0.005$) for upper right lip and lower left lip with the exception of the upper left lip (correlation value = 0.092, $p = 0.147$) and lower right lip (correlation value = 0.030, $p = 0.642$) unlike other studies.^{20,21}

Conclusion :

Cheiloscopy as a means of identification has been proven valid by many workers. Our study has shown the common patterns found

in the ethnic Meitei subjects, a majority group in a North-eastern state of India. This study has also shown that sexual dimorphism exists in the upper and the lower lips and in the upper right and lower left quadrants of the lips with a significant statistical difference. The results of this study will provide more arsenal in the armament of forensic identification.

Ethical Clearance: Taken

Conflict of Interest: Nil

Source of Funding: Nil

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ORIGINAL ARTICLE

Trends of Homicidal Deaths in Gwalior Region: An Autopsy Based Retrospective Study

Saxena D,¹ Juglan S,² Tomar JS,³ Varun A.⁴

Assistant Professor,^{1,4} Associate Professor.^{2,3}

1,2. Department of Forensic Medicine and Toxicology, Gajra Raja Medical College, Gwalior.

3. Department of Forensic Medicine and Toxicology, Mahatma Gandhi Memorial Medical College, Indore.

4. Department of Forensic Medicine and Toxicology, Sri Aurobindo Medical College and Post Graduate Institute, Indore.

Abstract:

In the present study homicidal victims were autopsied to determine the profile and pattern of injuries sustained. The study was conducted at the department of Forensic Medicine and Toxicology Gajra Raja Medical College Gwalior to know the incidences and trends of the homicides, taking it as the first step in the prevention of crime. During the above said period of 2 years a total number of 4291 cases were autopsied out of which 107 cases were homicidal in nature. The study shows that the overall number of people who suffered a violent death had increased which were 45 cases in the year 2020 to 62 cases in 2021. Majority of victims fall in the age group of 21-30 yrs, 37 cases (34.57%). Sex wise distribution showed male preponderance with 70 cases. In our study death due to firearm injuries were the most common form of assassination practiced (42.9%) followed by blunt weapon injuries (28.97), sharp weapon injuries (15.88%) and the number of asphyxia deaths were less (12.14%). Motive was financial matter (30.84%), family disputes (22.42%) arguments (19.62 %), land disputes (15.88 %). The incidence of infidelity and unknown motives was reported in (7.47 %) and (3.73 %) respectively. The present study was conducted over the period of two years from January 2020 to December 2021. The data collected includes all reported unnatural deaths from the urban and rural areas of the district on which autopsies were conducted at the mortuary of Department of Forensic Medicine and Toxicology, Gajra Raja Medical College Gwalior.

Keywords: Homicidal deaths; Weapon; Violent deaths; Firearm injuries.

Introduction:

Killing or homicide is a socially unethical act long recognized by the Indian criminal justice system since ancient times. Similar to other criminal law jurisprudences, the modern Indian criminal law jurisprudence also categorizes homicide into two categories: lawful or simple homicide and unlawful homicide.¹

Intentional homicide studies are important not only because of the seriousness of the crime, but also because intentional homicide is one of the most measurable and comparable indicators for monitoring violent death. Because of its lethal outcome, homicide is particularly amenable to temporal (longitudinal) and cross-national (geographic) comparisons: it tends to have greater definitional specificity than other crimes in different historical and national contexts.² There were an estimated 475000 deaths in 2012 as a result of homicide. Sixty percent of these were males aged 15–44 years, making homicide the third leading cause of death for males in this age group.³

In India a total of 1,955 cases of murder were registered during 2021, showing an increase of 5.7% over 2020 (1,849 cases). The crime rate registered also show an increase in 2020 to 2021. 'Disputes' was the motive of murder in highest number of cases

followed by 'Personal Vendetta or Enmity' and 'Love Affairs'.⁴ In order to establish a baseline for future development and to increase awareness of violence as a major worldwide public health issue, this study presents the patterns of mortality from homicide.

Materials and Methods:

The present study was carried out at the Department of Forensic Medicine and Toxicology of Gajra Raja Medical College, Gwalior Madhya Pradesh on 107 alleged homicidal cases brought for autopsy over the period from January 2020 to December 2021 after getting approval from Institutional ethical committee. All cases of alleged homicides specified in the above mentioned period are confirmed by investigating officers before autopsy. All known cases of homicidal deaths were analysed who were brought for medico legal post mortem examination during the study period in Mortuary of Department of Forensic Medicine & Toxicology, Gajra Raja Medical college.

Preliminary data related to name, age, sex, address, brought by whom, date, time and place of incidence were noted. A semi-structured proforma was designed to collect information on socio-demographic profile of cases, pattern of homicide and injury sustained. The inquest report was carefully read, before starting post-mortem examination, detailed history regarding the mode and motives of injury, methods and weapons used for killing was obtained from inquest report, hospital papers, from the concerned Investigating officer and also from relatives. The clinical records of the admitted cases were also carefully studied to know the nature, extent and gravity of injury. This study excluded deaths from burn injuries, poisoning, car accidents, and

Corresponding Author

Dr. Abhishek Varun

Email : abhishekvarun1@gmail.com

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falls from height because the manner of death was not immediately apparent and was difficult to ascertain at the time of the autopsy. Collected data was transformed into variables, coded, entered and analyzed by using Microsoft Excel. It is compared and discussed with studies available in literature.

Result:

During the study period total 4291 autopsies were conducted, of which homicidal deaths were 107 cases (2.49%). The incidence of homicidal deaths in year 2020 was 2.07% which increased from 2.92% in 2021 [Table1]. Of the total 107 alleged homicide cases, 70 (65.42%) cases were males and 37 (34.58%) cases were female [Table 2]. Most common age group affected was between 21-30 (34.57%) followed by 31-40 (28.97%) and 21.49% in 41-50 age group, then 51-60 years (6.54), 11-20 years (4.67%), 61-70 years (2.80%) and 01-10 years (0.93%) [Table 3].

The majority of homicidal deaths involving firearm injuries were seen in 46 cases of which male were 39 (36.44%) and 07 (6.54%) female. Second most commonly encountered deaths due blunt weapon were 31 (28.97%) in the present study, followed by injuries due to sharp weapon 17 (15.88%). Homicide by violent asphyxia was observed in 13 (12.14%) cases of which 02 (1.86%) were male and female 11 (10.28%) [Table 4].

In the present study financial matter was responsible for 30.84 % homicidal deaths mostly due to repayment or debt of money, financial gain, followed by family disputes 24 cases (22.42 %) due to domestic conflicts, arguments 21 cases (19.62 %), land disputes 17 cases (15.88 %) due to violent rage and quarrel as maximum of the population of the region belongs to farmer and jamindars. The incidence of infidelity and unknown motives was reported in 8 cases (7.47 %) and 4 cases (3.73 %) respectively [Figure 1]. Cause of deaths was due to haemorrhagic shock in 53 cases (49.53%), followed by cranio-cerebral injury cases (32.71%). In the study 11 out of 13 cases of female deaths were due to asphyxia due to throttling and manual strangulation. Death due to abdominal perforations were noted (5.6%) [Table 6].

Discussion:

All forms of violence and homicidal deaths are closely related to social factors like bad leadership, lax application of the law, gender norms, unemployment, income and gender inequality, rapid social change, and a lack of educational opportunities. There is also a high correlation between various forms of violence

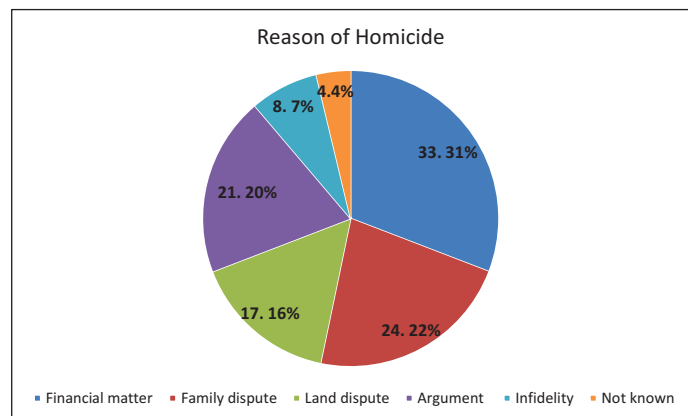


Figure 1. Distribution of homicidal cases on the basis of reason.

Table 1. Total number of autopsies and its relation to Homicidal deaths.

Period	Total autopsies	Homicidal autopsies
Jan 2020 – Dec 2020	2169	45 (2.07%)
Jan 2021 – Dec 2021	2122	62 (2.92%)
Total	4291	107 (2.49%)

Table 2. Distribution of homicidal cases on the basis of male and female Ratio.

Period	Homicidal deaths	Male	Female
Jan 2020 – Dec 2020	45	29 (64.44 %)	16 (35.55%)
Jan 2021 – Dec 2021	62	41 (66.12%)	21 (33.87%)
Total	107	70 (65.42%)	37 (34.58%)

Table 3. Distribution of homicidal cases in relation to different age groups.

Age (in years)	No. of cases	Male (%)	Female (%)	Percentage
01 – 10	01	01 (0.93%)	00 (0.00%)	0.93 %
11 – 20	05	03 (2.8%)	02 (1.86%)	4.67 %
21 – 30	37	23 (21.49%)	14 (13.08%)	34.57 %
31 – 40	31	20 (18.69%)	11(10.28%)	28.97%
41 – 50	23	16 (14.01%)	07 (6.54%)	21.49%
51 – 60	07	05 (4.67%)	02 (1.86%)	6.54%
61 – 70	03	02 (1.86%)	01 (0.93%)	2.80%
Total	107	70 (65.42%)	37 (34.57%)	100 %

Table 4. Distribution of cases according to pattern of homicide.

Weapon	Male (%)	Female (%)	Total (%)
Firearm Injuries	39 (36.44%)	07 (6.54%)	46 (42.9%)
Sharp weapon injuries	11 (10.28%)	06 (6.50%)	17 (15.88%)
Blunt weapon injuries	18 (16.82 %)	13 (12.14%)	31 (28.97%)
Asphyxial deaths	02 (1.86%)	11 (10.28%)	13 (12.14%)
Total	70 (65.42%)	37 (34.57%)	107 (100%)

Table 5. Distribution of cases on the basis of cause of death.

Reason	Male (%)	Female (%)	Total
Hemorrhagic Shock	40 (37.38%)	13 (12.14%)	53 (49.53%)
Cranio-cerebral Injury	23 (21.49%)	12 (11.21%)	35 (32.71%)
Asphyxia	2 (1.86%)	11 (10.28%)	13 (12.14%)
Perforation	05 (4.67%)	01 (0.93%)	06 (5.6%)
Total	70 (65.42%)	37 (34.57%)	107 (100%)

and other factors including excessive alcohol consumption and easy access to weapons like firearms. Alcohol abuse negatively impacts physical and mental health, reducing self-control and increasing the likelihood that some drinkers would use violence when interacting with others.

In our two year study there is increase in the number of homicidal deaths during January 2021 - December 2021 as compared to January 2020 - December 2020, even though there is little decrease in the total number of autopsies.

The present study shows that all the age groups were involved. The highest incidence was amongst 21-30 year age group and majority of the victims were male (65.42%) which is consistent with the study by Alpesh B,⁵ Mohanty MK,⁶ Mada P,⁷ Mishra PK.⁸ Males are more likely to develop instances than females, which may be related to their propensity for risk-taking, physical aggression, and extracurricular activities. As males experience more violence in daily life since they are the family's primary wage earners and typically work outside the home while females prefer to stay inside.

In the present study death due to firearm injury were found to be most common (42.9%), followed by blunt weapon injuries (28.97%), sharp weapon injuries (15.88%) and the number of

asphyxia deaths were less (12.14%) which is in contrast to study conducted by Mishra PK⁸ and Rastogi AK⁹ in Bhopal and Indore region of Madhya Pradesh, due to the widespread use of unlicensed country-made weapons, homicide rates in our area are high.

Criminals typically buy cheaper firearms made in their own area. Since no licence is obtained for them, it is nearly hard to trace who owns the guns. Violence rates in India may vary greatly and in Gwalior region most of gunshot injuries were committed by illegal, unlicensed weapon. Due to their low cost, they are also destroyed or discarded after crimes. Thus, it becomes convenient to commit crimes and avoid being caught. There is less probability of criminals obtaining more licenced firearms because they are only granted after comprehensive verification. This may be the cause of the low number of homicidal fatalities in Bhopal and Indore regions.

During the medicolegal examination the reasons for homicide are difficult to establish for which homicidal deaths was examined and the primary cause, motives or precipitating event was determined. In our study financial matter (30.84%) was the commonest precipitating factor/motive behind homicide which is in contrast to the study conducted by Alpesh B. Bambhaniya, Mehul C. Upadhyay and Taware AA.¹⁰ reported revenge as main motive (30%) and (31.88%) respectively. Whereas Mada P, Krishna PH reported quarrel, money matters and revenge were the main motivating factors.

Most common cause of death was shock and hemorrhage followed by death due to cranio-cerebral/head injury and in both male predominated, which is consistent with results of Parmar DJ¹¹ while females dominated in homicidal death due to violent asphyxia which is also consistent with the study of Parmar DJ.

Conclusion:

In contrast to fatalities from homicide that resulted in several wounds, victims of homicidal deaths with isolated bodily injuries displayed a specific pattern that may have been indicative of the assailant's level of anger, level of violence, and purpose to kill.

The study's findings also contribute to the development of a homicide profile by highlighting specific facts, such as the widespread use of firearms and the use of blunt and sharp instruments to inflict the most severe and lethal damage on internal organs. Men are more likely to die from mechanical trauma than women are from mechanical asphyxia, and there is evidence of linked causes like financial gain, family strife, quarrels, and infidelity.

By the help of active cooperation between the police and the community, community policing tactics seek to build police-community relationships and a problem-solving approach that is responsive to the requirements of the community. There are many strategies that have been created to stop young people from acting violently. The most popular methods include providing assistance

to kids and teenagers in controlling their anger, resolving disputes, and gaining the social abilities required to handle issues.

Systems that report homicides may not necessarily include all homicides that occur in a nation. This might happen when certain deaths are not documented by the criminal justice reporting system, or when deaths that are recorded are mistakenly categorised as being caused by causes other than homicide.

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ORIGINAL ARTICLE

The Estimation of Time since Death by Rule of Thumb method Applied to the Corpses Brought to the Mortuary, GGH, Guntur

Hussain JAP,¹ Rao SM,² Kumar AL,³ Sugnan B.⁴

Assistant Professor,^{1,4} Associate Professor.^{2,3}

1,2,4. Department of Forensic Medicine, Guntur Medical College, Guntur.

3. Department of Forensic Medicine, Govt. Medical College, Nandyal.

Abstract:

A physical change that may occur in a corpse after death would be heat exchange from the body to the surrounding environment. An attempt has been made by the investigators to estimate time since death by Rule of thumb method which takes into account the rate of fall of temperature. A total of 100 human corpses selected for the study. The study was conducted from January to March of the year 2022. It is very difficult to specify normal body temperature, as this value can vary considerably between individuals. Rectal temperatures in a group of healthy subjects can vary between 34.2 °C- 37.6 °C, with a mean 36.9 °C. Rectal temperature is often referred to as deep central temperature, similar in value to that of brain, heart, lungs and abdominal organs.

Keywords: Core temperature; Deep central temperature, Diurnal variation.

Introduction:

A remarkable physical change that may occur in a corpse after death would be heat exchange from the body to the surrounding environment provided there might have been temperature gradient existed between the body and the environment. It is very difficult to specify normal body temperature, as this value can vary considerably between individuals. Rectal temperatures in a group of healthy subjects can vary between 34.2 °C- 37.6 °C, with a mean of 36.9 °C. Rectal temperature is often referred to as deep central temperature, similar in value to that of brain, heart, lungs and abdominal organs. Many factors influence body temperature. Most individuals show diurnal variation in which the body temperature fluctuates by ± 0.5 °C. around the person's normal mean temperature. There are so many factors influence body temperatures like emotional stress of pleasure and displeasure, febrile diseases and endocrine disorders like hyperthyroidism, exposure to a cold environment, peripheral circulatory disorders etc. Age also affects body temperatures, children tend to have higher rectal and oral temperatures than adults. Conditions that prevent heat loss or heat production and which lead to thermoregulatory imbalance are like heat stroke, fainting, heat exhaustion etc.

Materials and Methods:

In this study a total of 100 human corpses were taken to estimate the time since death from Rule of thumb method where time since death is known. Of the 100 cases, 50 were males and another 50

were females (Figure 1). The study was conducted for a period of 3 months in the winter season from January to march of the year 2022. The winter season is ideal for studying the cooling pattern of the human corpse because ambient temperature is always less than body temperature which is unlike in summer where ambient temperatures recorded is always far higher than the body temperature.^{1,2} All these cases are collected from the Acute Medical Care unit of the Government General Hospital who were admitted and undergone treatment as Medico Legal Cases and sent to the mortuary for autopsy. The recording of rectal temperature of the corpse was done in the Acute Medical Care Unit of the hospital after death declaration by the duty doctor to the attenders. Then corpse was shifted to the mortuary by the ward attenders for autopsy. After admission to the mortuary, the name, sex, age, height & built, weight, Medico Legal Case number & In-patient number, date and time of death, cause of death were recorded. Then the bodies were stripped, made naked, placed over the mortuary table in prone position with both upper limbs lying side by the body. Thermometer (chemical), graduated from 0° C to 50° C was inserted into the rectum of the corpse by keeping the buttocks wide apart, such that at least 10 cms of it from its tip should be there in the rectum^{3,4} (Image 1, 2).

The chemical thermometer, as such kept there undisturbed, and reading is taken after 5 mts interval, the time being required for its stabilization.^{3,4} The recording of rectal temperature was made by the investigator without disturbing the corpse and thermometer.^{3,4} The readings are substituted in the given set of formulae to obtain calculated time since death. The results thus obtained are analyzed with the original time since death of the chosen corpses. Informed consent was taken from the deceased attenders for the same. Institutional ethics committee gave no objection certificate for the project. The general method used by many to calculate the postmortem period involved the following two formulae i.e. method A and method B. Method A is in degrees Fahrenheit and method B is in degrees centigrade.⁵⁻⁷

Corresponding Author

Dr. A.P. Jaffar Hussain

Email : apjaffarhussain@gmail.com

Mobile No. +91 9444123069, 7799643150

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Method A

$$\text{Time since death (TSD in Hours)} = \frac{\text{Rectal temperature at time of death (}^{\circ}\text{F)} - \text{Rectal temperature at time } T_1 \text{(}^{\circ}\text{F)}}{15}$$

Method B

$$\text{Time since death (TSD in Hours)} = \frac{\text{Rectal temperature at time of death (}^{\circ}\text{C)} - (\text{Rectal temperature} + 3 \text{ at time } T_1 \text{(}^{\circ}\text{C)})}{15}$$

Table 1. No. of cases vs time since death.

Sl.No	Mode of Death	No.of Cases (n)	Original TSD	Calculated TSD
1.	Violent Deaths	100	2 Hrs	2hrs + 2-4 ^o C
2.	Non -Violent Deaths	100	2 Hrs	2hrs - 0.5-2 ^o C

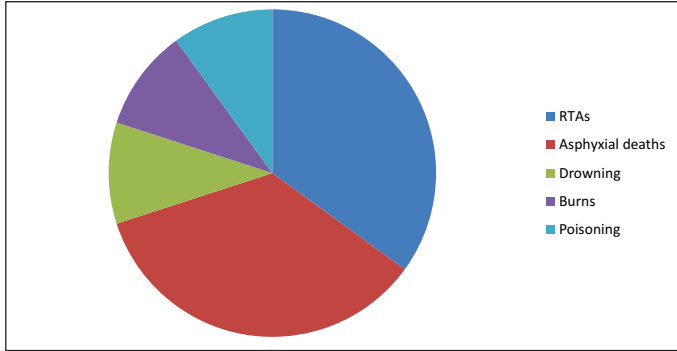


Figure 1. Percent wise distribution of cases.

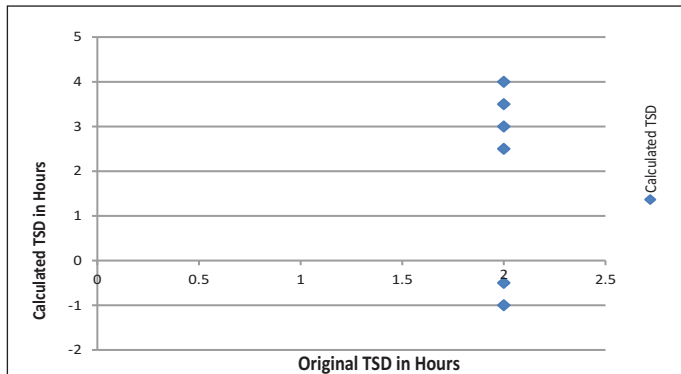


Figure 2. Calculated TSD vs original TSD.

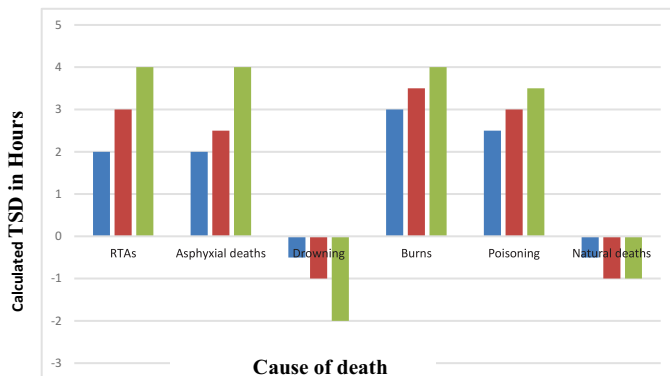


Figure 3. Fluctuation in calculated TSD vs original TSD.

Results:

In total 100 cases were studied (50 males and 50 females). Cases included in the study were; road traffic accidents (n=60), burns (n=10), asphyxial deaths (n=10), poisoning (n=10) and natural

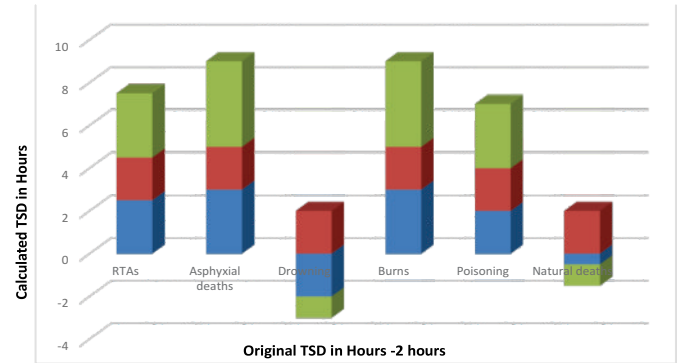


Figure 4. Calculated TSD vs original TSD.

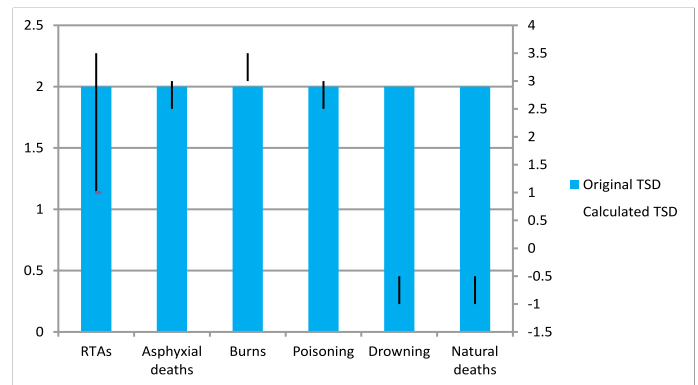


Figure 5. Calculated TSD vs original TSD.



Image No:1

Image No:2

deaths (n=10) Figure 1.

The time since death estimated by Rule of thumb method is more or less compatible with the original time since death. Table No:1, Figure 2.

The estimated time since death by Rule of thumb method and original time since death fluctuates by ± 0.5- 4 hours in all the studied cases. Table No:1, Figure 2. The over estimation of time since death in violent death cases by + 2 to 4 hours is due to production of metabolic heat after death which continues for about 02-04 hours Figure 3,4,5. The under estimation of time since death in poisoning cases, natural death cases by -0.5 to 2 hours is due to decrease in the production of metabolic heat after death, Figure 3,4.

Discussion:

The estimation of time since death by Rule of thumb method is an acceptable method in a human corpse by recording the rectal temperature either at the scene of offence where the body was first found dead or at the time of conducting the postmortem examination. To study the cooling patterns of the human corpses, it is ideal to choose winter season of the year, where the body temperature is always significantly high than the ambient temperature. During the process of recording rectal temperatures, the ambient temperature was almost remained more or same for the entire 3 months of study period and it was 27 °C - 28 °C. The rectal temperatures recorded from the selected human corpses varied from 36 °C - 39 °C. All the cases selected had died due to unnatural deaths of varied etiology showing significant rise in body temperature at the time of death. The elevated body temperature recorded from all the corpses signifying the occurrence of post-mortem calorificity probably due to violence & exertion they faced at the time of death. On average, it took 18-20 hours for the thin built bodies to reach the ambient temperature, whereas 20-22 hours for moderately built bodies and for thick built bodies 22-24 hours.^{1,2}

The shape of the cooling curve of a human corpse is of great importance as it is inevitably the basis on which all post mortem temperature investigations were made. The human body cools in a manner adequately described mathematically by the double exponential formula. The cooling curve obtained from the observed data of the investigators show more or less double exponential one. It is observed that the process of cooling is retarded in its earlier stages represented by a flat portion in upper most part of the cooling curve in all observed cases, signifying the occurrence of a lag period in the earlier stages of cooling, known as "temperature plateau" determined physically by the variable period of 2-4 hours in all cases.^{5,6} The duration of plateau largely depends on the original body temperature at the time of death which is considerably high in violent unnatural deaths.^{5,6}

The phenomenon of temperature plateau was due to delay in establishment of temperature gradients and the continuation of metabolic processes that do not cease at the moment of death but continue for a short period after clinical death, responsible for production of heat at cellular level, which maintains the plateau.^{5,6} Followed by a plateau, the cooling curve shows a steeper part, having two different components of variable lengths i.e., the upper sloping part of variable length and the lower linear part of variable length. The upper sloping part of the cooling curve represents the period of quickest cooling; whereas the lower linear part corresponds to period of slowest cooling.⁷ The part of the cooling curve that is of forensic use is the sloping one, which represents the period of fast cooling.⁷

The cooling of a human corpse does not follow the Newton's law of cooling and it is adequately described by a double exponential formula, and the shape of the curve is a sigmoid one.⁷ The initial stages of cooling reported a "lag period" known as temperature plateau for a variable length on the cooling curve; the calculated

period of plateau on the curve is 2-4 hours in all observed cases. The steeper part of the cooling curve shows two different components of variable length i.e., the upper sloping and lower more (or) less linear part.⁷ The duration of the sloping part on the curve is proportional to the original body temperature at the time of death.⁷ The duration of the linear part on the curve is proportional to the original body temperature at the time of death.⁷ The initial rate of cooling to be 0.5°C/hour and reaches the 1°C/hour during the period of maximum cooling. The rate of cooling varied from 0.3–0.6°C/hour the average being 0.5°C/hour. With such a small rate of fall in temperature, it is not advisable to estimate the time since death, based on the cooling process of the body.⁸⁻¹⁰ The average rate of fall in temperature thus obtained is during winter season, hence the applicability of this data to the temperature based - time estimation methods are restricted to winter season only.⁸⁻¹⁰

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ORIGINAL ARTICLE

Assessment of Perception and Interest by Clinical Rotation Students Towards Forensic Medicine and Medicolegal in the Surabaya Region, Indonesia

Ramadhani P,¹ Ikhsan MK,¹ Yudianto A,² Sulistiyorini N,² SuminoR.²

1. Resident of Forensic Medicine and Medicolegal Specialist Program, Faculty of Medicine, Universitas Airlangga, Jl. Mayjen. Prof. Dr. Moestopo 47, Surabaya, Indonesia.

2. Department of Forensic Medicine and Medicolegal, Faculty of Medicine, Universitas Airlangga, Jl. Mayjen. Prof. Dr. Moestopo 47, Surabaya, Indonesia.

Abstract:

This study aimed to determine medical students' perception and interest in Forensic Medicine and Medicolegal (FMM). In the Cross-sectional study, the tool used is an online questionnaire with a content validity ratio of zero point seven hundred fifty, the type of questionnaire is a Likert-type question. The sample of this research is clinical rotation students who have passed the FMM station. Sampling using the purposive sampling method with the Slovin formula. A total of one hundred and twelve respondents from five medical faculties were involved in this research. Based on Spearman's statistical test, shows a positive correlation between perception and interest but the correlation level is quite adequate or moderate level ($r=.394$, $N=112$, $p=\text{Sig. (2-tailed)} 0.00$, $\text{Sig. (2-tailed)} < 0.01$). The lowest level on the question points to an interest in continuing the FMM specialist career. Clinical rotation students in the Surabaya area have a positive correlation between perceptions and interest in FMM, but the correlation level is moderate, especially in continuing their careers in FMM. This is a challenge for the world of medical education and the Ministry of Health of the need for forensic medicine and medicolegal services that are not evenly distributed in Indonesia.

Keywords: Forensic medicine and medicolegal; Perception, Interests; Medical student career; Specialist.

Introduction:

Health issues related to the administration of justice and insurance are becoming hot topics in Indonesia. Forensic Medicine and medicolegal in their development have the scope of health cases related to criminal cases, the justice system, and insurance, forensic examination of living victims is called Clinical forensic medicine¹ and the examination of death cases whose focus is on finding the cause of death is called forensic pathology.² Forensic medicine and medicolegal in the process of investigating a crime also play a role in the field of identification with serobiomolecular techniques, biological evidence found at the crime scene is analyzed to obtain DNA from the perpetrator.^{3,4} The number of Forensic and Medicolegal (FMM) specialists in Indonesia is approximately 200, far from ideal with a total population of over 270 million consisting of 37 provinces. FMM services are not evenly distributed in all provinces in Indonesia, out of 89 medical faculties, there are only 7 medical faculties in Indonesia that have opened the FMM specialist doctor education program (SDEP).⁵ There are also not that many prospective forensic residents, there are only 2 to 3 registrants in each periode, and once there were no registrants. The purpose of this study was to determine the perceptions and interests of medical students toward FMM.

Materials and methods:

Research subjects and design: This type of research is analytic

Corresponding Author

Muhammad Kholil Ikhsan

Email : mkholil.ikhsan@gmail.com

Mobile No. : 0000-0001-9736-2734

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observational with a cross-sectional design. This study involved 112 students who met the inclusion criteria. Respondents who participated in this study were medical students from 5 different medical faculties in the Surabaya area who completed a clinical rotation of forensic and medicolegal medical stations offline for the period January-August 2022 at the Department of Forensic and Medicolegal Medicine, Faculty of Medicine, Airlangga University, Dr. Soetomo Hospital, Surabaya. There are 7 medical faculties in East Java, Surabaya, 5 of them undergoing clinical rotation at the FMM station at the Department of Forensic Medicine and Medicolegal, Faculty of Medicine, Airlangga University, Dr. Soetomo Hospital, Surabaya. Students are ready to undergo clinical rotation offline after the covid-19 pandemic, personal protective equipment has been prepared, although some students experience anxiety according to studies conducted in Korea.⁶

Population and sample: The population in this study were all clinical rotations of medical students for the period January-August 2022 at the Department of Forensic Medicine and Medicolegal, Faculty of Medicine, Airlangga University, RSUD Dr. Soetomo totaling 357 students from 5 different Faculties of Medicine, namely; Airlangga University (UNAIR), Hang Tuah University (UHT), Wijaya Kusuma University (UWKS), Muhammadiyah University Surabaya (UMS), and Ciputra University (UC). The sample in this study is the one that meets the requirements based on the inclusion criteria. The minimum sample size used in this study can be calculated using the Slovin formula, which obtained at least 78 respondents.

Instruments: The instrument used is an online questionnaire (Google form), perception and interest questionnaire (with a 5-point Likert scale) designed with permission and adopting previous research in other provinces conducted by (Suryadi et al., 2022).⁷ Questionnaires by previous researchers have been tested

Table 1. Interpretation of spearman's rho correlation r value.⁸

Spearman's rho	Correlation
≥ 0.70	Very strong relationship
0.40-0.69	Strong relationship
0.30-0.39	Moderate relationship
0.20-0.29	Weak relationship
0.01-0.19	No or negligible relationship

*This descriptor applies to both positive and negative relationships.

Table 2. Sociodemographic characteristics of the subject (n=112).

Characteristics	Variables	Frequency	Percentage (%)
Gender	Male	30	26.8
	Female	82	73.2
Age (years)	21	16	14.3
	22	36	32.1
	23	23	20.5
	24	25	22.3
	25	5	4.5
	26	5	4.5
	27	0	-
	28	2	1.8
Registered as Medical student	Students class of 2011	1	0.9
	Students class of 2012	1	0.9
	Students class of 2013	0	-
	Students class of 2014	1	0.9
	Students class of 2015	2	1.8
	Students class of 2016	40	35.7
	Students class of 2017	12	10.7
	Students class of 2018	55	49.1
University medical school	Airlangga (UNAIR)	32	28.6
	Hang Tuah (UHT)	17	15.2
	Wijaya Kusuma (UWKS)	28	25.0
	Muhammadiyah Surabaya (UMS)	19	17.0
	Ciputra (UC)	16	14.3

for validity with Content Validity Ratio/CVR by experts, the assessment of each statement item involves 8 panelists consisting of 4 FMMs experts and 4 non-FMMs experts such as anatomy pathology, biomedical science, tropical medicine, and public health. The average result of the CVR value is 0.750. From this CVR value, it can be stated that the instrument's content validity is at a high level.

Research procedure: The data collection technique in this study used primary data using an online questionnaire (Google Form) that the researcher had prepared for the respondents, which was distributed through social media by the enumerator to help collect students in filling out the questionnaire. Data collection time starts on September 1-16, 2022. All respondents fill out a questionnaire independently consisting of perceptions related to FMMs (33 statements) and interests (6 statements), each statement item is coded, P1-P33 for statement items perceptions and I1-I6 for the statement of interests items.

Perception is the response or assessment of clinical rotation students at FMMs. Perception of measurement using a Likert scale consisting of 5 answer choices: strongly agree, agree, doubt, disagree, and strongly disagree. To answer a positive statement,

strongly agree was given a score of 5, agreed was given a value of 4, doubt was given a value of 3, disagreed with a value of 2, and strongly disagreed was given a value of 1. Interest is a feeling of preference or interest in FMMs without coercion felt by clinical students' rotation. The measurement of interest uses a Likert scale consisting of 5 answer options, namely strongly agree, agree, neutral, disagree, and strongly disagree, strongly agree is given a value of 5, agree is given a value of 4, doubt is given a value of 3, disagrees is a value of 2, and strongly disagree given a score of 1.

Data analysis: This study uses data analysis to describe each variable. Descriptive statistics were used to explain the respondent's characteristics, perceptions, and students' interests in FMMs. For inferential analysis, Spearman's rho correlation coefficient is used to determine the relationship between variables (perception and interest), the correlation is significant at ($p < 0.01$), and the interpretation of the r value of Spearman's rho correlation is expressed in (Table 1) to show the level of strength of the relationship between variable. Data were processed and analyzed using IBM SPSS version 25.

Ethical considerations: Ethical clearance was obtained from the research ethics committee of Dr. Soetomo regional general hospital (Registration number- 1664/118/3/IX/2022). A cover letter consisting of informed consent was attached with each questionnaire, which included a description of the study and participants' rights to decline altogether or to leave the questions answered. The consent was implied through the completion of the questionnaire. The participant's name, address, or signature were not included in the questionnaire to keep the participant's identity anonymous. Participants did not receive any incentives or financial compensation for participating in the study.

Results:

Characteristics of subjects: The majority of respondents are female, with a percentage of 73.2%, and the remaining 26.8% are male respondents, the age group of respondents is 22 years (32.1%), and the highest number of years entering a medical degree is in the 2018 batch (49.1%), while the origin universities from consecutive respondents from UNAIR (28.6%), UWKS (25.0%), UMS (17.0%), UHT (15.2%), and finally UC (14.3%) (Table 2).

Description of perception statement: Most of the respondents answered the statement of a positive perception of the FMM. Because the statement was positive and the negative statement was recorded, most of the respondents answered "Agree" or "Strongly Agree" to the statement. Both "Agree" and "Strongly Agree" responses are considered positive perceptions⁹ as shown in table 3. Positive perceptions ranged from 25.9% to 71.4%, the highest percentages were in items P2, P30, P3, and P11, respectively. This shows that most respondents understand that the scope of FMM contributes significantly to the management of both living and dead victims of a crime, besides that FFM also adheres to human rights and is impartial without taking sides in concluding an examination result.¹⁰ The lowest positive percentage on item P1 "Forensic medicine and medicolegal is indispensable in medical and legal practice" where the answers "strongly agree" (3.6%), "Agree" (25.9%), and "Doubtful" (70.5%), respondents do not fully understand that FFM is needed

Table 3. Analysis of the distribution of respondents' answers regarding perception in forensic medicine and medicolegal sciences (n=112).

#	Statement (Perception)	Strongly Agree(%)	Agree (%)	Doubtful (%)	Disagree (%)	Strongly Disagree (%)
P1	Forensic medicine and medicolegal are indispensable in medical and legal practice	3.6	25.9	70.5	0	0
P2	Forensic medicine and medicolegal contribute to upholding justice and human rights	71.4	25.9	1.8	0	0.9
P3	A clinical forensic examination is beneficial for the victim/patient	70.5	27.7	1.8	0	0
P4	A clinical forensic examination should be carried out in all clinical cases that have the potential to become legal issues	61.6	34.8	3.6	0	0
P5	Establishing a standard operating procedure in the hospital regarding the urgency of clinical forensic examination is necessary.	54.5	41.1	4.5	0	0
P6	It is necessary to carry out clinical forensic supervision by carrying out a follow-up examination of the visum et repertum	53.6	42.9	3.6	0	0
P7	A follow-up visum et repertum (medicolegal reports) is beneficial for the victim/patient	67.9	27.7	4.5	0	0
P8	Forensic pathology examination is beneficial for the victim/patient	66.1	29.5	4.5	0	0
P9	Forensic pathology is useful in cases of clinical death	66.1	29.5	4.5	0	0
P10	An autopsy is necessary for the investigation of deaths in clinical cases if the external examination is still in doubt	69.6	27.7	1.8	0	0.9
P11	Forensic pathology examination is useful in cases of death due to crime	70.5	28.6	0	0	0.9
P12	Forensic pathology examination is useful in cases of accidental death	59.8	31.3	8.9	0	0
P13	An autopsy is necessary for the investigation of death in a victim of a criminal case if the external examination is still in doubt	67.9	29.5	2.7	0	0
P14	An autopsy is necessary for the investigation of deaths in accident victims if the external examination is still in doubt	57.1	35.7	5.4	0.9	0.9
P15	Ethical and medicolegal assessments benefit the patient	62.5	33	4.5		
P16	There needs to be a standard operating procedure in the hospital regarding the urgency of ethical and medicolegal assessments	67	30.4	2.7	0	0
P17	Ethical and medicolegal studies are useful in cases of ethical dilemmas in medical practice	62.5	33.9	3.6	0	0
P18	Ethical and medicolegal studies are useful in cases of ethics and medicolegal conflicts	65.2	31.3	3.6	0	0
P19	Ethical and medicolegal studies are useful in cases of medical disputes.	62.5	33.9	3.6	0	0
P20	With the high number of criminal cases in Indonesia, the role of forensic medicine and medicolegal science is needed in society	68.8	28.6	2.7	0	0
P21	With the high number of ethical dilemmas and medical disputes in Indonesia, the role of forensic medicine and medicolegal science is very much needed in society	62.5	34.8	2.7	0	0
P22	Expert information during an examination at the investigation level is very useful for the police's duties.	68.8	29.5	1.8	0	0
P23	Expert information during an examination at the court level is very useful for judicial and prosecutorial duties.	68.8	28.6	2.7	0	0
P24	The role and function of forensic medicine and medicolegal are needed by the state	66.1	32.1	1.8	0	0
P25	The role and function of forensic medicine and medicolegal science are needed by higher education institutions	65.2	30.4	4.5	0	0
P26	It is necessary to increase the number of forensic and medicolegal specialists in Indonesia	60.7	32.1	7.1	0	0
P27	There is a need for additional training and practical exposure to forensic medicine and medicolegal in undergraduate medical education.	56.3	33	9.8	0.9	0
P28	There is a need for additional training and practical exposure to forensic medicine and medicolegal in medical professional education.	55.4	38.4	5.4	0.9	0
P29	Forensic medicine and medicolegal are professions with good prospects in the future	49.1	41.1	8	1.8	0
P30	Forensic and medicolegal medicine science must be conducted on the principle of being independent and impartial (not taking sides)	71.4	26.8	1.8	0	0
P31	Specialization education in forensic medicine and medicolegal is equivalent to other specialties.	66.1	30.4	3.6	0	0
P32	The career opportunities for forensic medicine and medicolegal specialists are very large because they can work in higher education institutions, police agencies, police hospitals, and teaching and noneducational hospitals	52.7	43.8	3.6	0	0
P33	Research opportunities and scientific developments in forensic medicine and medicolegal are very broad and promising	53.6	39.3	6.3	0.9	0

Table 4. Analysis of the distribution of respondents' answers regarding interests in forensic medicine and medicolegal sciences (n=112).

#	Statement (Interests)	Strongly Agree (%)	Agree (%)	Doubtful (%)	Disagree (%)	Strongly Disagree (%)
I1	I think forensic medicine and medicolegal science are both interesting and exciting fields.	32.1	49.1	16.1	1.8	0.9
I2	I am interested in hearing or watching information or news in the media related to forensic medicine and medicolegal science.	34.8	47.3	15.2	0.9	1.8
I3	I enjoy studying forensic medicine because of the nature of the job.	25	40.2	28.6	3.6	2.7
I4	I am interested in studying forensic medicine for personal interests and personal reasons (e.g. family or friends).	26.8	39.3	17.9	13.4	2.7
I5	I am interested in continuing my career in the fields of forensic medicine and medicolegal science.	9.8	17	32.1	28.6	12.5
I6	I feel challenged when dealing with victims and perpetrators of crimes.	19.6	43.8	20.5	10.7	5.4

Table 5. The correlation between perception and interest.

	Perception	Interests		
Spearman's rho	Perception	Correlation Coefficient	1	.394**
		Sig. (2-tailed)	.	0
		N	112	112
	Interests	Correlation Coefficient	.394**	1
		Sig. (2-tailed)	0	.
		N	112	112

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

in providing ethical recommendations related to the legal practice of a medical procedure and patient safety issues.¹¹

Description of interests statement: Most of the respondents answered positively regarding the statement of interest but the highest score in the "Agree" answer (49.1%) and the highest "Strongly agree" answer (34.8%) as shown in table 4. Only specific on item I5 "I am interested in continuing my career in the fields of forensic medicine and medicolegal science" most of the respondents gave answers "Doubtful" (32.1%), "Disagree" (28.6%), and "Strongly Disagree" (12.5%), where the statement narrowed down to FFM as their next career choice as a specialist, only (17.0%) answered "Agree" and (9.8%) answered "Strongly agree" to choose FFM as their future career choice, the rest responded negatively with an answer. "Disagree" (28.6%), "Strongly disagree" (12.5%), and the most answers were "Doubtful" (32.1%).

Statistical analysis: In table 5, Spearman's statistical test shows (r=0.394, N=112, p= Sig. (2-tailed) 0.00, Sig. (2-tailed) < 0.01) whose interpretation is a positive correlation between perceptions and interests of medical students' clinical rotation of FMM but with a "moderate relationship" correlation level according to the interpretation of Spearman's rho correlation r value (table 1). In this case, the majority of respondents have a positive perception of FMM but do not have a high level of interest and tend to be hesitant, especially in terms of choosing FMM as their career choice and choice of a specialist in the future.

Discussion :

Career choice is an important and unavoidable milestone in the life of every medical student, not only for life but also for family and social life. Choosing a career among these specializations usually depends on a variety of intrinsic (i.e., related to personal characteristics and preferences) and extrinsic (i.e., related to the work environment) factors. These include individual suitability, gender, manageable lifestyle, previous clinical experience, role models, financial compensation, prestige, work pressure, future job security, hours worked, quality of entry-level education, selection of specializations, and types of services provided,¹² the choice of specialization should also take into account the distribution and need in national health services, avoiding a shortage or oversupply of doctors available in various specialties, which can lead to an imbalance in the availability of health services.¹³

However, this is a cross-sectional study, and the subjects of this study are medical students who are undergoing clinical rotation, there are still other factors that they may not have discovered until they graduate to become doctors.¹⁴ In this study, the number of respondents were more women (73.2%) than the rest were men (26.8%) (table 2), this can also affect the results of the study. Previous research at King Saud University on female students showed interest in ENT-Ophthalmology (12.1%), Surgery (11.7%), Pediatrics (10.8%), and Dermatology (8.2%), male students preferred General Surgery (15.7%), Internal Medicine (15%), ENT-Ophthalmology (12%) and Orthopedics (9.1%), the less popular specialties are Community Medicine, (6.6%), Anesthesia, (6%) and Forensic medicine (4.6%).¹⁵ Research conducted in Greece regarding the reasons students choose the Forensic Medicine specialization most commonly is due to scientific interest in the field (40%), followed by better job opportunities (21%), and satisfying detective searches (19%), which are quite interesting. None of the students mentioned prestige as their motivation.¹⁶ Suggestion factors also have a role in determining specialization, successively levels of advice are from families, practicing doctors, seniors, and hospital staff, then the student's own reasons factors such as interesting cases contribute (36.5%), challenging and difficult (33%), good lifestyle (32.5%), impact on patient's quality of life (28.2%), prestigious job (24.0%) and mentor (7.6%).¹⁷

Previous research in Indonesia by Windasari et al (2022) showed that there are still obstacles in the field of FMM which consists of 3 groups, namely obstacles when going to study when undergoing an education program, and when already working as an FMM specialist, 41.5% of respondents met obstacles when going to study forensic medicine specialists The main obstacles relate to the absence of scholarships (13.6%), the absence of support from the original institution/workplace (7.8%) and the absence of support from family 5, 1%. Only 35.4% of respondents underwent education smoothly. The rest encountered problems, mainly related to the lack of a variety of examination cases during education (21.7%), the lack of examinations in the field of Forensic Medicine (15.9%), and the presence of uncooperative seniors (7.2%). When they entered the work area in the field of Forensic Medicine, the number of FMM specialist doctors who encountered obstacles increased by 81%, the obstacle was mainly

related to the limited supporting tools for the examination of Forensic Medical services (63%), the lack of financial assistance for examining forensic cases for victims/patients (44%), insufficient number of forensic medical examinations/services (43%), and lack of financial support from the workplace related to services provided by FMM specialists (40%).¹⁸ Suboptimal support is an obstacle in determining career development and FMM services.¹⁹

Conclusion:

Clinical clerkship students in the Surabaya area have a positive correlation between perceptions and interest in FMM, but the correlation level is moderate, especially in continuing their careers in FMM. This is a challenge for the world of medical education and the Ministry of Health to the need for Forensic and Medicolegal medical services which are not ideal for the population and are not evenly distributed in every province in Indonesia. Optimal support related to careers and facilities for Forensic Medicine and Medicolegal Installations in each hospital can improve the quality of Forensic and Medicolegal Medical Services and increase medical students' interest in this field. Medical education needs to include counseling programs in selecting specialist careers that consider the number and distribution.

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ORIGINAL ARTICLE

A Cross Sectional Study of Fingerprint Patterns and Ridge Densities in Relation to Sex

Sreekumar B,¹ Pannag SK,² Fernandes AV.³

Senior Resident,¹ Assistant Professor,² Professor & HOD.³

1-3. Department of Forensic Medicine & Toxicology, Goa.

Abstract:

Fingerprints are the impressions left by the epidermal ridges of human fingers and these are found to be very unique. The study was conducted at Goa Medical College, Goa in order to determine the relationship between sex and finger print patterns as well as the relationship of ridge densities with respect to sex of an individual. Present study showed that Loops were the most common pattern in males and females followed by whorls. The least common patterns seen were the composites in males and in females. After statistical evaluation it is found that the average ridge density in males is 13.06 and the average ridge density in females is 14.54.

Keywords: Fingerprint patterns; Dactylography; Fingerprint ridge density; Sex determination.

Introduction:

Establishment of identity has many facets, and one among the many methods used nowadays, include fingerprint analysis or dactylography. Dactylography is the technique by which establishment of identity is done by collection of imprints of the dermal papillary ridges, commonly referred to as “fingerprints” from digital bulbs and their comparison with pre-existing fingerprint records. As Locard's principle of exchange states:- When any two objects come into contact, there is always a transfer of material from one object to the other.¹ Likewise, fingerprints are all around us. The system was introduced by Sir William J Herschel in 1877. The first instance of fingerprints being used in crime detection was in Argentina in 1892.²

General parameters of identification include race, age, sex, complexion, stature and features, hair, scars, tattoos, occupational marks, handwriting, clothing, personal articles and effects, speech or voice, gait, DNA Profile/typing/DNA fingerprinting. Fingerprints have proven to be positive proof of identity by different law enforcement agencies for more than a century now.³

It is said that no two fingerprints are ever the same and an overwhelming mathematical probability that no two will ever match.⁴ Also, this uniqueness is maintained throughout life since there will never be a change in the fingerprint pattern.⁵ Their easy availability and requirement of less sophisticated techniques of print development make it an easy tool for the Forensic pathologist or anthropologist for personal identification.⁶ There are many advantages to this technique, some examples being, they can even be taken from a decomposed body (provided the palmar skin is present), they can be transported to different

countries in cases of internationally operating criminals, they can be used for prevention of impersonation, can also be used as extra precautionary measures in banks or legal documents.² Fingerprints have an application in avoiding inadvertent or deliberate swapping of neonates in hospitals. Identification of gender is one of the main parameters under consideration when fingerprints are scrutinized.⁷

This study in particular focuses on confirming the ridge densities of males and females in the Goan population and its accuracy in determining the sex of the individuals from the ridge densities.

Materials and Methods:

The present cross sectional study has been conducted at the department of Forensic Medicine & Toxicology, Goa Medical College, Goa, India after obtaining clearance from the Institutional Ethics Committee (IEC).

Inclusion criteria: Total subjects included were 75 males and 75 females. Resident doctors, students and staff from Goa Medical College and nearby Goan population above the age of 18 years were included in the study. Age is determined from government authorised ID cards like driving license, aadhar card etc. Subjects with no finger deformities, palmar scars or skin diseases were only considered.

Exclusion criteria: Subjects having any injuries/deformities/palmar scars or skin diseases that could alter the fingerprint pattern were not chosen. Subjects of non Goan ethnicity were not considered (verified using Government IDs). Informed consent was obtained prior to taking fingerprints after proper explanation of aims, objectives and methodology of the study.

Materials: The materials used in the study are as follows:

- 1) Inkless fingerprint pad.
- 2) Magnifying lens.
- 3) Pencil.
- 4) Transparent sheet with 5 mm x 5 mm square marked which was placed over the fingerprints to count the ridge density.
- 5) Tabulated Proforma to collect 10 fingerprints.
- 6) Tissue papers.

Corresponding Author

Dr. Bharat Sreekumar

Email : bharatsreekumar@gmail.com

Mobile No. : +91-9744093375

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Table 1. Fingerprint patterns in males.

Pattern	Number	Percentage
Loops	452	60.26%
Whorls	194	25.86%
Arches	66	8.8%
Composite	38	5.06%
Total	750	100 %

Table 2. Fingerprint patterns in females.

Pattern	Number	Percentage
Loops	486	64.8%
Whorls	123	16.4%
Arches	120	16%
Composite	21	2.8%
Total	750	100%

Table 3. Chi square test result of finger print patterns in relation to gender.

	Results				Row Totals
	Loops	Whorls	Arches	Composite	
Male	452	194	66	38	750
Female	486	123	120	21	750
Column Totals	938	317	186	59	1500

Table 4. Standard deviation of fingerprint density calculation (Males).

Sample Size	Mean	Standard Deviation	Average ridge density (M ± 2SD)
75	13.06	0.26	13.06 ± 0.52

Table 5. Standard deviation calculation of fingerprint density (Females).

Sample Size	Mean	Standard Deviation	Average ridge density (M ± 2SD)
75	14.54	0.36	14.54 ± 0.72

Methodology: The purpose of the study was initially explained to the participants and informed consent taken. The subjects were asked to wipe their hands clean with tissue paper so as to remove excess oil, sweat and dirt. Subject was asked to keep his/her hands relaxed. Impressions of the pulps (distal phalanges) of all digits of both hands were taken. The fingerprints were collected in such a manner that the thumbs were rolled towards the subject's body (ulnar to radial side) and the fingers were rolled away from the body (radial to ulnar side). This was done in the tabulated sheet with allotted slots for each finger. Rolling of the digits to obtain the impressions was done by the subjects themselves, without intervention by the investigator, so as to avoid smudging of prints.

For analysing the ridge densities, the method used by Acree⁸ was used. Each print/impression was divided into four quadrants by drawing an imaginary vertical axis along the vertical midline of the print and an imaginary horizontal axis along the horizontal midline of the print. To study the fingerprint ridge densities, a square of 5mm x 5mm (25mm²) which was drawn on a transparent sheet was placed on the center of the upper radial quadrant of the impression of the pulp (distal phalanx) of the respective digit, outside the central core region. Ridge density was determined as ridge count in 5mm x 5mm dimension squares (25mm²) (Figure 1). The ridges were counted along the diagonal line of the square. This method can be easily replicated in all samples which ensure that uniformity is maintained in the methodology for all samples. In this way, total ridge density was determined as ridge count/25mm².⁹ The advantage of this method is that uniformity in counting is established in all samples even if done repeatedly.

Moreover, epidermal ridges were not analyzed in the central core

region due to the variation in patterns, causing further errors in counting recurring ridges. Areas outside the central core regions do not pose this problem.

Results:

The total number of male fingerprints examined was 75 and predominant fingerprint pattern noted was loops (60.26%), followed by whorls (25.86 %), arches (8.8%) and the least was composite (5.06%) comprising of central and lateral pocket loops and twinned loops (Table 1).

The total number of female fingerprints examined was 75 and the predominant fingerprint pattern noted was loops (64.8 %), followed by whorls (16.4 %), arches (16%) and the least was composite (2.8%) comprising of central and lateral pocket loops and twinned loops (Table 2).

In order to determine the statistical significance (p-value) of the different patterns in relation to the gender, the Chi Square test was used (Table 3). The chi-square statistic is 37.7103. The p-value is < 0.00001. The result is significant at p < .05. There is statistically significant association between fingerprint patterns and gender.

To evaluate the ridge densities of both genders, mean and standard deviation of the samples were calculated. Unpaired T-test was applied to assess the significance (p-value) and the average Ridge Density in males was found to be 13.06 ± 0.52 (Table 4) and in females it was found to be 14.54 ± 0.72 (Table 5). The t-value was calculated to be -28.62392. The p-value is < .00001. The result is significant at p < 0.05.

Discussion:

In determining the individuality of persons, impressions of the fingers, palms and soles have had a vital role in investigative procedures. Its uniqueness and easy accessibility in the realm of identification has given it much importance over the time. Patterns as well as ridge densities are analysed for the specific identification of suspects. It becomes even more significant in case of chance or latent prints wherein identification of the gender of the suspect can be corroboratively determined from this very simple technique.

Present study showed that loops were the most common pattern in males (60.26%) and females (64.8%) followed by whorls. Whorls were second most common with 25.86% in males and 16.4% in females. The least common patterns seen were the composites with a percentage of 5.06% in males and 2.8% in females. It is observed that arches were more common in females than males with percentage of 16% and 8.8% respectively. Males had a higher percentage of composites when compared with females.

A study by Bansal HD et al. is conducted on 536 Marathi subjects (256 males and 280 females) of Nagpur city, India and ulnar loop (51.3%) was found to be the most common pattern observed. No statistically significant difference (at level p<0.05) were observed between distribution of fingerprint patterns in males and females of the population. But the current study showed that there was a difference in patterns among both gender, with difference in proportion of arches.¹⁰ Kukadiya et al. conducted a study of fingerprint pattern among the Saurashtran population and total number of loops was 844 (58.9%). Similarly numbers of



Figure 1. Method of counting fingerprint ridge density.

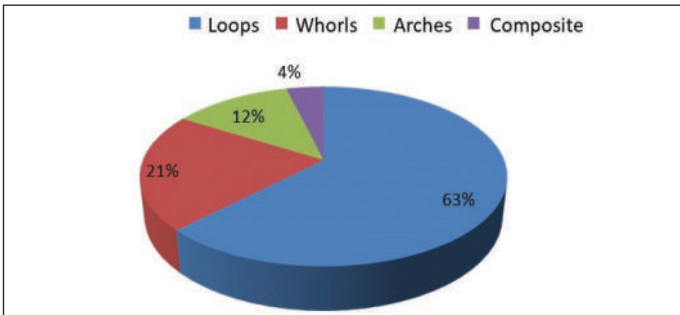


Figure 2. Proportion of fingerprint pattern in the whole study population.

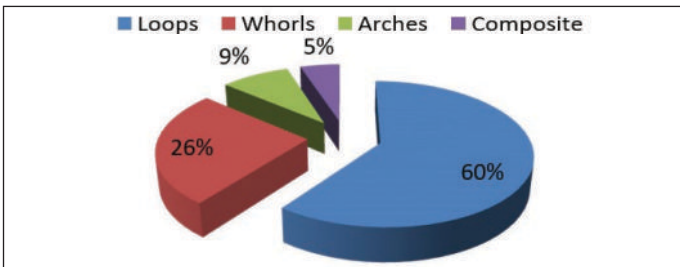


Figure 3. Proportion of fingerprint patterns (males) pie chart.

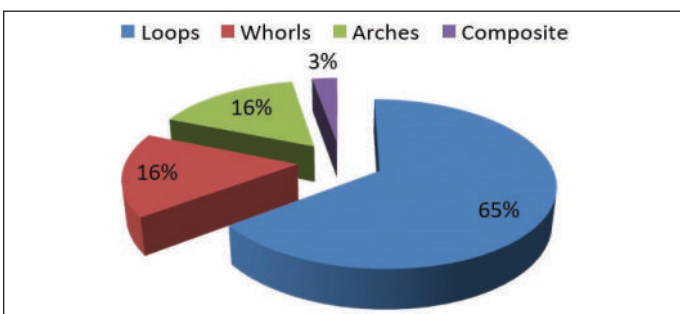


Figure 4. Proportion of fingerprint patterns (females) pie chart.

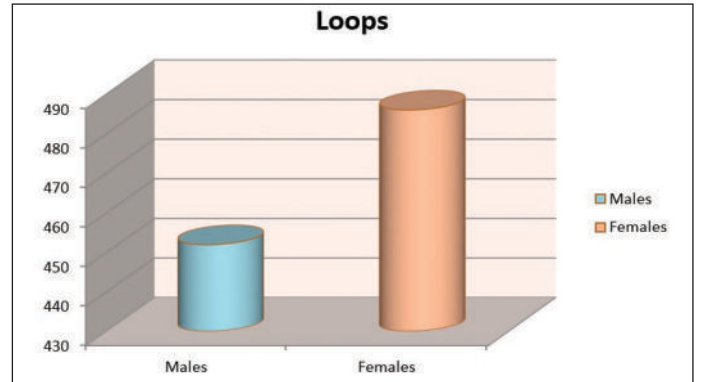


Figure 5. Proportion of loops in males & females.

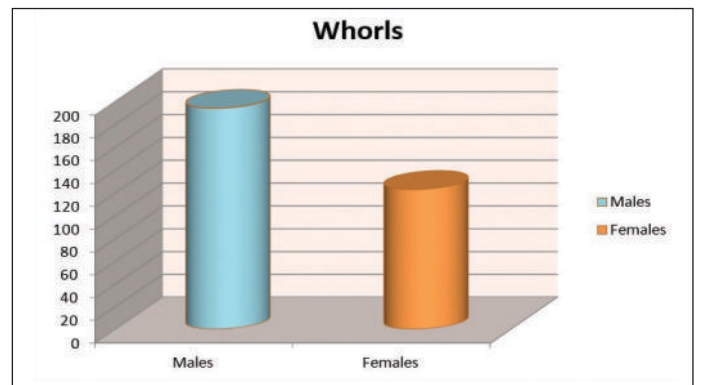


Figure 6. Proportion of whorls in males & females.

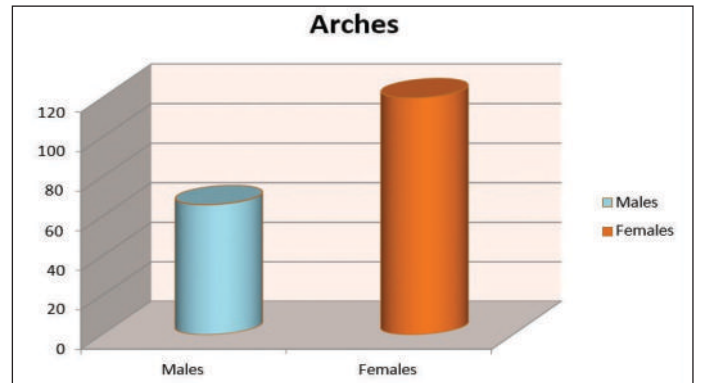


Figure 7. Proportion of arches in males & females.

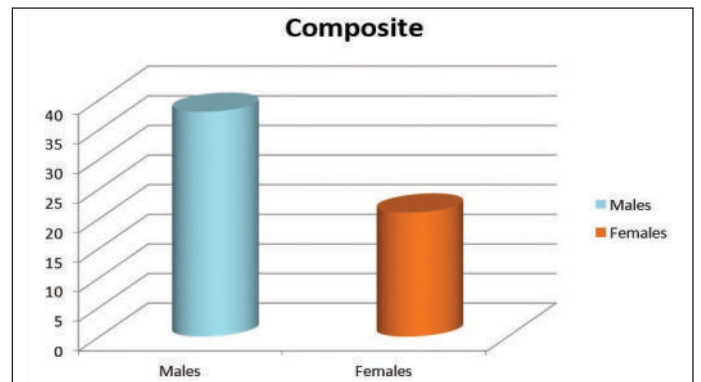


Figure 8. Proportion of composite in males & females.

whorls were 444 (29.6%) and number of arches was 173 (11.5%), showing that loops were more common finger print patterns found, than the whorls and arches. Frequency of loops were found to be higher in females; 444 (52.63%) and whorls were found to be higher in males; 254 (57.09%). Arches were found more in females; 90 (51.73%) as compared to males; 83 (48.26%). The results of this study are in consistence with the present study.¹¹ Loops were again found as the most common pattern in a study on fingerprint patterns in 50 males and 50 females at Mandya by Kumar V. et al. in 2019, followed by Plain whorl. As per Kumar V. et al., the least frequently observed pattern in the total population were simple arches, twinned loops, tented arches, radial loops, accidental types and exceptional arches both in male and female.¹² A similarity in findings that loops followed by whorls is the most common pattern seen is evident in this study as well. Narayana BL et al. in 2019 analyzed 50 males & 50 females in Andhra Pradesh and concluded that frequency of loops were found to be higher in males (51.23%) compared to that of females (48.76%). Whorls and arches were seen higher in females compared to males. Composites showed equal incidence in both sexes.¹³ This study shows results very much in contradiction to the current study since whorls were 25.85 % in males and 16.4 % in females, indicating a higher incidence in males than females. Similarly Composites were greater in males than females with a difference of about 3% between the two sexes. Loops were seen as having the highest frequency (52.71 %) in a study conducted at Bhaktapur on a sample size of 198 people by Shrestha I & Malla BK. Whorls were second most common in both the genders.¹⁴ These findings are in consistence with the present study. A study by Sinha RR, Kumar B et al. on 200 medical students in Bihar showed that most common pattern was loop and the least common was arch. In gender distribution, loops were common among females (58.5 %) than males (55.5%). The whorls were more common in males (33%) than females (27.5). Males showed predominance in composite pattern as well.¹⁵ A contradiction in the result was seen in the present study since composites were seen as the least common pattern and not arches. Similar results were seen in cases of loops and whorls, wherein, the females having higher number of loops than males and males having higher number of whorls than females, respectively, in the present study.

The most prevalent finger prints were the loop and whorl in a study by Chukwumah AL conducted on medical students in Nigeria. Whorls were higher in males (51.5%) than females (48.5%), whereas females had a higher incidence of loops (52%) and arches (51%).¹⁶ The findings appear very similar to the current study with females having higher incidence of loops and arches.

After analyzing the observations, it is evident that the patterns show uniqueness with respect to an individual but the point of generalization becomes difficult due to the variation seen within the geographical locations itself. A study among the South Indian population to determine FP ridge count was done by Nithin MD et al. consisting of 550 subjects (275 males & 275 females) and concluded that fingerprint possessing ridge density <13 ridges/25 mm² is most likely to be of male origin. Likewise, a fingerprint having ridge count >14 ridges/25 mm² are most likely to be of

female origin.¹⁷ The findings from this study are almost similar as the present study with the average ridge density of the male being 13.06 ± 0.52 and the average ridge density of females at 14.54 ± 0.72 . This also shows that females have a higher density of ridge count than males. Nayak et al. in their study conducted in Manipal found a statistically significant difference in fingerprint ridge densities of male and female fingerprints were seen in a study population of 100 males and 100 females of Indian origin. A mean fingerprint ridge density of 12 ridges/25 mm² or less was found to be more likely to be of males and a mean ridge count of more the 12 ridges/25 mm² was more likely to be of female origin.¹⁸

This study was done with a wider population range and the ridge densities calculated differ slightly from the present study, with the upper margin of the male ridges at 12/25mm,² whereas the upper margin in the present study was found to be 13/25mm,² similarly for females it was found to be 14/25mm² in the present study, whereas the lower margin was 12/ 25 mm² in the previous study. However, the study seems to be in consistent with the findings for females, i.e., a ridge density more than 12/25mm² is likely to be a female.

A study specific to North Indian young population was done by Krishan K et al. in which a different methodology was applied wherein three regions from each fingerprint was examined for ridge density and still concluded that females have a higher ridge density than males.¹⁹ The result is similar to the present study, which also highlights that irrespective of the change in methodology, the final inference remained the same. A total 500 (250 male + 250 female) person participated in the study conducted by Kumari P et al. in the population of Patna, Bihar and mean fingerprint ridge density in female was 13.97 & 11.97 in male.²⁰ This study has derived results almost similar with the present study and also the importance that the study population was from North India, showing consistency with the findings from the population of south India.

The ridge density ranges from 11-15 ridges/25mm² in male and 11-16 ridges/25mm² in females as stated in a study by Kumar L et al. comprising of population from Uttarakhand state. Study also pointed out that males never had a ridge count more than 15 and the number of females with ridge count 15-16 was very high. The current study showed that males only had a maximum of 14 ridges/25mm,² but the value remains consistent with the female population.²¹ Ridge density study done by Khadri SY et al. around Bijapur region found out that there was not much of a significant difference in the ridge densities between male and females. Average male ridge count was calculated to be 12.4 and in females it was 12. This was in contradiction to the present study since the ridge densities of the females were significantly higher than the males.²² A significant study in 1999 was conducted by Acree among Caucasian and African American population, concluding that a ridge density of 11 ridges/25 mm² or less is more likely to be of male origin, and a ridge count of 12 ridges /25 mm² or more is most likely to be of female origin.⁸ The importance of this study was that different races were considered, compared and the findings were still consistent with that of the present study, i.e., the females having more ridge density than males. An international study by Nayak et al. on Chinese and Malaysian

population found out that in Chinese subjects, the ridge density ranged from 9.3 to 14.9 ridges/25 mm² for males and from 11.1 to 16.4 ridges/25 mm² for females. In Malaysian population, ridge density ranged from 9.4 to 14.4 ridges/25 mm² for males and from 11.4 to 15.3 ridges/25 mm² for females. Females were found to have significantly higher ridge density than males.²³ Ridge density analysis was done in Sohag, Egypt by Hilal MA & Mohamed SA, concluding that the mean value of fingerprint ridges in females were 17.74 ± 1.630 and in males were 15.02 ± 1.326.²⁴ This study also proves females have a higher fingerprint ridge density than males, also, consistent with the present study even though value are a bit off set. An analysis of fingerprint ridge density in the Indo Mauritian population and its application to gender determination was done by Agnihotri AK et al. on 200 healthy medical students and a conclusion was made stating the maximum mean ridge density in men (12.2~12) is less than the ridge density in women (12.71~13).²⁵ Again the findings are very much in correlation with the present study. A study done by Gungadin S at Mauritius shows a very similar result with the current study, that the males had a fingerprint ridge density of <13 ridges/25mm² and females had a ridge density of >14 ridges/25 mm². It had successfully hypothesized that females have a higher fingerprint ridge density than males.²⁶ Fingerprint ridge densities more than 14/25mm² indicative of females and less than 14 /25 mm² were males was found in an analysis done in Chinese population by Xie H & Lin Z, again in correspondence with present study.²⁷

A database consisting of 380 males and 380 females was considered for fingerprint ridge density analysis by Ceyhan E B and Sagiroglu S in Turkish population and the results derived were identical to the present study. It was shown that the average ridge density of female was 14.10 ridges/25mm² and the average ridge density of male was 11.49 ridges/25mm².²⁸ Significant differences between genders based on ridge density were obtained in the study by Soanboon P et al. in Thai population, which states that females exhibit higher ridge density, i.e. narrower ridges, than males.²⁹ A very similar study was done in the Turkish population by Oktem H et al. and the findings were very much in consistency with the present study i.e., females have a higher ridge density than males.³⁰

Conclusion:

Fingerprint as a preliminary diagnostic tool for identification of gender (sex) was the core principle analysed in this study. Based on data collected and further scrutiny it has come to be evident that observing fingerprint patterns alone, one cannot necessarily deduce the gender of a person, but considering the dimorphism in the ridge count, one can reach a likely conclusion on the gender of the person, as was seen consistent with many studies in comparison. The most common fingerprint pattern seen was that of the loop followed by whorls, arches and composite. Whereas, loops and arches were more common in females than males, whorls were predominant in the male population. Males had a higher incidence of composite patterns as well. In the present study the mean average found after examining the ridges were 13.06±0.52 in males and 14.54±0.72 in females. Even though the exact values of ridge densities are seen varying in different

studies, it is almost always a common finding that women have higher ridge density than men and the value seems to be commonly fluctuating in the values of 10-13.5 ridges/25mm² for male and >14 ridges/25 mm² for females. Using the ridge densities for gender identification, it could be particularly in use when amputated hand or bodies of unknown person are at question, provided, the likely race of the person can be estimated on gross examination, for further accuracy. Even though these parameters can be used as preliminary diagnostic tools for gender identification, in the manner that if the average ridge density calculated in an unknown body is >14 ridges/25 mm², then it is likely to be a female body, still, further study and research considering a higher sample size and variation in race is required to improve the accuracy and legitimacy of this method.

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ORIGINAL ARTICLE

A Study of Pattern of Unnatural Deaths at Government Medical College Associated Hospital, Ambikapur, Sarguja, Chhattisgarh

Ramtake AK,¹ Chaure L,² Singh NK.³

Associate Professor,¹ Demonstrator,² Tutor.³

1,2. Department of Forensic Medicine and Toxicology, Bharat Ratna Late Shri Atal Bihari Vajpayee Memorial Govt. Medical College, Rajnandgaon.

3. Department of Forensic Medicine and Toxicology, Indira Gandhi Institute of Medical Sciences, Sheikhpura, Patna.

Abstract:

The incidence of unnatural deaths is increasing day by day at an alarming rate. The aim of our study was to characterize the cases of unnatural deaths autopsied at the mortuary of Government Medical College associated hospital, Ambikapur, Sarguja, Chhattisgarh. This is retrospective study which included 530 cases of unnatural deaths which were autopsied between April 2016 to March 2017. In our study, RTA (road traffic accident) constituted the maximum number of cases 211 (39.81%), followed by poisoning 97 (18.30%), mechanical asphyxia 69 (13.02%), burns 60 (11.32%) and electrocution 08 (1.51%) which constituted least number of cases. Out of 530 cases of unnatural deaths, 338 (63.77%) cases were males and 192 (36.23%) cases were females. In the present study, maximum number of victims 136 (25.66%) were in the age group of 21-30 years. Maximum number of the victims 372 (70.19%) were married, followed by unmarried victims 152 (28.68%). Most of the cases 322 (60.75%) belonged to rural area. In the present study, maximum number of cases 212 (40%) were reported in summer season, followed by 180 (33.96%) and 138 (26.04%) cases in winter and rainy seasons, respectively. Among overall cases of unnatural deaths, maximum number 146 (27.55%) of incidents occurred in the night hours. In the present study, maximum cases i.e. 389 (73.39%) were accidental in nature.

Keywords: Unnatural deaths; Road Traffic Accident; Rural; Electrocution; Accidental.

Introduction:

Unnatural deaths are all deaths, excluding natural deaths and deaths from diseases.¹ Unnatural deaths happen almost everywhere in the world. Data on unnatural deaths in a particular geographic area can give the reflection of its law and order situation. A low value should be described in favour of peace, harmony and security to human life and property.² Most countries have a legal procedure for investigating deaths which are not obvious natural diseases. In England and Wales, there are about 600000 deaths annually, of which some 400000 are certified by doctors, the remainder being investigated by the coroner. In other countries, these latter deaths are also screened by officials, either coroners, Procurators Fiscal in Scotland, Medical Examiners in many states of the USA, magistrates, judges and police in other countries. The systems differ widely, but in general those deaths which are criminal, suspicious, accidental, suicidal, sudden and unexpected, unexplained or in any way not due to natural causes, cannot be certified by a doctor and must be reported for medicolegal investigation.³ The study helps to understand the pattern of unnatural deaths and proves to be helpful to the authorities to take preventive and remedial steps for the preventable causes of unnatural deaths.

Corresponding Author

Dr. Nawal Kumar Singh

Email : nawal.rims05@gmail.com

Mobile No.: 08210044654

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Materials and methods:

This is retrospective study which included 530 cases of unnatural deaths which were autopsied between April 2016 to March 2017 at the mortuary of Government Medical College Associated Hospital, Ambikapur, Sarguja, Chhattisgarh. The data is collected from Case papers, Inquest reports and from postmortem reports. The data thus obtained was analyzed and the study was done with respect to: types of unnatural deaths, age & sex wise distribution, marital status, domicile pattern, diurnal variation, season wise distribution and manner of death.

Results:

Distribution of cases according to types of unnatural deaths: In the present study, RTA constituted the maximum number of cases 211 (39.81%), followed by Poisoning 97 (18.30%), Mechanical Asphyxia 69 (13.02%), Burns 60 (11.32%) and Electrocution 08 (1.51%) which constituted least number of cases.

Distribution of cases of unnatural deaths according to age and sex: Out of 530 cases of unnatural deaths, 338 (63.77%) cases were males and 192 (36.23%) cases were females, thus indicating that majority of victims were males. In the present study, maximum number of victims 136 (25.66%) were in the age group of 21-30 years, followed by 115 (21.70%) cases were in the age group of 31-40 years. Minimum numbers of victims were in the age group of less than 10 years 15 (2.83%).

Distribution of cases of unnatural deaths according to marital status: In the present study, maximum number of the victims 372 (70.19%) were married, followed by unmarried victims 152 (28.68%).

Table 1. Distribution of cases according to types of unnatural deaths.

Type	Total No. of cases	Total Percentage (%)
RTA	211	39.81%
Burns	60	11.32%
Poisoning	97	18.30%
Fall from Height	37	6.98%
Bites and Stings	38	7.17%
Assault	10	1.89%
Mechanical Asphyxia	69	13.02%
Electrocution	08	1.51%
Total	530	100%

Table 2. Distribution of cases of unnatural deaths according to age and sex.

Age (in Years)	Male	Female	Total No. of cases	Total Percentage (%)
<10	10	05	15	2.83%
11-20	25	16	41	7.73%
21-30	96	40	136	25.66%
31-40	65	50	115	21.70%
41-50	41	31	72	13.58%
51-60	37	19	56	10.57%
61-70	30	24	54	10.19%
71-80	20	5	25	4.72%
>80	14	2	16	3.02%
Total	338 (63.77%)	192 (36.23%)	530	100%

Distribution of cases of unnatural deaths according to Domicile pattern: In the current study, maximum number of cases 322 (60.75%) belongs to rural area.

Distribution of cases of unnatural deaths according to seasonal variation: In the present study, maximum number of cases 212 (40%) were reported in summer season, followed by 180 (33.96%) and 138 (26.04%) cases in winter and rainy seasons, respectively.

Distribution of cases of unnatural deaths according to diurnal variation: In the present study, among overall cases of unnatural deaths maximum number of incidents occurred in the night hours 146 (27.55%).

Distribution of cases of unnatural deaths according to manner of death: In the present study, 389 (73.39%) cases were accidental in nature followed by 131 (24.72 %) which were suicidal and 10 (1.89%) which were homicidal in nature.

Discussion:

Unnatural deaths claim a substantial number of lives in developing countries like India. The unnatural causes of death are many with accidents being the most common amongst all. Over the decades, there has been a steady increase in the transportation deaths and injuries, on road, rail and in the air. Accidental burns, poisoning, drowning, electrocution and fall from height are also on the rise. Suicidal and homicidal fatalities are common among both the urban and rural population. In the present study, RTA constituted the maximum number of cases 211 (39.81%), followed by Poisoning 97 (18.30%), Mechanical Asphyxia 69 (13.02%), Burns 60 (11.32%) and Electrocution 08 (1.51%) which constituted the least number of cases. Our result was similar to the observations made in the study conducted by Rahim M & Das TC (2009)² where RTA cases (68.92%) constituted maximum numbers of cases of unnatural deaths and by Santhosh CS et al. (2011)⁴ where RTA (61.67%) accounted for majority of cases among unnatural deaths.

Table 3. Distribution of cases of unnatural deaths according to marital status.

Marital Status	Total	
	No.	%
Married	372	70.19%
Unmarried	152	28.68%
Unknown	06	1.13%
Total	530	100%

Table 4. Distribution of cases of unnatural deaths according to domicile pattern.

Domicile	Total	
	No.	%
Urban	202	38.11%
Rural	322	60.75%
Unknown	06	1.13%
Total	530	100%

Table 5. Distribution of cases of unnatural deaths according to seasonal variation.

Seasons	Total	
	No.	%
Summer	212	40%
Rainy	138	26.04%
Winter	180	33.96%
Total	530	100%

A deviation from our findings was seen in the study conducted by Roy Shobhan et al. (2019)⁵ where RTA was found to be second most common type of case being 15.47% and Burn was found to be third most common type of case being 8.7% while poisoning was found to be only 5.54%. Yet electrocution was found to be 2.28% which was almost similar to our study.

Out of 530 cases of unnatural deaths, 338 (63.77%) cases were males and 192 (36.23%) cases were females, thus indicating that majority of victims were males. In the present study, maximum number of victims 136 (25.66%) were in the age group of 21-30 years, followed by 115 (21.70%) cases, which were in the age group of 31-40 years. Minimum number of victims was in the age group of less than 10 years 15 (2.83%). Our result was similar to the observations made in the study conducted by Sharma BR et al. (2006)⁶ in which males were 69.3% and females were 30.7% and maximum numbers of victims (49%) were in the age group of 21-30 years; as well as by Rahim M & Das TC (2009)² in which males were 77.27% and females were 22.72% and maximum number of victims (33.72%) were in the age group of 21-30 years. Also, Roy Shobhan et al. (2019)⁵ found 66.93% cases to be male and 32.36% cases to be female, while in 0.7% cases gender could not be determined. Roy Shobhan et al. (2019)⁵ also found maximum number of cases belonging to 21-30 years of age group (22.95%) followed by 31-40 years of age group (18.99%). The study conducted by Kumari Sangeeta et al. (2017-2019)⁷ found female autopsy cases to be 23.3%.

In the present study, maximum number of the victims 372 (70.19%) were married, followed by unmarried victims 152 (28.68%). Our results for overall cases of unnatural deaths were similar to the observations made in study conducted by Sharma BR et al. (2006)⁶ where 63.04% persons were married and 36.96% were unmarried; by Bansude ME et al. (2012)⁸ in which 80.06% victims were married followed by 19.94% unmarried victims. In the current study, maximum number of cases 322 (60.75%) belongs to rural area. Our results for overall cases of unnatural deaths were similar to the observations made in study conducted by Kumar S et al. (2013)⁹ where maximum number of victims were from rural area (51.48%); by Sarkar AP et al.

Table 6. Distribution of cases of unnatural deaths according to diurnal variation.

Time of Incident	Total	
	No.	%
Morning (6.01am to 12 noon)	137	25.85%
Afternoon (12.01 pm to 6pm)	126	23.77%
Evening (6.01pm to 12.00 am)	121	22.83%
Night (12.01am to 6 am)	146	27.55%
Total	530	100%

Table 7. Distribution of cases of unnatural deaths according to manner of death.

Manner of death	Total	
	No.	%
Accidental	389	73.39%
Suicidal	131	24.72%
Homicidal	10	1.89%
Total	530	100%

(2013)¹⁰ in which majority of cases were from rural area (64.5%). In the present study, maximum number of cases 212 (40%) were reported in summer season, followed by 180 (33.96%) and 138 (26.04%) cases in winter and rainy seasons, respectively. Our results for overall cases of unnatural deaths were similar to the observations made in study conducted by Yousfani GM & Memon MU (2010)¹¹ in which unnatural deaths occurred more in summer season (63%). In the present study, among overall cases of unnatural deaths, maximum number of incidents occurred in the night hours i.e. 146 (27.55%).

Our results for overall cases of unnatural deaths were correlating with the observations made in study conducted by Kumar S et al. (2013)⁹ in which cases were most commonly occurring during night (36%). In the present study, 389 (73.39%) cases were accidental in nature followed by 131 (24.72 %) which were suicidal and 10 (1.89%) which were homicidal in nature. Our results for overall cases of unnatural deaths were similar to the observations made in study conducted by Kumar S et al. (2013)⁹ in which (64.46%) cases were due to accident followed by suicide (22.75%) cases and homicide cases (12.77%). A deviation from our finding was seen in the study conducted by Biswas DK et al. (2008-2010),¹² who found maximum number of cases to be suicidal (45%) followed by accidental (35%).

Conclusion:

In our study, we conclude that RTA constituted the maximum number of cases 211 (39.81%), followed by Poisoning 97 (18.30%), Mechanical Asphyxia 69 (13.02%), Burns 60 (11.32%) and Electrocution 08 (1.51%) which constituted the least number of cases. Out of 530 cases of unnatural deaths, 338 (63.77%) cases were males and 192 (36.23%) cases were females. In the present study, maximum number of victims 136 (25.66%) were in the age group of 21-30 years. Maximum number of the victims 372 (70.19%) were married, followed by unmarried victims 152 (28.68%). Most of cases 322 (60.75%) belonged to rural area. In the present study, maximum number of cases 212 (40%) were reported in summer season, followed by 180 (33.96%) and 138 (26.04%) cases in winter and rainy seasons, respectively. Among overall cases of unnatural deaths, maximum number of incidents occurred in the night hours i.e. 146 (27.55%). In the present study, maximum number of cases 389 (73.39%) were accidental in nature.

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ORIGINAL ARTICLE

Morphological and Histological Evaluation in Suspected Cases of Sudden Cardiac Death: A Cross Sectional Study

Pandit JN,¹ Arava SK,² Yadav A,³ Prasad K,⁴ Gupta SK.⁵

Senior Resident,¹ Professor,² Additional Professor,^{3,4} Professor and Head.⁵

1,3-5. Department of Forensic Medicine, All India Institute of Medical Sciences, New Delhi.

2. Department of Pathology, All India Institute of Medical Sciences, New Delhi.

Abstract:

During the autopsy, acute plaque changes such as occluding thrombus, atheromatous disruption, or both are seen in more than half of sudden coronary death cases. At the department of Forensic Medicine and Toxicology, we are getting the cases of sudden cardiac death (SCD) frequently for medico-legal autopsy. The majority of these are found to be due to coronary insufficiency which had been unexpected and unexplained on history taking before the autopsy. Even during the autopsy, some cases do not show any evident gross findings and the diagnosis of SCD can only be made by microscopic examination of the heart and after excluding other possible causes of death. Thus, forensic pathologists have a great opportunity to study SCD and its relationship with different organic and functional causes. The authors have conducted this study intending to evaluate the morphological findings and histopathological changes in suspected cases of sudden cardiac deaths. In this cross-sectional study, the gross pathologies were seen as petechial hemorrhage, soldier's patches, coronary occlusion, bridging of coronary arteries, cardiac tamponade, aortic dissection, valvular pathology, and recent or remote changes of ischemia in the myocardium, etc. Most commonly, the coronary artery occlusions were seen in LAD (59%), especially in its proximal portion (47%). Grade I ischemic changes were seen in maximum cases (in 23% cases), followed by Grade III (in 20% cases), then Grade II (in 16% cases) and least as Grade IV ischemic changes seen in 2% of cases.

Keywords: Sudden cardiac death; Histopathological examination; Thrombo-atheromatous plaque; MT and VVG staining; Myocardial bridging; Myocardial ischemia.

Introduction:

The widely accepted definition of sudden cardiac death (SCD) is an unexpected death that occurs within 1 hour from the onset of symptoms or death of an individual occurring within 24 hours having been last seen alive and well if it is un-witnessed.¹ Despite dramatic improvements in therapeutic measures, cardiovascular disease (CVD), especially ischemic heart disease (IHD) remains the leading cause of mortality worldwide. Earlier the SCD was predominantly seen in older male but now the incidence in youngsters below 40 years and females are also increasing. Among the IHDs, atherosclerosis of the coronary artery causing myocardial insufficiency is the major cause.²⁻⁴ Pathological conditions other than the myocardial insufficiency that leads to SCD includes inflammatory diseases like myocarditis/endocarditis, various cardiomyopathies, valvular heart diseases, coronary artery disease (CAD), cardiomegaly, aortic rupture, arrhythmias and channelopathies.⁵⁻⁷ Despite of meticulous autopsy, some cases do not show any evident gross findings and, the diagnosis of SCD can only be made by microscopic examination of the heart and after excluding other possible causes

of death. The forensic pathologist has a unique opportunity to come across a wide range of SCD and its study in relation with different organic and functional cause. Here, the authors have conducted this study intending to evaluate the morphological findings and histopathological changes in heart in suspected cases of sudden cardiac deaths.

Material and Methods:

This was a cross-sectional study conducted between September 2017 and May 2019. In total, 100 cases of sudden cardiac death brought for medicolegal autopsy were selected for evaluation. Ethical approval was obtained from the Institute Ethics Committee. The study subjects included both sexes across different ages wherein the autopsy was conducted within 48 hours of death. Any case having external/internal injuries, suspicion of poisoning, or any organic pathology other than cardiac disease was excluded from the study.

Virchow's method of dissection was applied in all the cases. After the removal of the heart from the body, the inflow-outflow method of sectioning was used in most of the cases. In case of suspected hypertrophy or dilated chambers, we used transverse sectioning at 1cm interval from apex to just below and parallel to atrioventricular apparatus. The liquid/clotted blood was removed, and then the heart was weighted and grossly examined for any organic pathology.

To examine coronary atherosclerosis or thrombus, the coronary artery tree was divided into segments according to previously established clinical criteria. The left coronary artery comprises

Corresponding Author

Dr Abhishek Yadav

Email : drayad_in@yahoo.com

Mobile No: +91-98180 52523

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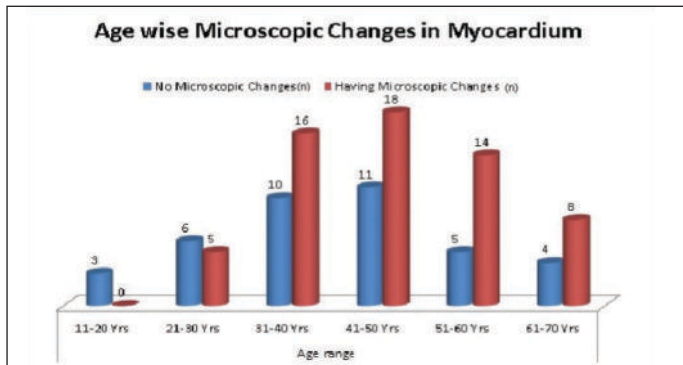


Figure 1.. A age wise distribution of cases having microscopic changes in myocardium. Majority of ischemic changes are seen in third and fourth decade of age group.

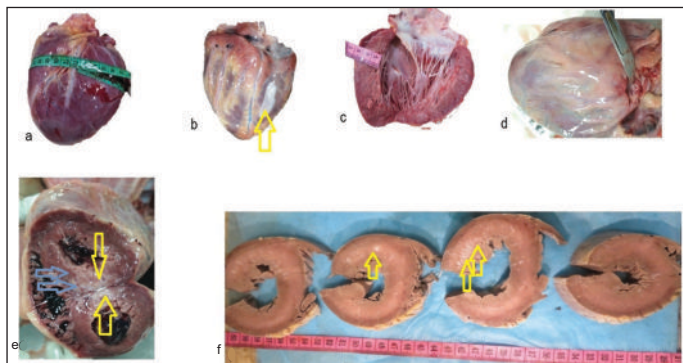


Figure 2. a-f: Photograph showing gross pathology, a-Cardiomegaly with heart weight 650 gm; b-Posterior surface of heart showing Soldier's patch indicating evidence of chronic pericarditis; c-Hypertrophic cardiomyopathy having left ventricular wall thickness about 3 cm; d-Complete atherosclerotic coronary blockage in proximal portion of LAD; e-Ischemic cardiomyopathy involving posterior wall (yellow arrow) and IVS (blue arrow) showing trans mural infarction; f-Dissection of heart by short axis method to show ventricular hypertrophy and pathology in the myocardium-ischemic changes can be seen as whitish patches at places;

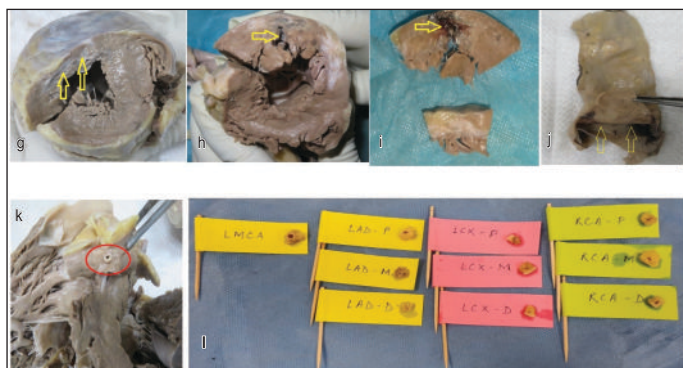


Figure 2. g-l: g-Thinned out and fibrotic left ventricular free wall due to chronic ischemic changes; h& i-Rupture (yellow arrow) of the ventricular wall due to ischemic changes (blue arrow); j-Rupture of aortic wall due to descending aortic dissection; k-Intramural course (bridging) of left anterior descending artery; l-Sections representative of most involved area in each segment of coronary arteries in a normal heart.

the left main coronary artery (LMCA), left anterior descending artery (LAD), and left circumflex coronary artery (LCX). The LAD was further divided into three parts namely proximal, middle, and distal. Similarly, LCX and the right coronary artery (RCA) were also distributed into proximal, middle, and distal

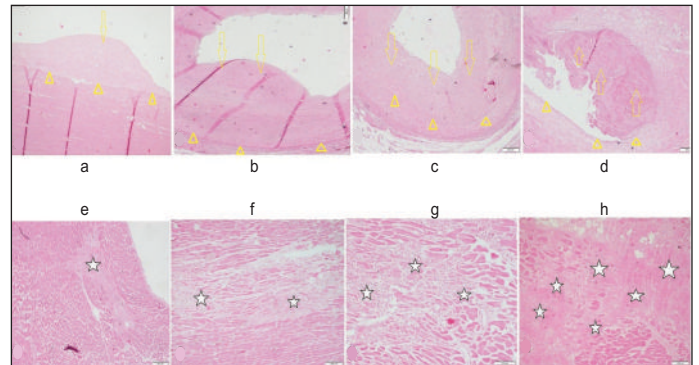


Figure 3. Clerotic changes (yellow arrows) and normal intimal line (yellow triangles), a-Uncomplicated atherosclerosis occluding <25% of the lumen; b-Fibro atheroma with approximate 25 – 50 % of lumen compromised; c- Fibro atheroma with approximate 50 – 75 % luminal occlusion; d-Complicated atheromatous plaque with >75% occlusion of lumen by fibrin thrombus in the lumen. Photomicrograph showing ischemic changes (white stars) in myocardium, e-Grade 1 MI having focal area of replacement fibrosis; f-Grade 2 MI with replacement fibrosis and neovascularisation; g-Acute ischemic changes of Grade 3 at the site of ruptured left ventricular wall; h- Extensive involvement of myocardium with replacement fibrosis due to ischemic sequelae (Grade 4 MI).

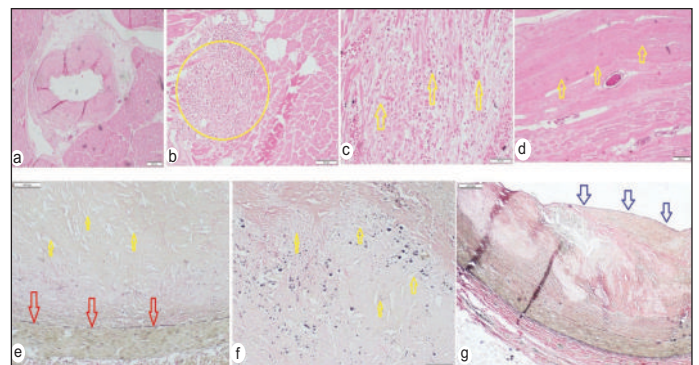


Figure 4. Photomicrograph showing, a- deep intramural course (Bridging) of coronary artery; b-Granulomatous myocarditis; c-Giant cell myocarditis; d-VVG stain highlighting internal elastic lamina (yellow arrowed arrows) with numerous cholesterol clefts (redyellow arrows) in the atheromatous plaque; e-Atheromatous plaques with cholesterol cleft and calcification (VVG stain); f-Uncomplicated fibro-atheromatous plaque with fibrous cap (VVG stain).

parts. Sectioning started from ostium to terminal pericardial branches at about 3 mm intervals for all the coronary arteries to determine the presence or absence of atherosclerotic plaques, internal proliferation, haemorrhage, and thrombus with their sites and resultant percentage of luminal blockage. The coronary artery narrowing was graded from Grade I to Grade IV⁸ in a manner like the guideline used for grading the degree of narrowing of the coronary artery as mild, moderate, and severe given by Kyung-Moo Yang et al.⁹ Sectioning was done as far as possible, and the course of the vessels and anatomical position were noted.

Part of the heart including all valves and coronaries having any gross pathology was preserved in 10% formalin for grossing and examination of histopathological changes. Standard automated histokinetic processing procedure was done for microscopic examination, in which we have taken sections from the Anterior,

Table 1. Distribution of pathological findings of heart in younger and older people.

Pathological findings	Age ≤40 years (n=40)	Age >40 years (n=60)	Total (N=100)
Myocardial ischemia	21	40	61
Coronary occlusion of any grade	22	41	63
DCMP	2	0	2
Valvular heart disease	1	2	3
Bridging of coronary	1	4	5
Rupture LVW	0	1	1
Giant cell myocarditis	0	1	1
HOCM	0	1	1
Ruptured aortic dissection	0	1	1
Granulomatous cardiomyopathy	15	12	27
Normal heart			

Table 2. Correlation between weight, gross pathology, and histological changes in heart.

	Heart weight	Histological Changes (n)		Total (n)
		Not present	Present	
No Gross pathology (n)	≥ 500 grams	0	2	2
	< 500 grams	25	7	32
Gross pathology present (n)	≥ 500 grams	2	3	5
	< 500 grams	12	49	61
	Total	39	61	100

Table 3. Correlation between coronary occlusion and ischemic changes in myocardium.

	Coronary occlusion	Ischemic changes in myocardium		Total
		Not present	Present	
	Not present	27	10	37
	Present	12	51	63
Total		39	61	100

posterior, lateral, and IVS wall, sections from all coronaries, sections from any gross pathology, and then stained with Haematoxylin and Eosin (H & E) stain, Masson's Trichrome (MT) stain, and Verhoeff-van Gieson (VVG) stain when required. The results were analysed statistically using IBM SPSS statistics version 25 software.

Results :

The age range of the case included in the study was from 19 years to 68 years with a mean of 44.3 ± 12.4 years. The male-to-female ratio was 6.14:1 and the mean BMI was 26.26 ± 5.08. Of the 100 cases studied, 40% were under 40 years of age. Among these, 21 cases (52.5%) had evidence of microscopic changes in the myocardium, whereas, among the subjects over 40 years of age, 66.7% showed microscopic changes in the heart (Table 1 & Figure 1). On examination of the heart either from wet dissection during autopsy or after fixation, we found gross pathology in 66% of the cases. The gross pathologies were seen as petechial hemorrhage, soldier's patches, coronary occlusion, bridging of coronary arteries, cardiac tamponade, aortic dissection, valvular pathology, and recent or remote changes of ischemia in the myocardium. Cardiac tamponade due to rupture of the ventricular wall was found in 5% of cardiac death cases. In one case rupture of aortic dissection was seen. Cardiomegaly in which heart weight was more than 500 gm was present in 7 cases (Table 1 & 2 and Figure 2).

Out of 100 cases, 63% case showed coronary blockage either due

Table 4. Involvement of single, double, and triple vessels observed in gross examination.

N=100	Single vessels involved (n)	Double vessels involved (n)			Triple vessels involved (n)
		RCA + LAD	RCA + LCX	LAD + LCX	
RCA	2	12	0	9	18
LAD	20				
LCX	2				
Total	24	21			

Table 5. Distribution of coronary occlusion in different segments with severity grade.

Artery involved	Frequency of involvement (n)				
	Grade 1	Grade 2	Grade 3	Grade 4	Total
LMCA	1	1	1	2	5
LAD- P	2	7	15	23	47
LAD- M	0	2	10	15	27
LAD- D	0	3	2	7	12
LCX- P	1	8	11	9	29
LCX- M	0	5	8	4	17
LCX- D	0	1	3	2	6
RCA- P	3	5	9	8	25
RCA- M	0	3	5	10	18
RCA- D	0	0	0	0	0

LMCA= Left main coronary artery, LAD= Left Anterior Descending Artery, RCA= Right Coronary Artery, LCX= Left Circumflex Artery, P= proximal segment, M= middle segment, D= distal segment.

to atherosclerotic plaque or an associated occluding ante mortem thrombus (Table 2 & 3). In the 63% cases having the coronary occlusion, total 45% cases had only atherosclerotic changes and 18% of cases had evident thrombo-atherosclerotic plaques. Single vessel involvement was seen in 24% of cases, involvement of two vessels was seen in 21% of cases, and in 18% of cases, all three vessels were involved (Table 4). Most commonly, the coronary artery occlusions were seen in LAD (59%), especially in its proximal portion (47%). The maximum numbers of coronary occlusions were in the Grade 4 category. The right coronary artery was seen to be the least affected and not a single case showed occlusion in its distal part (Table 5 and Figure 3 a-d).

Out of 100 cases, on examination of the cardiac tissue, recent or remote ischemic changes in the myocardium were seen in 61% of cases. However, in 39% of cases, no microscopic changes were evident (Table 3). Grade I ischemic changes (focal lesion) were seen in 23% of cases, Grade II ischemic changes (patchy area of replacement fibrosis with neovascularisation) were seen in 16% of cases, Grade III ischemic changes (large area of replacement fibrosis) seen in 20% of cases, and Grade IV ischemic changes (extensive lesion) seen in 2% of cases (Figure 3 e-h). In one case Giant cell myocarditis and one case Granulomatous myocarditis were seen (Figure 4).

Out of 100 cases, 27% cases had no coronary occlusion or any ischemic change in the myocardium; 10% cases had no coronary occlusion but features of myocardial ischemia were seen on microscopy; in 12% cases microscopic changes of ischemia are not seen but found evidence of coronary occlusions; both the features are found in 51% cases (Table 3).

Discussion:

Although SCD may occur even below 18 years of age, almost 97% of SCD cases are seen in the adult and older age group.¹⁰⁻¹² IHD, which is mainly due to coronary atherosclerosis, remains the most common underlying pathology (42%). Myocarditis, cardiomyopathies, congenital heart disease, genetic structural disorder, and channelopathies predominantly occur in younger age groups.^{2-4,12} Pathologically coronary artery disease is said to be present when the heart shows narrowing up to more than 75% of at least one of the three coronaries by atherosclerotic changes/thrombotic plaque¹³ although individuals having more than 90% of coronary narrowing can survive without any significant symptoms. Autopsy provides a valuable tool in the assessment of pathologies that are difficult to assess in living subjects.

In routine autopsy practice, approximately 15% of SCD remains unexplained.¹² No immediate or early change is seen on gross examination and even on microscopy in SCD in some cases of myocardial ischemia and cardiac arrhythmias. In these cases, the diagnosis of SCD is done by exclusion, based upon negative findings ruling out other causes of death.^{4,14,15}

From a pathological point of view, CAD can be diagnosed in a heart showing narrowing of arterial lumina in at least one of the three coronaries i.e. the left anterior descending, left circumflex, and the right coronary artery by three-fourths or more by atherosclerotic change and/or thrombotic plaque.¹³ CAD can involve single vessels, double vessels, or triple vessels.

Atherosclerotic lesions are classified by American Heart Association (AHA) as follows^{8,16-18}

Type I: Remote intimal foamy cell (minimal change)

Type II: Abundant intimal foamy cells frequently seen in layers (fatty streaks)

Type III: Pools of extracellular lipids with undefined core (intermediate lesion or pre-atheroma)

Type IV: Well-defined lipid core with normal intima at the luminal surface (atheroma or fibro plaque)

Type V: Lipid core with a fibrous cap with or without calcification (fibro atheroma)

Type VI: Fibro atheroma with cap defect (hemorrhage or thrombosis)

Type VII (Vb): Prominent calcification.

Type VIII (Vc): Prominent fibrous tissue.

During the autopsy, acute plaque changes such as occluding thrombus, atheromatous disruption, or both are seen in more than half of sudden coronary death cases. However, among the hearts having myocardial scars without any acute infarction, only 46% have active coronary lesions.¹⁹ Bridging the coronary artery also plays a significant role to cause sudden cardiac death. Here, an anomalous coronary artery dips into the myocardium instead of traversing solely in the epicardial fat.^{20,21} Another frequent pathological finding in SCD is rupture or erosion of plaque rich in proteoglycans and smooth muscle cells which lack a superficial lipid core.^{19,22}

The normal heart weight of adult males and females is ranging from 300-350 gm and 250- 300 gm respectively⁹ depending on the height and weight of the individual. The criterion of heart weight >400 gm is frequently used to define a big heart.⁹ In a study, stepwise logistic regression was performed to determine the combination of variables that would contribute to the identification of cardiac death it was found CAD was the first contribution followed by old MI, recent MI, and heart weight >500 gm.⁶ In our study, we found 7 cases (7%) having heart weight >500 gm of which 5 cases also showed gross pathology (grade II coronary occlusion in 2 cases, dilated cardiomyopathy in 2 cases and hypertrophic cardiomyopathy [left ventricular wall thickness 32 mm] in 1 case); histological changes (grade 1 to 2 ischemia) in 5 cases; and in 3 cases both the gross and microscopic changes were seen. The average weight of the heart in our study was 360.52 ± 97.07 gm which is similar to the results of Yang's study.⁹

Myocardial bridging, i.e. a segment of the coronary artery being intramural and lying underneath a band of the heart muscle, is also a contributing factor to SCD. Here, the coronary is susceptible to compression during cardiac systole, resulting in a functional inability to supply blood to the distal part of the heart. Even during the diastolic phase of the cardiac cycle when the coronary flow is expected to be the maximum, it has been seen ultrasonographically that myocardial bridging is responsible for the delayed relaxation during early diastole and reduced distal coronary pressure during mid diastole.^{20,21,23} In our study, we found 3 cases having bridging of coronary artery among these 2 cases were also associated with atherosclerotic coronary occlusion.

In SCD, ischemic heart disease due to coronary atherosclerosis is more common than thrombus formation.^{9,24-25} Other gross findings are fibrosis of the myocardial wall, valvular abnormalities, rupture of the ventricular wall due to recent or remote ischemic changes, hypertrophic cardiomyopathy, dilated cardiomyopathy, and ruptured aorta. Spontaneous dissection of the coronary artery is also a significant gross finding.⁹ In our study, we found gross pathology in 66% of cases like different grades of atherosclerotic occlusion and/or thrombo-atheromatous plaques, ruptured ventricular wall, recent or remote ischemic changes, HOCM, DCM, valvular pathology, and pericarditis. Among these, the most common gross finding was coronary occlusion (63% of cases). This is similar to the observations of Zipes et al., who found hypertrophic cardiomyopathy (48%) followed by idiopathic LVH, coronary anomalies, and rupture aorta to be the common findings in age <35 years, while coronary abnormality (80%), followed by HOCM and valvular heart were commonly seen in age group >35 years.¹⁹

The most involved coronary arteries are the proximal part of the left anterior descending and left circumflex artery.⁹ In our study, we found the proximal portion of LAD (47%) had the commonest involvement followed by the proximal part of LCX (29%), then the middle part of LAD (27%), than the proximal part of RCA (25%) and, the distal part of RCA is not involved at all. Our findings are consistent with the study conducted by Mizgala et al.²⁶ and Joseph A et al.,²⁷ in which proximal LAD was found to be the most frequently involved coronary artery in CAD.

In the pathology of CAD, however, an associated thrombus is also frequently seen.⁹ In our study, atherosclerotic changes were seen in 45% of cases while thrombotic plaque was seen associated with atherosclerosis in 18% of cases.

Single vessel involvement was seen in 24% of cases, double vessel involvement was present in 21% of cases, and in 18% of cases, triple vessels were involved. The findings were compared with those of Virmani et al., who conducted a study on 48 autopsy cases of the aged 30 years and younger having severe coronary atherosclerosis and showed that single vessels disease (44%) was greater than double (40%) and triple vessels (16%) disease.²⁸

Gross and microscopic examination is the usual routine autopsy procedure to find out the cause of death in sudden death cases. Evident gross features of cardiac death like fibrosis of the myocardium, coronary atherosclerosis, thrombo-atheromatous plaque, calcification, or vegetation can also be confirmed by Histopathological examination.

In some cases, where no gross changes of fibrosis are evident, these may be detected on histological analysis.^{29,30} It has been found that in about 37% of cases where the referring pathologist concluded it to be a normal heart on autopsy, specialist evaluation by microscopic found significant pathological changes in the heart.³⁰ A study done by Sree Lakshmi K et al.³¹ revealed that out of 88 cases, 30 cases (34.09%) showed evidence of atheromatous plaque in the coronary arteries; out of 30 cases, 8 cases showed critical narrowing of the coronary arteries but no gross or light microscopic evidence of MI. The lesions might be from focal ischemic changes to extensive myocardial damage. These findings as well as those of Noronha et al.³⁰ are supported by our study, where we found that 10 cases have microscopic features of ischemia without coronary occlusion and 12 cases have coronary occlusions without any microscopic features of ischemia. The coronary occlusion due to atherosclerosis or thrombo-atheromatous plaque was found in 63% of cases, Grade I (<25% lumen narrowing) lesions were seen in 3% of cases, Grade II (25 - 50% lumen narrowing) lesions were seen in 5% of cases, Grade III (50 - 75% lumen narrowing) lesions were seen in 10% of cases, and in 45% cases Grade IV (75 - 100% lumen narrowing) lesions were found.

Silpa gurg et al.³² found in their Histopathological evaluation of various heart disease deaths, changes of atherosclerosis followed by myocardial infarction, myocardial hypertrophy, myocarditis, pericarditis, aortic stenosis, and infective endocarditis. The pathological features observed in our study in decreasing order of frequency were atherosclerosis, thrombo-atheromatous plaque, different grades of myocardial ischemia (Grade I to IV), coronary bridging, left ventricular hypertrophy, giant cell myocarditis, and granulomatous cardiomyopathy.

Grading of ischemia is done based on the severity of myocardial damage; Grade I ischemic changes (focal lesion) are seen in 23% of cases, and Grade II ischemic changes (patchy area of replacement fibrosis with neovascularisation) are seen in 16% of cases, Grade III ischemic changes (large area of replacement fibrosis) seen in 20% of cases, and Grade IV ischemic changes (extensive lesion) seen in 2% of cases. Giant cell myocarditis and Granulomatous myocarditis were seen in 1 case each.

Conclusion:

The study shows that SCD predominantly affects the male sex, and its incidence is increasing in the younger individual under the age of 40 years. The common cause of SCD was coronary artery disease/myocardial ischemia. The left anterior descending artery involvement was the most. In 27% of the cases, the heart was found normal and the SCD in these cases may have possibly been due to arrhythmias, channelopathies, or other genetic anomalies. Such cases can pose a dilemma to the pathologist in arriving at a definite cause of death and to relative to accept the medico-legal reports. A molecular study is needed to overcome this dilemma. Our pilot study showed the incidence of CAD/MI is increasing in the younger individual which is an alarming sign for health.

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ORIGINAL ARTICLE

Profile of Medico-legal Autopsy Cases in a Rural based Tertiary Care Hospital of Central Part of Gujarat during COVID-19 Pandemic: A One Year Retrospective Study

Patel SH,¹ Gupta SK,² Goswami DD.³

Associate Professor,¹ Professor,² Senior Resident.³

1. Department of Forensic Medicine & Toxicology, Gujarat Medical Education & Research Society Medical College, Panchmahal, Godhra.

2. Department of Forensic Medicine & Toxicology, All India Institute of Medical Sciences Rajkot.

3. Department of Forensic Medicine & Toxicology, Gujarat Adani Institute of Medical Sciences, Bhuj.

Abstract:

During COVID-19 pandemic, almost all the efforts had been made by each and every state of countries across the world to collect the data on deaths due to COVID-19, however very few articles are available regarding the indirect effects of COVID-19 pandemic. The downfall of unnatural deaths seemed inevitable even during the lockdown period. The study was conducted to analyze the pattern and distribution of autopsy cases related to natural and unnatural deaths during COVID -19 pandemic Financial Year (FY) 2020-21. It was observed that minimum numbers of cases were received during the month of August 2020 and maximum numbers of cases were received in March 2021. A total of approximately 74 % of unnatural deaths registered during the period of COVID-19 FY 2020-2021 were due to injuries. The results of study will contribute to the literature. This study may even help to compare any rise or decline in autopsy cases during COVID-19 pandemic with various states of India as well as foreign countries.

Keywords: Medico-legal autopsy; Profile; COVID-19 pandemic; Sudden deaths; Natural deaths; Unnatural deaths.

Introduction:

A medico-legal autopsy is the examination of a deceased person that mainly provides information on the cause and manner of death.¹ An autopsy is an important tool of quality assurance in clinical medicine. It serves to determine the exact cause of death, unravel unexpected complications of disease processes including adverse or any other effects of treatment as well as to validate the official mortality statistics.² The profiling of medico-legal autopsy cases helps to analyze data during COVID -19 pandemic as well as aid in ascertaining the cause of deaths and identify the areas where governmental intervention and personal intervention can be applied. The study also helps to get information related to rise or decline in unnatural deaths during COVID-19 pandemic. A retrospective study of autopsy cases can be extremely helpful to assess the feasibility of prospective studies and to help in their design.

A new viral disease named COVID-19 has recently turned into a pandemic. Compared to a common viral pneumonia it may evolve in an atypical way, causing the rapid death of the patient.³ Medico-legal profiling of autopsy provides an important statistical measure to gauge the causes and patterns of untimely loss of human life. Analyzing these and taking imperative measures to curb the same helps in preserving human resources and contribute to country's development.⁴

Corresponding Author

Dr Sweta H Patel

Email : drshwetafmt@gmail.com

Mobile No. +91-9426886360

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The study was conducted to analyze the pattern and distribution of autopsy cases related to natural and unnatural deaths during COVID -19 pandemic FY 2020-21.

Materials and Methods:

The present study was carried at the Department of Forensic Medicine and Toxicology, Shree Krishna Hospital, Karamsad, during the period of 1st April 2020 to 31st March 2021. The information related to cause of death and other relevant details were collected from the institutional/ departmental register and kept secured. All cases brought for autopsy at the mortuary of S.K.H Karamsad during the FY 2020-21 were incorporated and their details were entered in excel sheet with regards to age, gender, ethnicity, cause of death, etc. It's a retrospective study based on the available data.

Inclusion Criteria: All cases where autopsy performed on medico-legal cases received between 1st April 2020 to 31st March 2021 (COVID-19 FY 2020-21)

Exclusion Criteria: Cases including non-viable fetus and those where final cause of death was kept pending.

Results:

A total of 142 autopsies were conducted during period of 1st April 2020 to 31st March 2021. Of these 142 cases, 72.5% constituted males (103) and the remaining were of females. 81.6 % of deaths were due to unnatural cause. Deaths due to injuries covered a total of approximately 74 % of unnatural deaths registered during the period of COVID-19 FY 2020-2021.

Discussion:

COVID-19 is a global problem, and a topic that has been preoccupying the scientific community for almost a year now.⁵ Different medico-legal issues accompany this pandemic. Thus,

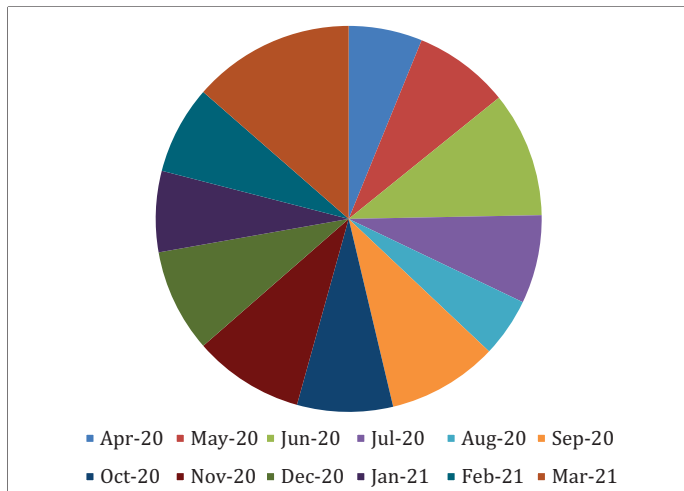


Chart 1. Month wise distribution of medico-legal autopsies conducted during COVID -19 FY 2020-2021.

Table 1. Distribution of causes of deaths during COVID -19 FY 2020-2021 (n-142).

Causes of death	Male subjects	Female subjects	Total	%
Natural	12	13	25	17.6
Unnatural	91	25	116	81.6
Undetermined	00	01	01	0.7
Total	103	39	142	100

Table 2. Distribution of cases according to causes of death among unnatural deaths during COVID-19 FY 2020-2021 (n-116).

Causes of Unnatural death	Male subjects	Female subjects	Total	%
Hanging	5	2	7	6
Head Injury/Multiple injuries /Spine Injury/Cut throat injury	71	15	86	74.1
Poisoning	6	5	11	9.4
Drowning	4	0	4	3.4
Animal bite	2	0	2	1.7
Burns	1	2	3	2.5
Electrocution	2	1	3	2.5
Total	91	25	116	100

the link between some types of violent deaths (e.g. suicides, domestic violence, etc.) and COVID-19 should be established.

In the present study, as per Chart no. 1 it was observed that minimum number of cases were received during the month of August 2020 and maximum number of cases were received in March 2021. As per Table No. 1 & 2, maximum number of unnatural deaths during the period of COVID-19 FY 2020-2021 were due to injuries. Of these injuries, only about 1 % of injuries were homicidal in nature.

As per Dmetrichuk JM, et al., a retrospective study conducted in Ontario, the short-term effects of the COVID-19 pandemic did not greatly increase homicide or suicide rates, nor decrease motor vehicle collision fatality rates.⁶ A study conducted by Robert Pell, et al. identified lockdown measures as a contributing factor in a minority of deaths by suicide, and drug and alcohol-related deaths.⁷ As per Koirala S et.al., the prevalence of suicide was more than those demonstrated by earlier observations in similar settings before the pandemic period.⁸ A retrospective study conducted by Babu, et al., noted statistically significant

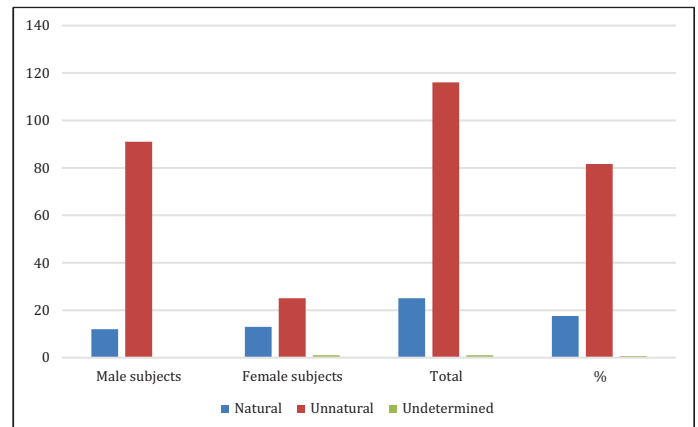


Chart 2. Gender wise distribution of causes of deaths during COVID -19 FY 2020-2021.

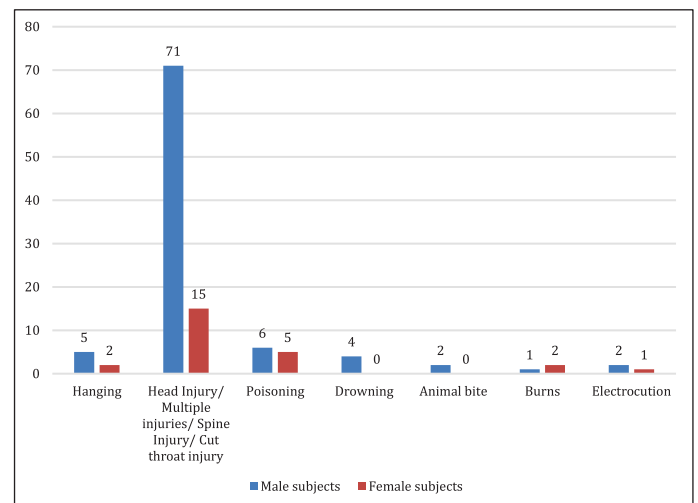


Chart 3. Gender wise distribution of cases according to causes of death among unnatural deaths during COVID-19 FY 2020-2021.

differences in patterns of deaths during two months of lockdown period.⁹ Literature suggests delays in the treatment of patients presenting with myocardial infarction (MI) during the pandemic, as a cause for increased mortality.¹⁰

Conclusion:

The results of this study will contribute to the literature. This study may help to compare any rise or decline in autopsy cases during COVID-19 pandemic with various states of India as well as foreign countries.

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ORIGINAL ARTICLE

A Study to Compare the Socio Demographic Profile and Causes of Death Between Wave 1 and Wave 2 of COVID 19 Deaths at NRS Medical College, Kolkata

Chattopadhyay S,¹ Dutta SS,² Adhikary S.³

Professor,¹ Associate Professor,² Senior Resident.³

1-3. Dept of FMT, N.R.S Medical College, Kolkata.

Abstract:

The COVID 19 pandemic has spread across the globe since December 2019. Its surge in three phases in India has been phenomenal. Mortality was more in the first and second waves. The present study is a descriptive study with an attempt to identify the mortality data in the 2 waves (W) – W1 extending from April 2020 to February 2021 and W2 from March 2021 to June 2021 at NRS Medical College, Kolkata. All SARS-CoV-2 positive cases that died in the hospital after admission or were brought dead at the hospital during the defined period were included in the study. Mortality among males was more than females in both the waves. In W1, individuals in the age group of 61-70 years were the most vulnerable whereas in W2 it was 51-60 years. However the cumulative mortality in the age group of 41-60 years increased from 33.7% in W1 to 41.8% in W2. The 4 to 14 days survival period after hospital admission increased from 34.3% in the first wave to 43.3% in the subsequent wave. Severe Acute Respiratory Infection was documented as the commonest cause of death in W1 and Pneumonia in W2. Nearly 60% of the deceased of W1 and 46.7% in W2 had comorbidities. Diabetes and hypertension were found to be the commonest comorbidities associated with fatality.

Keywords: COVID-19; Wave 1; Wave 2; Acute Respiratory Infection; Pneumonia.

Introduction:

An epidemic, as defined by The Centre for Disease Control and Prevention is “the occurrence of more cases of disease, injury or other health condition than expected in a given area or among a specific group of persons during a particular period”.¹ When an epidemic spreads extensively to multiple countries and continents affecting large number of people it is termed as a pandemic. The current pandemic of COVID 19, caused by the new strain of Corona Virus that is SARS-CoV-2 was first reported in Wuhan city of China in December 2019.² It manifested as an acute respiratory disease commonly referred to as the “Corona Virus Disease 2019 (COVID 19)”. The WHO had declared COVID 19 as a pandemic on 11th March 2020.³ The COVID 19 pandemic in India is obviously a part of worldwide pandemic of COVID 19 disease affecting a large number of people causing Severe Acute Respiratory Syndrome. The first case of COVID 19 in India was reported in January 2020.⁴ Till date the pandemic has had three surges in India. The first wave of COVID 19 in Kolkata began in April 2020 and extended till February 2021. The second wave extended from March 2021 to June 2021. The mortality in the first and second waves was much more as compared to the third wave. The present study was aimed to find out the socio demographic profile and cause of death in wave 1 and wave 2 of COVID 19 deaths at NRS Medical College and Hospital, Kolkata

and to compare any change in those parameters from wave 1 to wave 2.

Objectives:

1. To determine the prevalence of death among both sex and age due to COVID 19 infection in wave 1 and wave 2.
2. To determine the causes of deaths of patients died in COVID 19 infection in wave 1 and wave 2.
3. To find out the comorbidities associated with the fatal cases and the time interval between hospital admission and death.

Materials and methods:

The retrospective, descriptive study was conducted in the Department of Forensic Medicine and Toxicology, NRS Medical College, Kolkata for the period 1st April 2020 to 30th June 2021. All patients of SARS-CoV-2 who died in the hospital or were brought dead at the hospital with SARS-CoV positive report were included in the study. Patients brought dead with COVID positive report but lacking the required information or those who were initially COVID positive but became negative at the time of death were excluded from the study. Particulars of the deceased and the clinical data were collected from the bed head tickets of the deceased. In case of brought dead patients where medicolegal autopsy was conducted details were obtained from the inquest report and post mortem report of the deceased. The data so collected was analyzed and presented in the form of tables and charts. Confidentiality regarding identity of the deceased has been maintained. ethical clearance from Institute Ethics Committee was obtained before conducting the study vide memo no: NRSMC/IEC/07/2021 dated 20.07.2021. Consent from the family members was not possible as it was a retrospective study conducted from the hospital records.

Corresponding Author

Dr. Sayak Sovan Dutta

Email : dr.sayaksovan@gmail.com

Mobile No.: +91 8820569779

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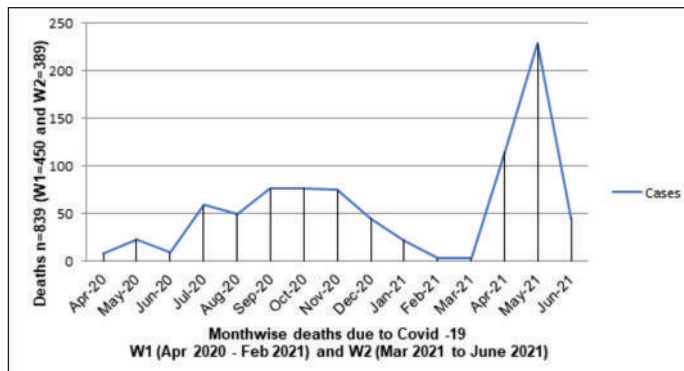


Figure 1. Monthwise deaths due to Covid 19.

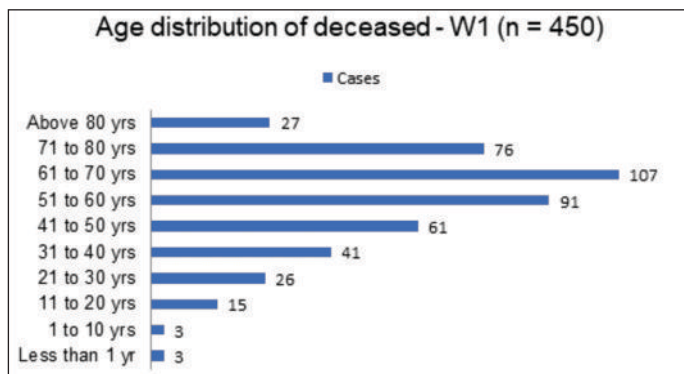


Figure 2 (a). Age distribution of deceased in wave 1.

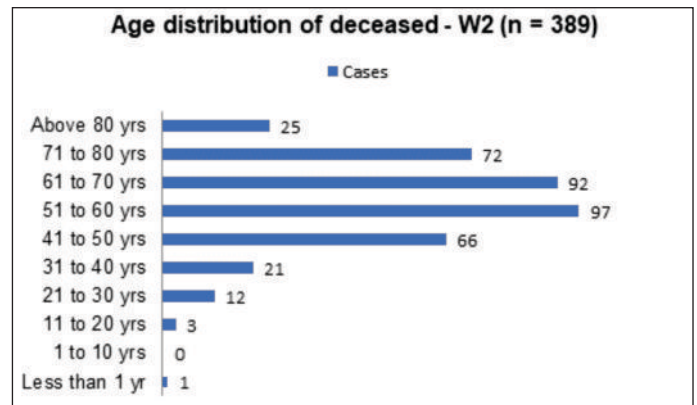


Figure 2 (b). Age distribution of deceased in wave 2.

Table 1. Interval between admission and death.

Time interval	W1 (n=450)	W2 (n=389)
Less than 2 hours	06 (1.3%)	02 (0.5%)
2 to 6 hours	12 (2.6%)	09 (2.3%)
6 to 12 hours	25 (5.5%)	14 (3.5%)
12 to 24 hours	31 (6.8%)	23 (5.9%)
1 to 2 days	75 (16.6%)	66 (16.9%)
2 to 4 days	65 (14.4%)	61 (15.6%)
4 to 7 days	69 (15.3%)	88 (22.6%)
1 to 2 weeks	86 (19.1%)	83 (21.3%)
2 to 4 weeks	44 (9.7%)	24 (6.1%)
More than 4 weeks	06 (1.3%)	04 (1%)
No admission	31 (6.8%)	15 (3.8%)

Results:

The wave 1 of COVID 19 in Kolkata persisted for a period of 11 months from April 2020 to February 2021 while wave 2 was of a much shorter duration of 4 months from March to June 2021. In the first wave 450 deaths were recorded in our hospital and 389 in the second wave. May 2021 recorded the maximum number of deaths, 229 cases in a single month [Figure 1].

The most common age group that succumbed to SARS CoV 2 infection in W1 was 61-70 years (23.7%) and in W2 it was 51-60 years (24.9%). It was observed that the mortality in 61-70 years was almost identical in W1 (23.7%) and W2 (23.6%) whereas the mortality in the cumulative age group of 41 to 60 years increased noticeably from 33.7% in W1 to 41.8% in W2. [Figure 2 (a) and Figure 2(b)].

In both the waves mortality among males was more compared to females (W1- males 64% females 36% and W2 - males 53% females 44%). However in our study the mortality among females increased from 36% in W1 to 44% in W2.

In W1 16.4% of the deceased expired within 24 hours of hospital admission while in W2 it was 12.3%. The survival period of 4-14 days increased from 34.4% in W1 to 43.9% in W2 [Table 1].

Analysis of the medical certificate of cause of death revealed SARI (Severe Acute Respiratory Infection) 20.2% to be the commonest cause of death in the first wave. Pneumonia along with respiratory failure together constituted 29.9% deaths. contrary to the observations of W1, Pneumonia 38.3% was the commonest cause of death in W2 and Pneumonia along with respiratory failure resulted in 60.4% of deaths which was almost

double as compared to W1 [Table 2].

Among the persons who died in W1, 59.1% had co-morbidities while in W2 46.7% had co-morbidities. In both the phases diabetes and hypertension was the commonest comorbidity recorded [Table 3].

Discussion:

The first wave of COVID 19 stretched over 11 months while the second wave persisted for only 4 months. In 2020 COVID 19 was the 3rd leading cause of death in the United States.⁵ The B.1.617 lineage which was a “Variant of Concern” was first reported in India in December 2020.⁶ With the introduction of the new variant the number of cases began to rise rapidly from March 2021 and peaked in May 2021. During this period the sub-lineage Delta (B.1.617.2) was one of the major causative agents in most of the cases.⁷ This variant was much more virulent than the previous strains resulting in more fatalities in a short period of time.

In our study we observed that elderly individuals in the age group of 61-70 years were victims of SARS-CoV-2 in the early phase of the pandemic. This was in concordance with the study reported from China where they found increased risk of death in patients aged 60 years and above.⁸ Fatality due to COVID 19 in the state of Tamil Nadu in India also showed the mean age of the deceased to be 62.5 years. However the mean age of hospital admitted patients in a tertiary care centre in Northern India was 40.1 +/- 13.1 years with male preponderance.⁹ In the 2nd wave in Kolkata the mortality in our hospital was more in the patients aged 51-60 years and the mortality in the age group of 41 to 60 years increased from 33.7% in W1 to 41.8% in W2. This may be due to the fact that the Delta variant was more harmful among the

Table 2. Causes of death in Wave 1 and Wave 2.

Cause of Death	W1 (n=450)	W2 (n=389)
Pneumonia	71 (15.7%)	149 (38.3%)
SARI	91 (20.2%)	62 (15.9%)
Respiratory Failure	64 (14.2%)	86 (22.1%)
Cerebro vascular Accident	44 (9.7%)	11 (2.8%)
Renal Failure	19 (4.2%)	07 (1.7%)
Acute myocardial infarction	14 (3.1%)	01 (0.2%)
Heart Failure	15 (3.3%)	00 (0%)
Encephalitis	23 (5.1%)	13 (3.3%)
Sepsis	35 (7.7%)	30 (7.7%)
Head Injury	27 (6%)	06 (1.5%)
Burn	08 (1.7%)	03 (0.7%)
Brought dead	25 (5.5%)	17 (4.3%)
Others	14 (3.1%)	04 (1%)

younger age group. In a study in London it was reported that the mean age of the patients infected with the Delta variant was less than the patients infected with the alpha variant.¹⁰ Moreover vaccination of the population above 60 years age had begun in Kolkata in January 2021. This might have played some protective role restricting the fatality in the aged individuals in our study.

Fatality among the males was more as compared to females in our study. Similar results were reported from countries of different continents like Asia, USA and Europe.¹⁰⁻¹³ During the 2nd wave mortality among the females increased from 36% to 44%. This points out to the vulnerability of the females in W2 which might be due to the new lineage of the SARS-Cov-2.

In our research we observed that the percentage of individuals who expired within 24 hours of hospital admission decreased and the 4 to 14 days survival period increased during the second phase of the pandemic. This may be due to the fact that during the first wave the virus was a completely unknown entity and the treatment was not known. Hence more number of individuals succumbed within 24 hours of admission. In the second wave the management protocols were developed leading to less fatality in the early stage and increased survival in the 4-14 days period. Asirvitham¹⁴ in their study during May to July 2020 in Tamil Nadu found 24.2% of deaths within 24 hours of hospital admission whereas the median interval between admission and death was 4 days. Damien reported that 48% of patients died with a median delay of 14 days after ICU admission.¹⁵

The hospital records in the W2 of our study pointed out that pneumonia was the commonest cause of death. It can be concluded from our observations that the new lineage of the virus caused more pneumonia as it was resistant to available modes of treatment. Contrary to our findings, a hospital based study in Germany reported shock with multi organ failure as the commonest immediate cause of death while respiratory failure was of much lesser frequency.¹⁶ On the other COVID 19 was documented as the direct cause of death in 92% of the fatalities due to SARS-CoV-2 infection in a teaching hospital in Leeds¹⁷ and refractory respiratory failure accounted for 45% of ICU deaths in another study.¹⁵

46.7% of the individuals in our study who expired in the 2nd wave had comorbidities. Such finding reiterates the fact that the new

Table 3. Co-morbidities among the deceased.

Co morbidities	W1 (n=450)	W2 (n=389)
No comorbidities	184 (40.8%)	207 (53.2%)
Diabetes	26 (5.7%)	38 (9.7%)
Hypertension	33 (7.3%)	26 (6.6%)
Diabetes and hypertension	24 (5.3%)	35 (8.9%)
Chronic Kidney disease	30 (6.6%)	13 (3.3%)
Chronic obstructive pulmonary disease	06 (1.3%)	05 (1.2%)
Malignancy	13 (2.8%)	04 (1%)
Haematological disorders	27 (6%)	03 (0.7%)
Heart disease	13 (2.8%)	06 (1.5%)
Tuberculosis	06 (1.3%)	00 (0%)
Hepatitis	09 (2%)	05 (1.2%)
Multisystem involvement	26 (5.7%)	21 (5.3%)
Congenital anomalies	03 (0.6%)	00 (0%)
Others	22 (4.8%)	08 (2%)
Not known	28 (6.2%)	18 (4.6%)

viral strain B.1.617.2 was highly virulent as majority (53.3%) of the deceased of the second wave did not have any comorbidity yet succumbed to the infection. Sefer¹⁶ was of the opinion that hypertension, ischaemic heart disease and obesity were the common comorbidities among majority of the patients. In another study in South India it was found that 85% of the patients had 1 or more co-morbidities.¹⁴

Conclusion:

The COVID 19 pandemic has spread across the globe in three phases till date. The appearance of different strains in each phase has resulted in variations in the infection and mortality rates during the three phases. The increased virulence of B.1.617.2 (Delta) in the 2nd wave in Kolkata caused surge in the mortality among the infected persons. The shift in the age group of the victims from the elderly to the middle aged and greater vulnerability of females is a cause of concern. Health policies need to be planned keeping in mind the change in the viral strain that may occur in future so that mortality can be minimized.

Conflict of Interest: The authors declare that there is no conflict of interest.

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ORIGINAL ARTICLE

Analysis of the Case Records for the Accuracy on Medical Certification of Cause of Death in a Tertiary Care Hospital

Arun KS Prakash,¹ Sanjeev K,² Charanya S,³ Senaraj PV.⁴

Associate Professor,¹ Professor,² Tutor.^{3,4}

1-4. Department of Forensic Medicine & Toxicology, SRM Medical College and Research Centre, Kattankulathur.

Abstract:

When a patient dies unexpectedly, the physicians will issue a certificate stating the cause of death. Incorrect and incomplete information on such certificates makes it difficult to obtain accurate information about the cause of death hindering the Public Health Surveillance and investigations. Our study aims to determine the accuracy and completeness of medical certification of cause of death. From 1st March 2019 and 31st July 2019, a total of 246 certificates on the cause of death issued to various departments were reviewed. Nearly 40% of death certificates were from the medical ward, 23% were from the emergency ward, and 27% listed the main cause as the main cause of death is the cardiovascular disease. RTA, suicide, homicide, and septicemia accounted for nearly 17% of death certificates, while 72% of the immediate lines were filled out correctly. 78% of the Antecedent line's fields were correctly filled, 65% were correctly filled on the underlying line, and 35% were filled incorrectly. Regarding errors, 33% of the certificates had one error, and 26% had two. Four or more errors were in 12% of the certificates. Only 9% of them had no error. It is necessary to take a multifaceted approach to raise doctors' knowledge and awareness of MCCD rules and regulations to improve the accuracy and dependability of data. According to this research, it is necessary to implement interventions that include tested education, system-related support, and additional training tailored to the completion of death certificates.

Keywords: Death certificates; Medical certification of cause of death; MCCD errors; Cause of death.

Introduction:

India will surpass China in terms of population growth by 2025, as global mortality tends to increase proportionally. Therefore, there is an urgent need to strengthen the current framework for death certification focusing on quality control at all levels.

The preferred diagnostic tool in epidemiology, preventative medicine, and clinical applications is the International Classification of Diseases (ICD). It is employed to investigate the onset and progression of diseases and other health problems. The precision of cause-of-death data on vital records, which is typically filled out by medical doctors, has a significant impact on the validity of cause-of-death statistics.¹

The family of the person who died can automatically register the death with the help of a death certificate, or more particularly, a certificate for the registration of the medical purpose for death. Additionally, it gives an estimate of the proportional contributions that various diseases find to death rates, which is crucial for keeping track of public health and enabling a significant research effort.² Decision-makers need accurate information on deaths and their causes as it provides a snapshot of the current state of health and makes it possible to track trends in the global disease burden. Understanding the magnitude and

distribution of the burden of disease is necessary for the development of policies, resource allocation to better address health needs, and evaluation of the efficacy of healthcare needs.³

The information in the death certificates regarding the cause of death is used for a variety of purposes, including evaluating the success of public health initiatives, giving feedback on the development and implementation of future policies, enhancing health management and planning, and identifying the priority areas for healthcare and medical research programmes.

The inaccuracy or incompleteness of the information on these certificates makes it challenging to obtain accurate information regarding the causes of death. There may be intentional or unintentional errors on the MCCD. Inaccuracy may occur for the purpose of monetary benefits associated with life insurance, inheritance of property, demonstrating an alternative result of a health programme or service, or avoiding criminal charges by altering the manner of death. Hence, we have evaluated the medical certification of the cause of death's accuracy and completeness.

Materials and methods:

The retrospective descriptive study was carried out at the department of Forensic Medicine in one of the tertiary care hospitals in Chennai. Medical certification of cause of death in the forms was examined for all the deceased patients who died in the hospital between 1st March 2019 and 31st July 2019. A total of 548 deaths occurred in the hospital in 2019. To assess the completeness and accuracy of form completion in accordance with the regulations, the cause of death certificates, medical history, and treatment records of the treating physician were

Corresponding Author

Dr. Arun KS Prakash

Email : kprakash@srmist.edu.in / drarunksprakash@gmail.com

Mobile No.: +91 98422 92308

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Table 1. Distribution of death certificates in different wards.

Types of wards	Frequency	Percentage
Medical ward	98	39.8
Emergency ward	57	23.2
Neurosurgical ward	38	15.4
Surgical ward	22	8.9
CCU+ICU	11	4.5
Oncology ward	7	2.8
Haematological ward	4	1.6
Cardiac medical ward	5	2.0
Orthopaedic ward	1	0.4
Cardiac surgical ward	3	1.2
Total	246	100

Table 2. Summary of errors.

Errors	Frequency	Percentage
Time interval between onset and death was blank	223	90.65
Overall, the medical certificate of cause of death incorrectly filled in	152	61.79
UCOD is not entered in the last line of part 1	138	56.10
Incorrect sequence of events	159	64.63
Additional errors	193	78.46
Blank line within the sequence of events	185	75.20
Multiple causes per line	190	77.24
Ill-defined condition entered as UCOD	140	56.91
Abbreviations used	42	17.07
Illegible hand writing	12	4.88

examined and analysed. For evaluation purposes, the most recent edition of Physician's Handbook on Medical Certification for Cause of Death (MCCD)⁴ was used. Datas were entered into Microsoft Excel and analysed with SPSS 22 statistical software. The sample size was calculated using the following formula, $N = z^2pq/d^2$ with $p=20\%$ ⁵, $z=1.96$, hence we got the final sample size of 246. **The centre's institutional and ethical review board approved the study protocol.**

Results:

In our study, nearly 40% of the death certificates were from the medical ward, 23% of the death certificates were from the emergency ward and 8.9% surgical ward, 15% of them were from the neurosurgical ward, 2% of the death certificates from the cardiac medical ward, and 1% death certificates from cardiac surgical wards (Table 1). In our study, cardiovascular diseases, RTA, suicide, and homicide accounted for 27% of the underlying causes of death listed on death certificates and septicemia accounted for nearly 17%, and neurological diseases accounted for 12% of the underlying causes of death on death certificates. Only 2% of the deaths were caused by connective tissue diseases (Fig 1). In summary of errors in our study, nearly 90.65% of the had left time interval between onset and fatal as blank. In total, 61.79% had the medical certificate of cause of death incorrectly filled out and 17% of them used incorrect abbreviations. Nearly 5% had illegible handwriting. Among certified persons in the death certificate writing, 63% of them were assistant surgeons, 22% were post-graduates, and 15% rank was not filled in the death certificate (Table 3). In our current study, 33% of the death certificates had one error, 26% of them had two errors 12% of

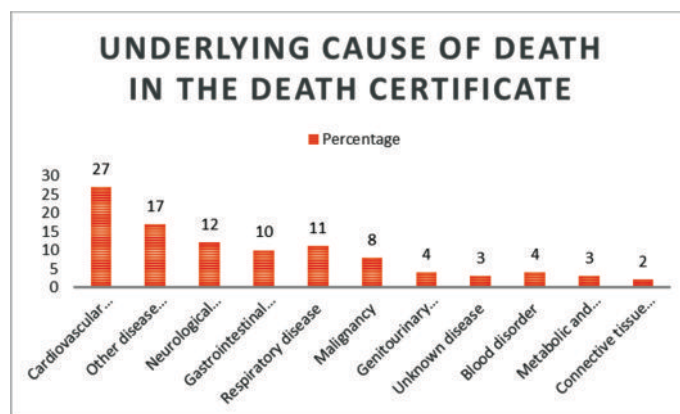


Figure 1. Underlying cause of death in the death certificate.

Table 3. Rank of the certified person in the death certificate writing.

Characteristic	Frequency	Percentage
Assistant Surgeon	155	63
Postgraduate	54	22
Rank was not filled	37	15
Total	246	100

Table 4. Distribution of errors categories.

Number of errors	Frequency	Percentage
No error	23	9.35
One error	80	32.52
Two errors	65	26.42
Three errors	48	19.51
Four or more errors	30	12.20
Total	246	100

Table 5. Cause of death as filled by the doctor.

Immediate		Antecedent		Underlying	
Correctly filled	Incorrectly filled	Correctly filled	Incorrectly filled	Correctly filled	Incorrectly filled
177	69	192	54	160	86
72%	28%	78%	22%	65%	35%

them had four or more errors. Only 9% of them had no error in the death certificates (Table 4). In our study, 72% of the immediate line was correctly filled, and 28% was incorrectly filled. On the antecedent line, 78% were correctly filled, and 22% of them were incorrectly filled. On the underlying line, 65% of them were correctly filled, and 35% of them incorrectly filled (Table 5).

Discussion:

Medical Certification of Cause of Death (MCCD) analysis gives precise morbidity and mortality data in the context of public health surveillance. A precise death certificate is essential for comprehending the magnitude and progression of vital events. Therefore, the purpose of our study was to evaluate the accuracy of cause of death reporting on medical death certificates. It was also intended to describe the encountered errors and their causes.

The illness, accident, or act of violence that started the chain is known as the underlying cause of death, and the subsequent incidents in the chain are known as the antecedent cause and immediate cause of death, respectively.⁶ In our study 78% of the antecedent line filled correctly, and 65% of underlying line is filled correctly. According to a survey conducted in the municipal corporation of Vadodra, Gujarat⁷ reported that only 27% of

certificates enclosed antecedent cause and only 0.8% includes underlying cause. Similarly, in a study carried out in an intensive care unit, Kathmandu, Nepal,⁸ the underlying cause of death had the highest error rate (46%). This could be as a result of the patient having multiple co-morbid conditions or the reality that the physician is not the patient's treating physician and has not carefully reviewed the patient's medical records.⁹

The leading causes of such a high error rate were identified as multiple co-morbid conditions in an individual patient, insufficient training for medical professionals, an excessive workload, and lack of familiarity with the deceased. House surgeons and physicians have been highlighted as a training priority group.

A cross-sectional study carried out by Kumar¹⁰ at a rural teaching hospital in Karnataka revealed that 82% of the 104 certificates examined consisted major errors and 77% contained minor errors. Sixty percent of certificates constituted both major and minor errors. In our study 12% of them had Four or more errors, 19% had three errors, and nearly 26% had atleast errors.

Conclusion:

Our study confirms, based on the percentage of medical death certification errors observed, that all issued medical death certificates contain a substantial number of errors. There is a similar number of low-quality certificates regardless of the deceased characteristics or the certifier's determining factors. In addition, it illustrates some of the factors associated with higher or lower error rates. In addition, it has determined the magnitude of ill-defined UCOD, which will serve as a vital input for hospital and national data.

The study uncovered significant deficiencies in the local practises for death certification. There is an immediate requirement for interventions that will enhance and improve the completion of death certificates. Every physician must understand the significance of cause-of-death data and how it relates to data on the nation's public health. Advocates for MCCOD should target specialists, hospital administrators, and senior clinicians with influence over junior medical officers in regards to the significance of obtaining accurate causes of death.

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ORIGINAL ARTICLE

A Comprehensive Retrospective Analysis in Understanding Covid-19 : Forensic Perspective from a Single Institute

Mary Sowjanya G,¹ Devaraju G,² Venugopal Rao G.³

Senior Resident,¹ Associate Professor.^{2,3}

1. Department of Forensic Medicine and Toxicology, AIIMS, Bibinagar.

2. Department of Forensic Medicine and Toxicology, Gandhi Medical College, Secunderabad.

3. Department of Forensic Medicine and Toxicology, Osmania Medical college, Hyderabad.

Abstract:

SARS-CoV-2 has spread swiftly and disseminated as a pandemic globally. As there was limited research on non-autopsy findings, a detailed analysis of facts gathered from the deceased can aid in a better understanding of the covid disease. The current retrospective cross-sectional study was conducted on the 388 probable COVID-19 fatalities, in the department of Forensic Medicine and Toxicology, between August 1st 2020 to August 1st, 2021. Deaths were more common in the age group of 41-60 years with male predominance with greater number being in the Pre vaccination period. 74% reported cough, 85% shortness of breath, 88% had fever and anosmia in very few cases. Co-morbidities observed were 18% of hypertension, 16% diabetes and 8% chronic renal disease. Common reasons being respiratory failure due to bilateral pneumonia followed by multi-organ failure and cardiac arrest. Comorbidities added to severity and vaccination has shielding effect in the prevention of deaths.

Keywords: Covid-19; Clinical features; Comorbidities; Vaccination.

Introduction:

Since the first case of Corona Virus Disease- 2019 (COVID-19) was discovered in Wuhan, China in December 2019, the SARS-CoV-2 virus has spread swiftly and became a pandemic. In March 2020, the WHO proclaimed COVID-19 a global pandemic.^{1,3} The morbidity and mortality rates of worldwide community due to this disease are dramatically increasing from time to time. However, more than 1.5 million people have died worldwide, with roughly^{3,5} 1.5 lakh in India. On 30 January 2020, Kerala reported the first confirmed Coronavirus disease in India.⁴ On 12 March 2020, Karnataka reported the first Corona virus death in India. Currently, 4.43 crores of people have been confirmed and 5.27 lakh deaths reported till date.^{5,6}

As of 12th April 2021, India was the second worst nation in terms of COVID-19 positive cases and third worst hit country in terms of active cases. As on 14.4.2021 the world continents reported a total of 13,67,39,552 COVID -19 positive cases and 29,47,244 deaths. The abrupt countrywide lockdown was effective but exacerbated the situation of the economically disadvantaged segments of society. Due to high risk of spread it became unavoidable to shutter economic and educational institutions.⁷⁻¹⁰

Face masks, sanitizing, and social distancing are the primary prevention methods. Mortality and Morbidity was unavoidable even with all these measures, only continuous monitoring of case

load globally, nationally and at every sub-governmental level by projects, research especially through pathological autopsies in COVID-19 deaths only can reflect the rate and nature of the spread.

Regardless of the fact that Forensic medicine specialty through autopsies can appreciate clear pathology of COVID-19 but due to strict High court orders of Telangana state autopsies were not performed in Covid-19 deaths. Albeit the non-autopsy data gathered from deceased can also provide interesting information. Keeping this in view the present study is conducted for a better understanding and insight into the disease process and clinical conditions of the deceased.

Materials and method:

The current record-based retrospective cross-sectional study was carried out at department of Forensic Medicine and Toxicology, Osmania general hospital Hyderabad from August 1st 2020, to August 1st 2021. Following the strict guidelines of High court, Telangana state autopsy, histopathological examination, chemical analysis were not performed on COVID-19 deceased. During the study period, a total of 388 suspected COVID-19 deaths were included. Information from hospital records, such as case sheets, investigations and death summaries, were obtained to gather relevant clinical information, history but in the instance of any unclaimed, information of deceased was obtained from the escort or investigating officer. Later data was entered and analysed using Microsoft excel spread sheet then expressed as frequencies and percentages.

Results:

Demographic: Out of 388 suspected COVID-19 deaths, 63.14 % (245) were males with 68 being COVID positive and 169 being COVID negative with COVID symptoms and 8 had symptoms

Corresponding Author

Dr. Mary Sowjanya Gaddala

Email : sowjanya.gaddala@gmail.com

Mobile No.: +91 8374909757

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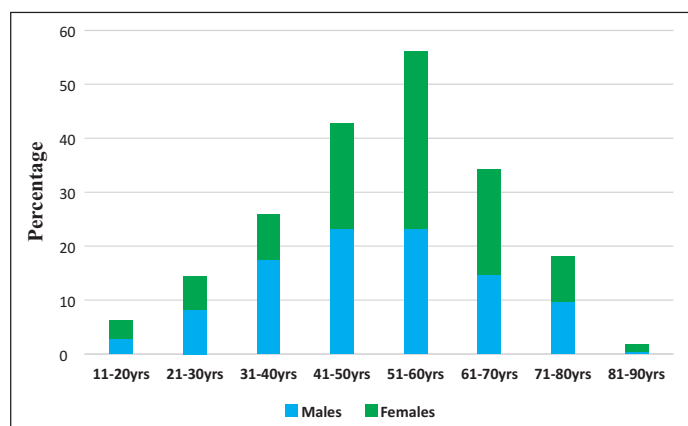


Figure 1. Age and gender distribution.

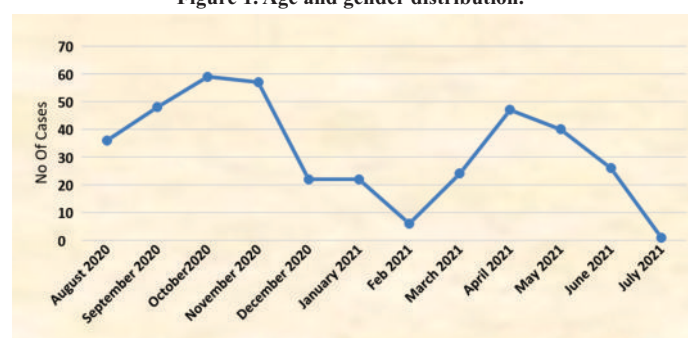


Figure 2. Trend of mortality.

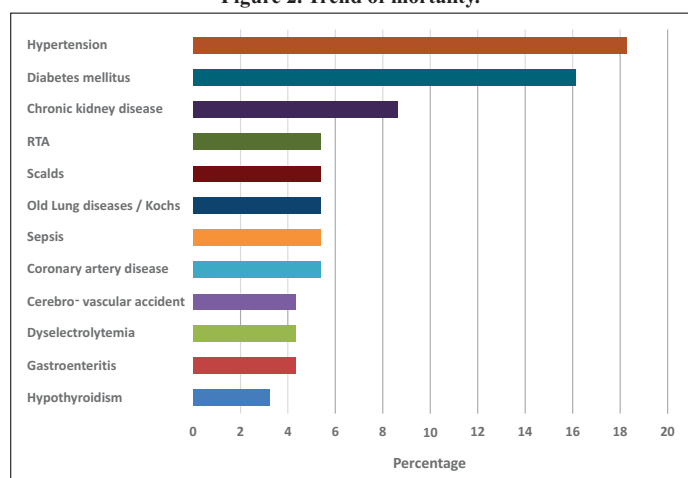


Figure 3. Cases distributed based on the risk factor (N=93).

but an inconclusive COVID report. There were 36.89% (143) females in toto, 5 were COVID positive, 85 COVID negative but with COVID symptoms and 53 had symptoms but an inconclusive COVID report.

In the current study, children under the age of 10 years neither male nor female died as a result of COVID-19. More COVID deaths were seen in the age group of 41-60 years with male predominance; less number above 80 years (Figure no:1).

Time Trends: More COVID deaths were observed in the months of October and November 2020 than in December 2020 during the COVID-19 prevaccination phase, which spanned from August 1st, 2020 to December 31st, 2020. While in the phase of vaccination, more COVID deaths were observed in April 2021,

Table 1. Other findings.

	N	%
Admission SpO2, %		
>90%	23	6
90-75%	318	82
75%	35	9
NA	12	3
Cough		
Yes	287	74
No	89	23
Unknown	12	3
Shortness of breath		
Yes	330	85
No	47	12
Unknown	12	3
Fever		
Present	341	88
Absent	35	9
NA	12	3
Anosmia		
Yes	8	2
No	369	95
Unknown	12	3
ICU admission		
Yes	357	92
No	31	8

fewer in July 2021 (Figure no: 2).

On further analysis for signs and symptoms, most of the patients who died had oxygen saturation below 90. Almost 74% presented with cough, 85% with breathing difficulty and 88% had fever. Very few cases presented with anosmia; 92% had ICU admission (Table no: 1).

A greater majority of cases had comorbidities and presented with COVID and its complications. The majority of cases had hypertension and diabetes, followed by chronic kidney disease; and an equal number of cases had history of lung diseases mostly Kochs, coronary artery disease, and sepsis (Figure no: 3).

Duration of ICU stay was ranging from 3 to 18 days. 70.8% of COVID-19 deaths observed within 4-7 days of hospitalization and 17% deaths occurred longer than a week. The majority of those who died suffered respiratory failure because of bilateral pneumonia followed by multi-organ failure, cardiac arrest.

Discussion:

The COVID-19 pandemic has caused global economic downturns and had major impact on global poverty and education. Individuals of all ages are vulnerable to illness and severe disease.¹¹ In the present study most affected age group was between 41- 60yrs. Less fatalities were observed above 80yrs which is consistent with Indians' average life expectancy, which is 70 years. Possibility of less severity in children below 10 years having high immune response, raised the issue whether they should receive vaccination or not. Both mortality and morbidity rates were high among elderly age group of above 60yrs during the first wave of COVID.¹² But during second wave, mortality was highest in the 40-year-old age group and above due to reasons like fear of death, lack of motivation and lack of awareness about the disease to consult doctor without delay, even in areas where oxygen is scarce. Studies from various parts of world showed that

persons above 60 years with medical comorbidities had succumbed to death early.^{13,14}

From December 2020, FDA approved vaccines came into effect. India started COVID immunization with Covishield from Astra Zeneca followed by indigenous Covaxin. The importance of vaccination in reducing the severity of illness cannot be overstated which subsequently decreased the mortality and hospital admission rates which is even evident in the current study too.^{15,16} But there have also been difficulties with the vaccine's availability and effectiveness.

Clinical presentation is almost similar all over the world. Studies reported that lower than 90 percent oxygen saturation is an important criterion for hospital admission which is consensus with the present study findings too. AIIMS New Delhi had released regular bulletins on criteria for admission where they have identified oxygen saturation as an important indicator to shift patients to hospital even though asymptomatic. It further recommended to have home-based oxygen saturation monitoring devices.¹⁷

Present study has shown very few cases with anosmia, stating that it might be a good prognostic indicator which concurs the study conducted by Rafal Butowt et al.¹⁸ and Meng X et al.¹⁹ Although COVID-19 is usually characterized by pulmonary symptoms, extra-pulmonary signs have been documented with variable degrees of frequency and intensity. According to Ramchandran P et al.²⁰ the most prevalent GI manifestation is diarrhoea (14.7%), second by nausea and vomiting (10.7%) as well as abdominal pain (2%). Yuan Tian et al.²¹ also reported diarrhoea as the most common GI symptom (22% and 10.1%, respectively).

Emerging evidence illuminates that co morbidities like hypertension, diabetes, overweight, coronary heart disease (CVD), neurological disease (CVA), obstructive pulmonary disease (COPD), asthma, chronic kidney disease (CKD), malignancy etc associated with increased severity and/or mortality in COVID-19 patients.^{16, 21-22}

Shahbazi F et al.²³ and Jin-jin Zhang et al.²⁴ reported that the percentage of hospitalization in COVID-19 patients was six times higher in persons with pre-existing medical conditions like diabetes, hypertension, and obesity than others without comorbidities. As per numerous studies results patients with comorbidities have weakened immune systems, and more likely to become ill early and die.

Conclusion:

In conclusion, COVID has affected all age groups with an exception of children under the 10 years. In persons who have received COVID vaccination, death rate declined. COVID patients with comorbidities succumbed to death earlier than COVID patients without comorbidities. Clinically, clinicians should be aware of the symptoms and signs in patients who have previously been impacted by COVID-19 in order to rapidly assess, identify, and halt long COVID-19 progression, minimise the danger of chronic effects, and assist in re-establishing pre-COVID-19 health status. More collective approach and research from multi-disciplinary teams especially by pathological autopsies with protective guidelines are more essential in

understanding the risk factors, etiology, pathophysiology, efficacy of drugs on COVID, to develop new preventive measures, rehabilitation techniques, and clinical management strategies with whole-patient perspectives designed for permanent cure, preventing new emerging strains and eradicating COVID-19 without any after math.

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ORIGINAL ARTICLE

Profile of Electrocution Deaths – A 3-Year Retrospective Study

Sumangala CN,¹ Patil VR.²Professor,¹ Senior Resident.²

1,2. Department of Forensic Medicine & Toxicology, Bangalore Medical College & Research Institute, Bengaluru.

Abstract:

Electricity is no longer a privilege, instead a necessity. However, when 3.2% of the accidental deaths in 2021 are due to electrocution (n=12529), one must study the factors that result in such deaths so that the law enforcing and safety regulating agencies have a database to refer to while formulating laws. This is a retrospective study done in the Department of Forensic Medicine & Toxicology at Victoria hospital attached to Bangalore Medical College & Research Institute, Bengaluru. Data was collected using records from January 2018 to December 2022 during which 53 cases of deaths due to electrocution were autopsied. Using a proforma, information with respect to socio-demographic factors, autopsy findings and cause of death was collected and analysed. On analysing the data collected, 0.6%, 0.7% and 0.7% (n= 14, 17, 22) of the total number of cases in 2020, 2021 and 2022 respectively were due to electrocution. A total of 53 cases were studied among which 45 were males (85%) and the rest were females. The highest number of cases (31%, n=17) were found in the 3rd decade of life. 40 cases (77%) were Hindus. Among the employed, 30.8% of them were electricians and 15.4% of them were construction workers. 27 cases had entry wounds at different sites on the upper limbs (19 in the right upper limb and 8 in the left upper limb). Visceral congestion, petechial haemorrhages in brain, lungs and heart were the common internal findings seen. Deaths due to electrocution need not present in a specific manner. Absence of entry wounds or exit wounds or both does not rule out electrocution. External examination and meticulous history taking is crucial to arrive at the cause of death.

Keywords: Autopsy; Electrocution; Entry wounds; Exit wounds.**Introduction:**

To be able to harness the power of electricity to make our everyday life easier has been one of the greatest gifts of science. However, damaged appliances, exposed wiring, open power distribution units, negligence while handling electrical equipment can result in detrimental effects that can vary from electrical shock to whole body burns and death. Injuries caused by electrocution, and their severity depends on various factors like voltage, frequency, period of contact, resistance offered by the body and so on. The resistance that is offered by the skin depends on the presence of moisture in the skin i.e., moist thin skin offering the least resistance of 100 ohms & dry skin offering the highest resistance of 1,00,000 ohms.¹ As reported by the National Crime Records Bureau in 2021, 3.2 % (n = 12529) of the total number of accidental deaths due to causes other than natural forces are because of electrocution.² As per the statistics from the Electrical Safety Foundation International, five occupations in the construction trades - electricians, construction laborers, roofers, painters, and carpenters - experienced more than 32% of all electrical fatalities, electrical power line installers and repairers about 8%, and tree trimmers about 5%.³ Improper grounding, wet conditions, damaged tools and equipment, inadequate wiring, exposed electrical parts, overhead power lines

and overloaded circuits are the common electrical hazards the scene of electrocution.⁴ Scrutiny into the deaths caused due to electrocution for the last three years will enable us to understand the presentation of such cases, the existing risk factors and it will further help authorities regulate the high-risk occupations better, ensuring the safety of employees.

Aims & objectives: 1) To study the various socio-demographic factors that play a role in fatal electrocution.

2) To study the pattern of injuries seen in fatal electrocution.

Materials and methods:

This is a study done in the Department of Forensic Medicine & Toxicology at the prestigious Victoria hospital attached to Bangalore Medical College & Research Institute, situated in South Bengaluru is associated with the highest number of autopsies per year in Bengaluru. It is a retrospective study done on the data collected using records from January 2018 to December 2022. Using a proforma, information about the cases like age, sex, religion, profession, the section under which the case was filed, entry wounds, exit wounds, injuries sustained, internal findings, duration of treatment if any and cause of death was systematically collected and analysed descriptively.

Inclusion Criteria:

- 1) All cases brought with a confirmed history of electrocution.
- 2) All the autopsied cases where cause of death was attributed to electrocution.
- 3) All cases which were brought with unknown history and electrocution was confirmed after post-mortem examination and scene examination.

Corresponding Author**Dr. Varsha R. Patil**

Email : dr.varshapatil93@gmail.com

Mobile No.: +91 8431087703

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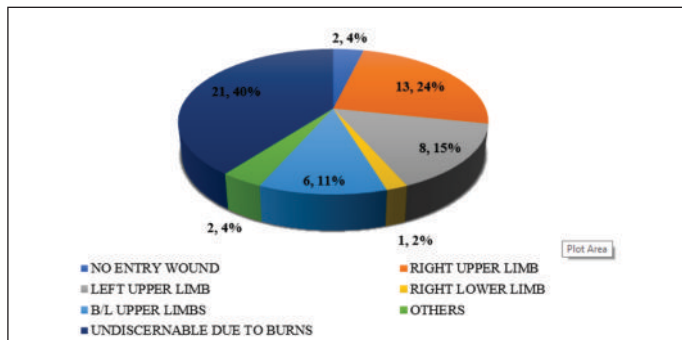


Figure 1. Entry wound sites.

Exclusion Criteria:

- Deaths due to lightning.

Results:

In this retrospective study, electrocution cases which were autopsied in three consecutive years were studied and they constituted 0.6%, 0.7% and 0.7% (n=14, 17, 22) of the total number of cases in 2020, 2021 and 2022 respectively. A sum of 53 cases were studied with respect to age, sex, religion, occupation, pattern of injuries, presence or absence and pattern of entry and exit wounds & final cause of death. Out of the 53 cases that were studied, males (85%, n=45) outnumbered females (15%, n=8). The highest number of cases were found in the 3rd decade of life (31%, n=17), followed by the 4th and 2nd decade of life (22%, n=12). The least number of cases were seen in the 1st, 6th & 7th decade of life (4%, n=2). Out of the 53 cases of electrocution autopsied, one case was unknown whose religion remains unknown. 40 cases (77%) were hindus, 7 (13.2%) were muslims & 5 (9.4%) were christians. 39 of the 53 cases were employed and the rest of them were unemployed, students and home-makers. Among the employed, 30.8% of them were electricians, 15.4% of them were construction workers and 12.8% of them were daily wage labourers. The next commonly noticed professions were factory workers and cable network technicians (10.3% each, n=4 each). Painters and housekeeping staff constituted 7.7% each (n=3 each). One of them was a farmer. 38 cases (71.7%) occurred due to contact with high tension electrical sources like high tension electric wires, transformers and sources in power plants. The rest of the cases (n=15, 28.3%) were due to contact with electricity through defective household appliances, switch boards and incautious usage of electric water heaters. 34 cases (64.2%) were booked under 174 CrPC, 18 cases (34%) under 304 (A) IPC and 1 case under 174 'c' CrPC.

On analysing the exit wounds of the cases where entry of the current was through the upper limb (n=27), 10 cases showed an exit wound in one or both feet. However, 13 cases did not have an exit wound. One case where the entry wound was on the left hand showed an exit wound on the right hand. We observed that entry wounds and exit wounds were indiscernible in 21 cases (39.6%) as a result of various degrees of burns sustained. 18 out of these 21 cases were due to contact with a high-tension electric wires, transformers, and equipment in power plants. 29 cases (51%) had suffered various degrees of burns, out of which 12 cases had suffered 40-60% superficial to deep burns.

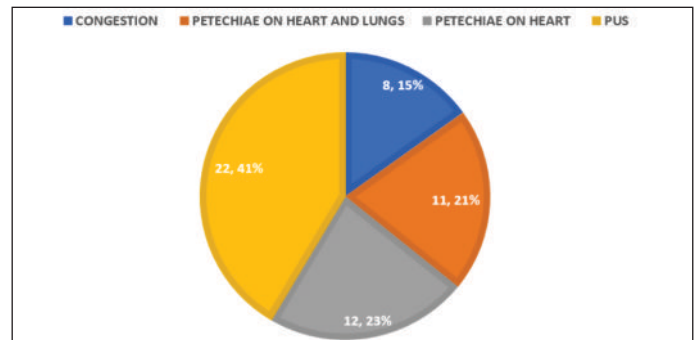
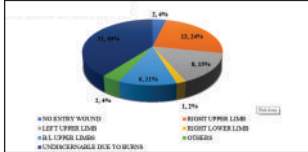
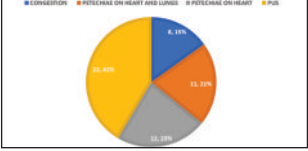


Figure 2. Different internal findings.

Sl. No.	Description
1	<p>The different sites where entry wounds were present were noted and tabulated. A pie chart was created pictographically represent the various sites involved.</p> <p>Entry wounds were seen in the: Right upper limb in 13 cases Right lower limb in 1 case Left upper limb in 8 cases Both upper limbs in 6 cases In 2 cases the entry wounds were present on face and neck. In 21 cases, the entry wound could not be made out because of burns and in 2 cases, there was no demonstrable entry wound.</p>  <p style="text-align: center;">Figure 1. Entry wound sites.</p>
2	<p>The different internal findings that were noted in all the cases were tabulated and then pictographically represented by a pie chart. 22 cases were treated and showed features of septicaemia, 12 cases had petechiae on the epicardium, 11 cases showed petechiae on the epicardium and the lung surfaces and 8 cases showed visceral congestion.</p>  <p style="text-align: center;">Figure 2. Different internal findings.</p>

The cause of death in 22 cases was due to septicaemia consequent upon electric burns sustained and was a result of electrocution and shock in 31 cases. Upon thorough investigation by the police and autopsy, only 2 out of 53 cases were found to be suicidal in manner, the rest of them (n=51) were accidental in manner.

Discussion:

This study was undertaken in a government college situated in the south of Bangalore, Karnataka. According to data published by National Crime Rate Bureau in 2021, electrocution deaths constituted 2.4% of the total number of accidental deaths in Karnataka.¹ In this retrospective study done for a period of three years, electrocution deaths constituted 0.7% of the total number of autopsies. A male preponderance was noted in this study, that could be attributed to men being the breadwinners in the family and being involved in work related to electricity, construction, painting buildings etc. Similar findings were observed in studies done by Shobhana S. S. and Raviraj K. G. at Bangalore and Reddy A et al. at Puducherry.⁵

Highest number of cases were observed in the third decade of life (21-30 years). Third decade of life is most commonly the age where one ventures out to earn for themselves and their family. More often than not, youngsters are involved in risk-taking work like climbing to higher levels exposing them to the perils of accidentally coming in contact with high tension wires and

transformers. Similar finding was observed by Rao D, who studied electrocution deaths from 2013 to 2021 that presented to The Oxford medical college, hospital and research institute, in Bangalore.⁶

In this study, electricians, construction workers, cable network technicians and painters constituted a majority (64.3%) among the employed indicating the high risk involved in these professions due to working in close proximity to high tension wires and transformers. This further draws attention towards the lack of safety measures undertaken while engaging in these activities, making this a significant occupational hazard. A similar observation was made by a study done on electrocution deaths in Croatia by Kuhtic I. et al., in which construction workers and electricians constituted 68% of the study population.⁷ In line with the above observation, 96.2% of the cases were also found to be accidental in manner. 3.8% of the cases (n=2) were suicidal in manner. Studies done by Giri S et al.⁸ and Shobhana SS et al.⁵ also showed similar results where 100% and 98.6% of the cases were accidental in manner, respectively.

Among the 30 cases with identifiable entry wounds, 27 cases (90%) had entry wounds at different sites in the upper limbs (19 in the right upper limb and 8 in the left upper limb). This indicates the predominance of right side being the dominant side in most individuals and the usage of right hand to carry out majority of the activities. Among these 27 cases, 17 cases did not have a demonstrable exit wound and 10 cases showed the exit wound on one or both feet. A case series by Hardjanto P et al. calls the exit wounds a 'silent witness', and emphasizes on the fact that studying exit wounds give an idea about the position of the body at the time of electrocution which in turn is an important point while investigating the manner of death. The possibility of having exit marks is minimized because the body was not on its weight or stood position against ground.⁹

In 54.7% (n=29) of the study population, victims had sustained varying degrees of burns. Medium and high voltage sources were the reason for 25 (86.2%) of them indicating the effects seen when one comes in contact with high tension electricity. In the rest of the study population (45.3%, n=24), burns were not seen. 62.5% of these cases were due to contact with low voltage sources (household electric supply). Even though sources carrying >600V appears to be more dangerous, the 'let-go phenomenon' makes the low voltage sources (<600V) equally dangerous. Alternating current (in household sources) causes a tetanic contraction that lasts as long as the contact is continued. This leads to the subject tightening his or her grip on a conductor, resulting in continued electric current flow through the person and lowered resistance.¹⁰ The different internal findings found in the study population in varying combinations were visceral congestion, petechial haemorrhages in brain, lungs and heart, soot particles in trachea (in cases with flash burns) and pus (in cases treated for electrical burns). A prospective study done by Giri S et al. from 2012 to 2016 at a tertiary care centre also shows similar findings of conjunctival congestion, visceral congestion and petechiae in various internal organs especially brain, lungs and heart.⁸

Conclusion:

Studying electrocution deaths and their autopsy findings in the last three years retrospectively gave an insight into the different ways in which electrocution deaths can present, the external findings, internal findings and the different professionals who are at risk. This gives the law enforcing and regulating agencies a database to work with while formulating safety rules. This autopsy-based study also emphasizes on a thorough head-to-toe external examination in cases with history of electrocution, keeping in mind that lack of entry and exit wounds will not rule out electrocution. In cases without specific findings, meticulous history taking and studying photographs of the scene of crime given by the investigating officer are of paramount importance.

Ethical Issues: None

Conflicts of Interest: None

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ORIGINAL ARTICLE

Toxicological, Pharmacokinetic and Molecular Properties Prediction by Bioinformatics Tools of Compounds from *Cassia Javanica*

K Jyothi Prasad,¹ Subash KR.²

Professor.^{1,2}

1. Department of Forensic Medicine, SVIMS-Sri Padmavathi Medical College for women, Tirupati.

2. Department of Pharmacology, SVIMS-Sri Padmavathi Medical College for women, Tirupati.

Abstract:

To predict the toxicological, pharmacokinetic and molecular properties of certain *Cassia javanica* compound extracts. This study was investigated on web-based bioinformatics prediction tools with PUBCHEM used for data extraction for authenticated various chemical structural compounds from *cassia javanica* followed by validation of chemical formula. The 2-dimensional structures are further converted to 3-dimensional (3D) structure with CHEMSKETCH software, the derived 3D structures are then screened for molecular and pharmacokinetic properties such as absorption, distribution, metabolism, elimination. The toxicological profiling for cardiac, respiratory, hepatic, carcinogenicity and mutagenicity is analyzed through toxicophore bioinformatics analysis of *Cassia javanica* chemical structures. The reports are analyzed and predicted for possible toxicological and drug like compound in extract of *cassia javanica*. The results obtained indicate that the compounds ent-Epiatzelechin (4 α -8) epiatzelechin, ent-Epiatzelechin (4 α -8) epicatechin and Emodin (1,3,8-trihydroxy-6-methylanthracene-9,10-dione) had the druglikeness score -0.93, -0.05, +0.93, and +0.74, respectively. On acute toxicity prediction, quercetin belonged to Class II and other compounds belonged to Class III. The study predicts emodin had druglikeness pharmacokinetic but unfavourable toxicological profile compared to ent-Epiatzelechin-(4 α -8)-epiatzelechin and ent-Epiatzelechin-(4 α -8)-epicatechin.

Keywords: *Cassia javanica*; Toxicology; Bioinformatics; Emodin.

Introduction:

Plants which are used in order to cure or prevent a disease or to alter pathological and physiological process or any plant working as a source of drugs or their precursors are known as medicinal plants.¹⁻³ *Cassia javanica* (*C. javanica*) is a member of sub-family caesalpinioideae and family Leguminosae (Fabaceae). *C. javanica* is naturally distributed from India to Malaysia, Southern China and the Phillipines. It is also cultivated in tropical regions of Asia. *C. javanica* has several pharmacological properties such as antioxidant, antidiabetic, anti-cancer and antimicrobial activities.⁴ *C. javanica* possesses various pharmacological activities - antidiabetic, antioxidant, anticancer and antimycotic activities. It has long been used in traditional medicine to cure various diseases. It has been used as antipyretic, laxative and antimalarial drug. It is known to decrease virulence of pathogenic organisms. It is used in the treatment of gastric pain and cold.

The phytochemical screening of the crude methanolic stem extracts of *Cassia javanica* plant showed the presence of different classes of organic compounds like alkaloids, tannins, flavonoids, saponins, phlobatanins, steroids, anthraquinone and cardiac glycoside. The aim of the study were to observe and analyse

pharmacokinetic and toxicological properties and probable characteristics of certain active principles ent-Epiatzelechin-(4 α -8)-epiatzelechin, ent-Epiatzelechin-(4 α -8)-epicatechin and Emodin(1,3,8-trihydroxy-6-methylanthracene-9, 10-dione) of *C. javanica* by insilico bioinformatics prediction tools.

Materials and Methods:

Hardware and Software: The selected compounds molecular properties of chemical structure from *C. javanica* active principle principles ent-Epiatzelechin-(4 α -8)-epiatzelechin, ent-Epiatzelechin-(4 α -8)-epicatechin and Emodin (1,3,8-trihydroxy-6-methylanthracene-9,10-dione) are carried out in widows NT workstation 2021 Model installed with updated support softwares java enabled with updated plugins.

Data Set: The chemical structures of principles ent-Epiatzelechin- (4 α -8) -epiatzelechin, ent-Epiatzelechin-(4 α -8)-epicatechin and Emodin (1,3,8-trihydroxy-6-methylanthracene-9,10-dione) from *C. javanica* with two-dimensional (2D) pictures were collected from accredited indexed published journals and other sources such as PubChem, ChEMBL, Chem PDB, and Asinex Ltd.⁵ After a detailed review, the structures were developed with ChemSketch, followed by PHASE software module was used to convert the 2D structures into three-dimensional (3D) structures.⁶

Virtual Screening : Drug likeness, Pharmacokinetic and Toxicological Prediction- The 3D structures developed are explored virtually using online prediction software.⁸ Results from computational analysis of compounds on drug likeness,

Corresponding Author

Dr. K. Jyothi Prasad

Email : jyothi.prasad99@gmail.com

Mobile No.: (0) 9701768830

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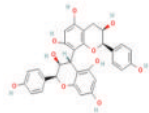
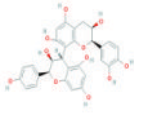
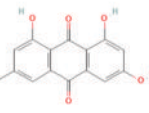
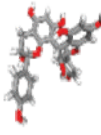
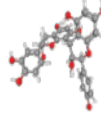
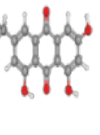
pharmacokinetics and toxicity are acquired in the virtual screening workflow protocol.⁷

Statistical Methods and Calculation: Interactive molecular properties calculator applet (MolSoft L.L.C. San Diego, CA, USA) is used for molecular volume and drug-likeness score.⁸ For prediction linear statistical model.⁹ The study is done in the department of Forensic medicine, Pharmacology and the college digital library using online tools during Aug 2022 to Oct 2022.

The study was self-funded conducted at SVIMS University, Tirupati, Andhra Pradesh, India. The study is considered under the category for exemption from institutional ethics committee approval as it does not involve animals and humans and done by computational bioinformatics tools.

Result:

Table 1: 2-D, 3-D structure and Physiochemical properties of certain cassia javanica extract compounds.

Sl. No	Characters	ent-Epiatzelechin-(4alpha-8)-epiatzelechin	ent-Epiatzelechin-(4alpha-8)-epicatechin	Emodin(1,3,8-trihydroxy-6-methylanthracene-9,10-dione)
1.	2D Structure			
2	3D Structure			
3	Chemical Formula	C ₃₀ H ₂₆ O ₁₀	C ₃₀ H ₂₆ O ₁₁	C ₁₅ H ₁₀ O ₅
4	Molecular weight	546.5 g/mole	562.5 g/mole	270.24 g/mole
5	Num. H bond acceptors	10	11	5
6	Num. H bond donors	8	9	3

H-bond-Hydrogen bond, 3D-3 dimensional, 2D-2 dimensional

Table 2. ADME predicted profile of certain cassia javanica extract compounds.

Sl. No	Pharmacokinetic Parameters	ent-Epiatzelechin-(4alpha-8)-epiatzelechin	ent-Epiatzelechin-(4alpha-8)-epicatechin	Emodin(1,3,8-trihydroxy-6-methylanthracene-9,10-dione)
1	G.I Absorption	Low	Low	Low
2	BBB penetration	No	No	No
3	P-gp Substrate	No	No	No
4	CYP450 3A4 Inhibitor	Yes	Yes	Yes
5	CYP450 3A4 substrate	Yes	Yes	Yes
6	Log KP	-7.45 cm/s	-7.80 cm/s	-6.02 cm/s
7	Drug likeness	No 2 violations	No 1 violation	Yes 0 violation
8	Bioavailability Score	0.999	1.0	0.999

log kp - Human skin permeability coefficients, P-gp -P glycoprotein, BBB-Blood brain barrier, G.I-Gastro intestinal.

Table 3: Toxicology prediction profile of certain cassia javanica extract compounds.

Sl. No	Profile	Ent-Epiatzelechin-(4alpha-8)-epiatzelechin Value (category)	Ent-Epiatzelechin-(4alpha-8)-epicatechin Value (category)	Emodin(1,3,8-trihydroxy-6-methylanthracene-9,10-dione) Value (category)
1.	Cardiac hERG Blockers	0.067	0.041	0.039
2.	hepatotoxicity	0.051	0.055	0.046
3.	respiratory toxicity	0.031	0.025	0.076
4.	Mutagenicity (AMES)	0.178	0.242	0.823
5.	Carcinogenicity	0.044	0.036	0.301

Calculated score < 0.5 = negative, calculated score ≥ 0.5 = positive.

Discussion:

C. javanica as is used in herbal preparation of Ayurvedic and siddha medicine for various ailments. The scientific rationale is yet to be explored for evidence based medicine. Various parts of plant is rich in phyto constituents and many biologically active ingredients. Previous published pharmacological studies reported hypoglycemic activity on laboratory-bred male Wistar albino adult rats,¹⁰ anticancer and antimycotic activities of honey samples from flowers, Propelargonidin from *C. javanica* is fungitoxic and Ent-epiatzelechin-(4α8)-epiatzelechin with antiviral properties.¹¹⁻¹³

The presence of toxic compounds in the plant extracts and reports of renal and hepatotoxicity of herbal preparations been reported on the increase and thus, pharmacokinetic and toxicological evaluation of plant extracts has become necessary in current research endeavors.¹⁴

The chemical constituents ent-Epiatzelechin-(4alpha-8)-epiatzelechin, ent-Epiatzelechin-(4alpha-8)-epicatechin and Emodin (1,3,8-trihydroxy-6-methylanthracene-9,10-dione) from *C. Javanica* had significantly similar pharmacokinetics profile in relation to Gastro intestinal (G.I) absorption, Blood brain barrier penetration, P-glycoprotein Substrate, CYP450 3A4 Inhibitor, CYP450 3A4 substrate, Log KP and Bioavailability Score. The drug likeness score was analysed based on Lipinski rule of 5 to predict if the molecules can be developed as possible drug candidate among ent-Epiatzelechin-(4alpha-8)-epiatzelechin, ent-Epiatzelechin-(4alpha-8)-epicatechin and Emodin (1,3,8-trihydroxy-6-methylanthracene-9,10-dione) from *C. Javanica*. The ent-Epiatzelechin-(4alpha-8)-epiatzelechin developed 2 violation and ent-Epiatzelechin-(4alpha-8)-epicatechin had 1 violation whereas Emodin had no violations and predicted to be probable drug like candidate for development and better G.I absorption.

Similarly with toxicological profiling of ent-Epiatzelechin-(4alpha-8)-epiatzelechin, ent-Epiatzelechin-(4alpha-8)-epicatechin and Emodin (1,3,8-trihydroxy methylanthracene-9,10-dione) had significantly similar prediction results respectively of following parameters, Cardiac- the human ether-a-go-go-related gene (hERG) Blockers 0.067,0.041 and 0.039, hepatotoxicity 0.051, 0.055 and 0.04, respiratory toxicity 0.031, 0.025 and 0.076. The cardiac potassium channel encoded by the human ether-a-go-go-related gene (hERG) and its receptor blocking results in long QT syndrome which can lead to fatal ventricular arrhythmias and sudden death similarly screening

liver and respiratory toxicity are essential for drug development in predicting toxicity during clinical trials. Among the above screened molecules Emodin (1,3,8-trihydroxy methylanthracene-9, 10-dione) is predicted to have positive effect for mutagenicity (AMES) 0.823 and carcinogenicity 0.301 with calculated score ≥ 0.5 and positive. The ent-Epiatzelechin-(4 α -8)-epiatzelechin and ent-Epiatzelechin-(4 α -8)-epicatechin was analysed with calculated score < 0.5 and predicted negative for carcinogenicity and mutagenicity.

Conclusion:

Emodin when compared with Epiatzelechin-(4 α -8)-epiatzelechin and ent-Epiatzelechin-(4 α -8)-epicatechin had better drug development prediction. The positive result from mutagenicity (AMES) and carcinogenicity test is indicating that the chemical is mutagenic and therefore may act as a carcinogen during animal studies. Toxicity results from animals are more definitive to take further judging the safety of medicinal plants, as use of medicinal plants increases, experimental screening of the toxicity of these plants is crucial to assure the safety before exposure to humans to prevent toxicity.

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ORIGINAL ARTICLE

A Cohort Study to Estimate Prevalence of Medical Negligence Cases Resolved by the State Consumer Disputes Redressal Commissions of South India

Perumal P,¹ Honnunar RS,² Bharathi LM,³ Bannur VS.⁴

Postgraduate,^{1,3} Professor and Head,² Assistant Professor.⁴

1,2,4. Department of Forensic Medicine and Toxicology, Jawaharlal Nehru Medical college, KAHER, Belagavi.

3. Department of General Medicine, Madurai Medical College, Madurai.

Abstract:

Medical negligence is a significant issue for the healthcare system since it is one of the risks to patient safety, which harms the patient. These accusations against doctors are significant because long-running litigation might have negative effects on both patients and doctors. To estimate the reasons and factors responsible for medical negligence and to ascertain pattern of cases and reasons for filing suit, outcome, time schedule of decision-making process. To determine role of Forensic expert's opinion in decision making. A prior approval was obtained from the Institutional Ethics and Research Committee. This retrospective and prospective cohort study focused on Cases which were registered and judgement disposed off medical negligence cases given in State Consumer Disputes Redressal Commissions of South Indian states. Following a case-by-case analysis, it was discovered that just 17 out of a total of 231 cases included government hospitals, while the remaining 214 cases were related to private hospitals. Furthermore, they were divided into corporate hospitals and self-owned institutions, which together accounted for 60 and 154 cases respectively. Any medical treatment where a consumer is charged a fee is covered under the new Consumer Protection Act 2019, and the doctor-patient relationship is considered "contractual." The goal of this study was to look into medical negligence complaints that were reported to the State Consumer Disputes Redressal Commissions of South India in order to offer suggestions to lessen the complaints and enhance service delivery.

Keywords: Medical negligence; Forensic expert; Doctors; Indemnity insurance; Human rights; Consumer protection.

Introduction:

When a doctor fails to provide reasonable skill and care during a patient's treatment, the patient suffers damage, which is referred to as medical negligence also known as professional negligence/professional malpraxis. The words "professional negligence" and "professional misconduct" are distinct. A doctor's unethical acts are considered professional misconduct. Medical negligence is the violation of a patient's legal right to care. Patients have the right to take legal action against professional negligence. Telemedicine services are included in the scope of new Consumer Protection Act, 2019. In the Indian Medical Association vs. V P Shantha case, the Honourable Supreme Court held that medical services would be treated as services under the Consumer Protection Act (CPA) 1986. This landmark decision embarked on the doctor-patient relationship as 'contractual'.^{1,2} When a doctor makes errors that damage a patient, such as "omission of right things and commission of wrong things", it is claimed that the doctor committed negligence. Some authors define a medical error as "the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim".³ The determination of medical negligence is based mostly on the following factors: (a) A duty of care, (b) Breach of duty, and (c)

The injury should have occurred as a consequence of the breach of duty, and (d) Damage.⁴ The House of Lords formulated the following proposition, which is popularly known as the 'Bolam's test'- a medical professional is not guilty of negligence if he has acted in accordance with a practice accepted as proper by a responsible body of medical men skilled in that particular art. Putting it the other way round, a man is not negligent, if he is acting in accordance with such a practice, merely because there is a body of opinion who would take a contrary view. This principle of Bolam's test was recognized in India by the Supreme Court's landmark judgment Laxman Balkrishna Joshi v Trimbak Babu Godbole in 1968.⁵ This original research article highlights the emergence of the concept of medical negligence and its effects on clinical practise.

Material and methods:

The professional malpraxis cases from 1st January 2010 to 15th December 2023 (13 Years) were analysed as part of a retrospective and prospective cohort research. The current study was conducted at Jawaharlal Nehru Medical College, KAHER in Belagavi, in the department of forensic medicine and toxicology. The Institutional ethics and research committee provided prior approval. The Helsinki biomedical ethics guidelines, which are principles and standards relevant to the ethics of human research, have been respected and adhered to throughout this study. The current research was based on the decisions made by the State Consumer Disputes Redressal Commissions of the South Indian states - Tamil Nadu, Karnataka, Kerala, Andhra Pradesh, and Telangana. Accurate information was given by the National Consumer Disputes Redressal Commission after it was

Corresponding Author

Dr. Perumal P

Email : perumalp632@gmail.com

Mobile No.: +91 9626755997

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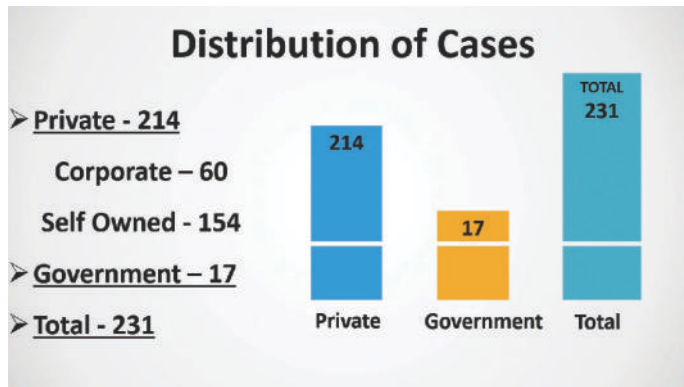


Figure 1. Distribution of speciality wise medical negligence cases in states of south india.

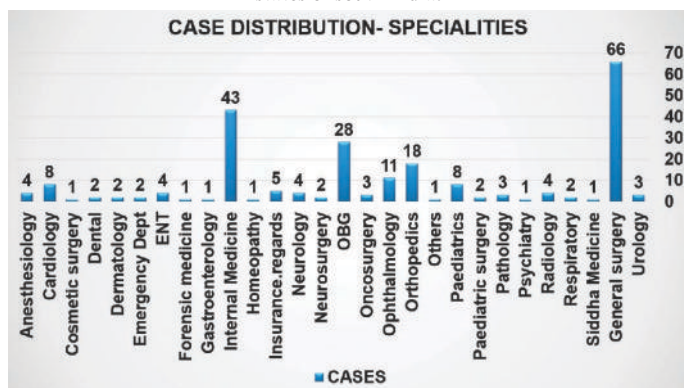


Figure 2. Distribution of speciality wise medical negligence cases in states of south india.

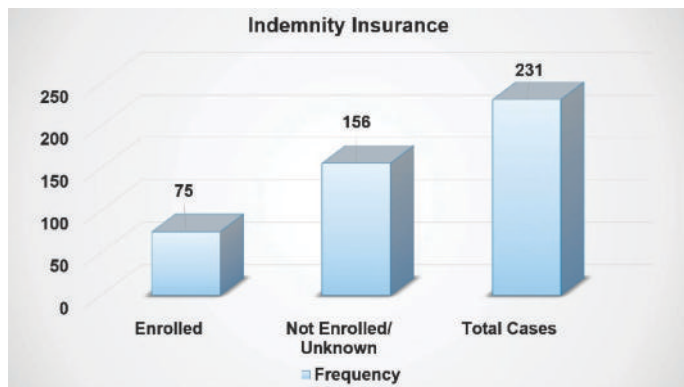


Figure 3. The frequency of doctors with indemnity insurance coverage

appropriately obtained by contacting the respective chairpersons and permission granted in principle to analyse the pertinent records. The judgements were obtained from the pertinent portals: The National Consumer Disputes Redressal Commission (NCDRC) website - <https://ncdrc.nic.in/>, as all decisions in disposed cases are freely available in the public domain, and the relevant commissions regularly update the public portal/website. Incidence and prevalence were estimated after a thorough analysis of all the cases of medical negligence resolved by the consumer commissions selected over the research period. This was followed by an analytical evaluation of the petitioner's justifications for bringing the lawsuit. It was observed the basic characteristics of the cases of medical negligence, the medical specialisations involved, the damages given by the relevant

commission, as well as how long it took for the cases to be decided or disposed. It was also evaluated if a medical expert's opinion mainly forensic surgeon was sought in the circumstance and, if so, whether that opinion influenced the decision-making process or the outcomes. The analysis included all medical negligence cases that were disposed within the selected time period; Sub-judice, Not updated / not finalized and repeated cases were excluded.

Med Calc 18.11, Epi Data Analysis v 2.2.0.164, and the Statistical Package for Social Science software (SPSS) version 23.0 were used to analyse the data. Frequencies and percentages were used to express qualitative variables.

Results:

Following a case-by-case analysis, it was discovered that just 17 out of a total of 231 Cases (7.36%) included government health institutions, while the remaining 214 cases (92.64%) were related to private hospitals. Furthermore, they were divided into corporate hospitals and self-owned hospitals, which together accounted for 60 (25.97%) and 154 (66.67%) cases respectively (Image-1). Further analysis of the outcomes of alleged medical negligence cases showed that, in 44 out of 231 cases (19.05%), negligence could not be established when it was contested before the relevant State Consumer Disputes Redressal Commission, while in 91 cases (39.39%) in which negligence was established, privately self-owned health facilities accounted for 53 cases, corporate hospitals for 29 cases, and government hospitals for only 9 cases. Image-2 shows distribution of speciality wise medical negligence cases in states of South India. In general, 63.36% of suits were in the field of surgery and its subspecialties, and 18.61% were in the field of internal medicine.

Table-1 shows distribution of medical negligence cases in states of South India. Regarding composite negligence, it was found that the complainant or plaintiff accused the negligence of more than one doctor in 100 (43.29%) out of 231 Cases. Out of 91 cases, composite negligence was proven in 46 (50.54%). In 45 (49.45%) out of 91 cases, were single doctor involved cases. Table-2 shows distribution of medical negligence case, Types in States of South India and Table-3 shows distribution of medical negligence proven status in states of South India. Out of 231 cases, 75 (32.47%) involved doctors who had indemnity insurance coverage (Image-3). These medical professionals and organizations were all private. This demonstrates that the possibility of future medical malpraxis lawsuits is becoming tangible in the medical profession, especially in the private sector. 65 cases (28.1%) out of 231 cases, commission reviews and sought for expert's opinion that were undertaken. 49 cases (21.2%) out of 231 cases, time period of decision making by the commission was 90 days or less.

Discussion:

Kevin Alan Lee said, "In my opinion, our health care system has failed when a doctor fails to treat an illness that is treatable". 'Medical negligence' is defined as lack of reasonable care and skill or wilful negligence on the part of a doctor in respect of acceptance of a patient, history taking, examination, diagnosis, investigation, treatment-medical or surgical, etc., resulting any injury or damage to the patient. Damage in this means physical,

Table 1. Distribution of medical negligence cases in states of south india.

States of South India	Case Frequency
Tamil Nadu	76
Karnataka	47
Kerala	35
Andhra Pradesh	57
Telangana	16
Total	231

Table 2. Distribution of medical negligence case types in states of south india.

Case Types	Case Frequency
First Appeals (A or FA)	115
Consumer Cases (CC)	8
Revision Petition (RP)	106
Transfer Applications (TA)	2
Total	231

Table 3. Distribution of medical negligence proven status in states of south india.

Negligence Proven Status	Frequency	Percent	Cum. Percent	Exact 95% LCL	Exact 95% UCL
Fully Proven (Government-9; Corporate-26; Self Owned-48)	83	35.93%	35.93%	29.74 %	42.48 %
Partially Proven (Government-0; Corporate-3; Self Owned-5)	8	3.46%	39.39%	1.51%	6.71%
TOTAL PROVEN CASES	91 (83+8)	39.39%	-	-	-
Not Proven	44	19.05%	58.44%	14.19%	24.71%
Court Dismissed due to Petitioner Withdrawn/ None appears for the Petitioner/Condonation of delay/Interlocutory order/Suo-Moto Notice/ Transfer Application	74	32.03%	90.48%	26.07%	38.47%
Ex-gratia Compensation	22	9.52%	100.00%	6.07%	14.06%
Total	231	100.00%	100.00%		

mental or financial injury to the patient.⁶ Medical malpractice is not defined by a simple error, a mistake in diagnosis, or a mistake during a procedure. The plaintiff (patient) must show each of the following four criteria in order to establish medical malpractice: a duty, owed to the patient, negligence or breach of duty (derelict), direct causation and damage. This may stem from Hippocrates, primum no nocere, or “First, do no harm.”^{7,8}

Internationally, the risk of being sued is also highest among older surgeons, with high workloads, long working hours and a history of prior claims.⁹ A doctor's future complaint risk is determined by four factors, including the doctor's specialty and sex, the number of prior complaints, and the amount of time since the last complaint. These factors are all taken into account when calculating the PRONE (Predicted Risk of New Event) score, a 22-point scoring system. The PRONE score did a good job at foreseeing following complaints, displaying strong validity and reliability as well as a goodness of fit. The PRONE score is one example of an existing medico-legal risk prediction tool that places a strong emphasis on non-modifiable demographic characteristics and past claims history. This restricts options for corrective action and does not explain why there is variance within high-risk groups. For instance, being an older male

surgeon does not automatically make a doctor a target of a lawsuit. Therefore, there is a critical need to comprehend the part that work stress, psychological well-being, and socio-demographic variables play in medical litigation. The most important and novel findings in this study are that doctors with lower self-rated health, lower self-rated life satisfaction (especially for male doctors) and those who had experienced a recent serious personal injury or illness were more likely to be sued. Prior studies have shown that poor doctor well-being, higher levels of burnout and chronic illness among doctors can lead to poor patient safety outcomes and medical errors.^{10,11}

The COVID-19 pandemic is putting strain on healthcare professionals and systems all around the world, making it more crucial than ever to provide supportive work environments that support physicians' mental health and overall well-being. There is growing evidence that occupational stress in healthcare organisations has a negative impact on doctors' health and the standard of patient care. Healthy lifestyle and positive psychology interventions can boost doctors' subjective well-being, enhance patients' perceptions of doctors' empathy and improve clinical outcomes. This is particularly important because we know from numerous studies that being sued can negatively impact on doctors' health and well-being.^{12,13} In 2017, supreme court stayed the national consumer disputes redressal commission order to include government hospitals treating patients free of cost by including them within the ambit of consumer protection act. According to the regulation, the State commission disputes redressal commission will not accept a complaint unless it is submitted within two years of the date the allegation first arose. A 30-day timeframe follows the day on which an appeal must be submitted against a state commission's order issued according to the legislation. A complaint filed with the consumer commission must be resolved within 90 days of the day the other party got notice, and within 150 days if it calls for the investigation or testing of commodities. Any appeal has to be completed within 90 days.

The term “egg shell skull” rule originated in the *Dulieu v White & Sons* (1901) judgment, in which the following pithy statement can be found: “If a man is negligently run over or otherwise negligently injured in his body, it is no answer to the sufferer's claim for damages that he would have suffered less injury, or no injury at all, if he had not had an unusually thin skull or an unusually weak heart”.¹⁴ Important medicolegal implications of the "egg shell rule" include the prohibition of practitioners from using a patient's unique predisposition for pathology and disease as a defence in court to diminish culpability. "Restitutio in integrum" which means restoring the injured or affected party to their original, pre-injury condition as much as possible. It signifies the aim to fully compensate and rectify the harm caused by the medical negligence, seeking to bring the individual back to the state they were in before the negligent act occurred. This is the common law's guiding concept for computing compensation. However, the method of calculating compensation is unpredictable and varies significantly between cases in the absence of a standard method of calculation. The multiplier method was created to facilitate compensation in relation to the motor vehicle accidents via a “no-fault” liability system.¹⁵ This

method accounts for the loss of income of the victim only. It is calculated by multiplying the victim's salary minus his expenditures (savings) with the total number of years that the victim would have earned his salary. The usual formula utilized to calculate compensation is - $\{(70 - \text{age}) \times \text{annual income} + 30\%$ for inflation - $1/3$ for expenses $\}$.¹⁶

Using a multiplier approach has several disadvantages, particularly for those who are unemployed, such as children, old persons, homemakers, etc. As a result, the supreme court has included new factors to the calculation of damages, such as the cost of medical care, damages for bodily and psychological suffering, damages for loss of consortium, and litigation costs. As per the Hon'ble supreme court, in Jacob Mathews vs State of Punjab, expert medical opinion should be sought before proceeding against a doctor in an alleged medical negligence suit.¹⁷ Concerning situations of medical negligence, there is a need to increase awareness and engagement among the healthcare professionals, patients and advocates.

In this arena, Forensic Medical experts may be extremely helpful by working as experts in medical negligence lawsuits filed in various consumer courts or by offering advice to patients or hospitals or doctors who have been wronged. The German Federal Ministry of Health conducted a relevant research analysing 4450 autopsies in 17 German Forensic Medicine institutions from 1990 to 2000 because there was a suspicion of medical negligence. They stated that while 2863 cases of medical negligence were resolved by autopsy, medico-legal autopsies are still an extremely competent tool to assess such situations.¹⁸ In order to decrease medical negligence cases, the results of this study suggest the following measures:

- Informed consent with videotape.
- The strongest defence for a doctor in a court of law against a claim of negligence is proper documentation. Common wisdom holds that, "if you have not documented it, you have not done it," in a court of law.
- Continue to gain knowledge about modern training and standards.
- Updating medical knowledge through CMEs, conferences, and workshops.
- Monitoring of diagnostic tests and referrals to specialists.
- Advanced communication abilities and a commitment to ethical medicine built on the foundation of evidence-based medicine.
- Don't communicate wrongly!
- Always respect the patient's right to privacy and confidentiality about their medical information, both ethically and legally.
- Ask for help - recognize your limitations and avoid attempting anything you don't feel confident doing.
- Should not refuse a patient during emergency.
- Explain questions regarding medication allergies, surgical procedures, what should be done, and how long they should take.

- Avoid criticizing other doctors by not doing so.
- Provide a prompt response; Avoid using intoxicants while workplace.
- A female person must be present before any female patients may be examined.
- Never make a cure promise.
- Before using or injecting a drug, its identification is required.
- Be extremely cautious about USG, lab results, and discharge summaries in computerized medical records.
- Be vigilant whenever delivering the patient's belongings or the deceased body to the family.
- Maintaining a healthy lifestyle and a balanced work/life schedule aids in maintaining mental acuity of doctors.

Conclusion:

The Consumer Protection Act, 2019 will act harmoniously to safeguard consumer rights in India through the inclusion of various innovative provisions, revisions to the current laws, and simplification of the processes. Since there is no inherent penalty for making false complaints, there may be a rise in the number of pointless cases; as a result, procedures like fining false complaints should be implemented, and if the physicians are not proven guilty, loss of pay should be provided to them. Since more than 80% of healthcare in India is provided by the private sector, it may be crucial for all doctors to get indemnity insurance because they often shoulder the burden of compensation. A study should take into account the possibility of judgement errors brought on by busy clinical practise. To eliminate violence against doctors, it would be crucial to have systems in place for the timely dispensation of cases. It is advised that doctors serve on the panels of the different commissions and mediation cells since the settlement of legal disputes requires knowledge. No amount of money awarded by the court in a case of medical negligence can make up for the value of the life that was lost loved ones. All doctors cannot be classified as negligent just because a few of them are. It is a kind of harassment as well as being embarrassing for doctors. Doctors aren't superhuman; they're also human beings with flaws. In certain cases, despite the doctor's best efforts to preserve the patient's life, the patient regrettably sadly passed away. The reality is what it is. Oh well, that's life!

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Ethical clearance: A prior approval was obtained from the institutional ethics and research committee.

Conflict of interest: None to declare.

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ORIGINAL ARTICLE

Reliability of Demirjian's and Willems method in Estimating Dental Age in Puducherry and Cuddalore Population, South India

Reddy JRC,¹ Sivasankari T,² Kumar S,³ Priya RS,⁴ Yazhini M.⁵

Professor and Head,^{1,3} Reader,² Postgraduate.^{4,5}

1,2,4,5. Department of Oral Medicine and Radiology, Indira Gandhi Institute of Dental Sciences, Sri Balaji Vidyapeeth (Deemed to be University), Puducherry.

3. Department of Forensic Medicine, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth (Deemed to be University), Puducherry.

Abstract:

Age estimation plays an important role in the field of forensic sciences. The Dental age estimation methods were different in different populations. This study aimed to evaluate the accuracy of determining the dental age by Demirjian methods and Willems method and comparing it with chronological age estimation. The study comprised 660 Digital Panoramic radiographs of which 228 were male and 373 were female with the age ranged from 6 to 17 years. The OPGs were used as samples to evaluate the accuracy of Demirjian's 7 teeth 1976 method, Demirjian's 8 teeth 2004 method, and Willem's method in estimating the dental age. Three different dental ages were obtained and a comparison with the chronological age of the patient was performed. The best method was evaluated by Descriptive statistics and Pearson Correlation Coefficient. The results found that Demirjian's 7 teeth 1976 method overestimated the Chronological age by 2.12 years, Willems method overestimated it by 0.59 years and Demirjian's 8 teeth method underestimated the chronological age by 0.25 years. Pearson Correlation Coefficient analysis revealed that Demirjian's 8 teeth 2004 is the most accurate method employed in dental age estimation. This study concludes by stating that the accuracy and reliability of dental age estimation and the interrelationship between the chronological age and dental age in Tamil Nadu and Puducherry population is best with Demirjian's 8 teeth method and Willems method, while Demirjian's 7 teeth method has failed to estimate the dental age in this population.

Keywords: Chronological age; Demirjian's method; Dental age; Forensic odontology; Willems method.

Introduction:

Estimating the age is a crucial part of forensic sciences.¹ Age estimation has been at the center to understand the very existence of both living and nonliving. Age is understood in terms of chronological age, biological age, social age, and developmental age but all of them are significantly variable. In forensic odontology, the purpose of age estimation is to estimate and evaluate if dental age matches the chronological age. There are many approaches for age estimation such as the Anthropological, Odontological, Histological and Biochemical approaches.² Most of the age estimation methods though reliable, they are time-consuming, expensive, and tissue invasive.³ Skeletal development is more affected due to malnutrition when compared to the dentition.⁴ This led to considering dentition as a quicker cost-effective and non-invasive technique for determining the age of an individual. Dental age estimation in children find its importance in determining a proper treatment plan and for forensic medico-legal purposes like juvenile criminal cases. They are also essential to categorize children in sports into various levels and categories.⁴ Calcified hard tissue structures such as bones and teeth are commonly used for age

estimation due to their reliability. Radiographical investigations such as intraoral periapical radiographs and orthopantomograms provide information regarding tooth maturation. There are various methods available for dental age estimation using OPGs conducted on different populations yet it needs studies and research on a large scale to establish a definitive derivation of age. In this study, dental age estimation using Digital Orthopantomograms is performed using Demirjian 7 teeth 1976, Demirjian 8 teeth 2004, and Guy Willems methods and is correlated with the chronological age, which is the gold standard. This study was carried out in the population of Puducherry and Tamil Nadu state. The objective of this study is to evaluate which of the above-mentioned method is better suited to the selected population. Hence the most reliable dental age estimation method which has more probability of providing an accurate age can be obtained for the selected population.

Materials and methods:

Study design: The Institutional Ethical Committee and Internal Review Board approved this study on 14/12/2018 with an IEC Approval code registered as IGIDSIEC2018NRP31PGYAOMR. This is an Observational cross-sectional study conducted in Puducherry and Tamil Nadu population. The study comprised 660 OPGs of which 228 were male and 373 were female with the age ranging between 6 to 17 years. The OPGs were used as the study tool to evaluate the accuracy of Demirjian's 7 teeth 1976 method, Demirjian's 8 teeth 2004 method, and Willems method in estimating the dental age. Retrospective and prospective radiographs were selected for the study based on the inclusion and exclusion criteria. The prospective period of the study

Corresponding Author

Dr. Siva Sankari T

Email : sankarisenthil1984@gmail.com

Mobile No. : +91-9443877381

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	MOLAR	BICUSPID	CANINE	INCISOR
A				
B				
C				
D				
E				
F				
G				
H				

Figure 1. 8 stages of tooth mineralization.

	MOLAR	PREMOLAR	CANINE	INCISOR
0	—	—		
1				
2				
3				
4				
5				
6				
7				
8				
9				

Figure 2. 10 stages of tooth mineralization.

spanned from Jan 2019 to June 2020. The OPGs used for the study were exposures made as a part of diagnostic and treatment planning requirements. There was no exposure made exclusively for the purpose of this study.

Study Criteria: The study criteria were set and the inclusion criteria were composed of OPGs within the chronological age group of 6-17 years; Subjects with complete case records and also

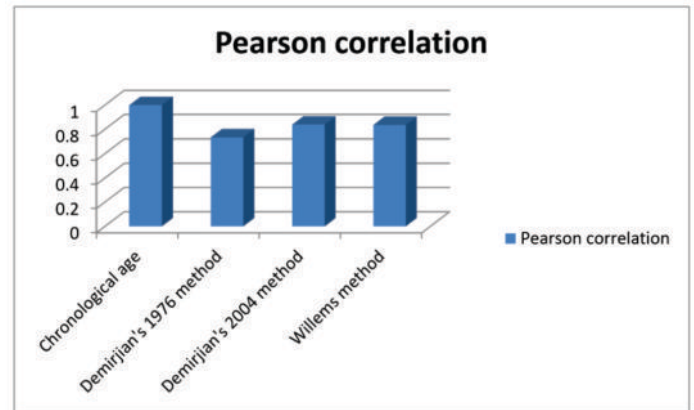


Figure 3. Pearson correlation coefficient test.

with their date of birth and date of OPG imaged⁵ and OPGs with acceptable image characteristics. The exclusion criteria included patients with metabolic disorders of bones, and teeth, and with growth deformities. Patients with a history of extraction in both mandibular quadrants.⁶ Syndromes associated with hard tissue (bones and teeth) also delayed the eruption of dentition.⁷ Patients with dental caries, malformed teeth, odontomas in the region of interest, and finally patients with orthodontic appliances.⁸

Chronological Age Estimation: The digital images were retrieved from the Orthophos XG- Dentsply Sirona machine with SIDEXIS XG software. Patient information such as Date of birth and gender were recorded. The chronological age of the samples was calculated from the date of birth to the date on which the OPG was imaged.

Dental age estimation: The acquired samples were stripped of the patient information and were submitted for evaluation of the maturity score for the dentition. The evaluation was performed by two qualified Oral Radiologists who were blinded toward the chronological age parameter. The age estimation was performed by all three above-mentioned dental age estimation methods. Both the Oral Radiologists were provided with 330 randomized samples dental age estimations were performed on the teeth in the left lower quadrant. If the quadrant presented with dental caries, restoration, or missing teeth, then the corresponding teeth in the right lower quadrant were utilized to perform the evaluation. As per Demirjian's 7 teeth method and Willems method, the teeth on the left lower quadrant were utilized to evaluate the eight stages of tooth mineralization (A- H) (Figure 1) and ten stages of tooth mineralization (0- 9) were utilized for Demirjian's 8 teeth 2004 method (Figure 2). The obtained stages of tooth mineralization were entered on the Microsoft Excel Sheet which was primed with the maturity score index and the dental age maturity formula for each method. As the stages were entered, the dental age was calculated by substituting the formula. Demirjian's 7 teeth 1976 and Demirjian's 8 teeth 2004 method formula: Male: $(0.000055 \times S3) - (0.0095 \times S2) + (0.6479 \times S) - 8.4583$ and Female: $(0.0000615 \times S3) - (0.0106 \times S2) + (0.6997 \times S) - 9.3178$.

Statistical Analysis: The statistical analysis was performed using SPSS software (statistical package for the social sciences) - version 17. The Intraclass correlation coefficient, Descriptive statistics, and Pearson correlation coefficient test was evaluated for the given study sample.

Table 1. Distribution of gender.

Gender	Frequency	Percent
Female	372	56.4
Male	288	43.6
Total	660	100.0

Table 2. Descriptive statistics (mean & standard deviation).

	N	Minimum	Maximum	Mean	Std. Deviation
Chronological age	660	6	17	13.27	2.691
Dental age by Demirjian 7 teeth method	660	6.20	16.30	15.3898	1.75355
Dental age by Demirjian 8 teeth method	660	4.90	16.30	13.0235	2.32392
Dental age by Willems method	660	5.70	16.00	13.8612	2.35682

Table 3. Descriptive statistics for female.

Distribution of Gender	Chronological age	Dental age by Demirjian 7 teeth method in years	Dental age by Demirjian 8 teeth method in years	Dental age by Willems method in years
Female Mean	13.53	15.5866	13.1126	14.0707
N	372	372	372	372
Std. Deviation	2.564	1.48857	2.06061	2.17555

Table 4. Descriptive statistics for male.

Distribution of Gender	Chronological age	Dental age by Demirjian 7 teeth method in years	Dental age by Demirjian 8 teeth method in years	Dental age by Willems method in years
Male Mean	12.93	15.1358	12.9083	13.5906
N	288	288	288	288
Std. Deviation	2.815	2.02021	2.62453	2.55062

Results:

The inter-observer variability was evaluated using the Intra-class Correlation Coefficient. The Intraclass Correlation between two observers in measuring the dental age by Demirjian's 7 teeth 1976 method, Demirjian's 8 teeth 2004 method, and Willems method was found to be 98.5%, 99.2%, and 99.5% respectively with a p-value of 0.001 (statistically significant). Descriptive Statistics were used to evaluate the accuracy and reliability of Demirjian's 7 teeth 1976 method, Demirjian's 8 teeth 2004 method, and Willems method. The gender distribution was also evaluated by Descriptive Statistics which calculated the mean and standard deviation. As per the overall Descriptive Statistics, Demirjian's 7 teeth 1976 method overestimated the chronological age by 2.12 years. Willem's method overestimated the chronological age by 0.5years. Demirjian's 8 teeth method underestimated the chronological age by 0.25 years (Tables 1 and 2). In females, Demirjian's 7 teeth 1976 method overestimated the chronological age by 2.06 years. Willem's method overestimated the chronological age by 0.54 years. Demirjian's 8 teeth method underestimated the chronological age by 0.42 years (Table 3). In males, Demirjian's 7 teeth 1976 method overestimated the chronological age by 2.2 years. Willem's method overestimated the chronological age by 0.66 years. Demirjian's 8 teeth method underestimated the chronological age by 0.02 years (Table 4). The inter-relationship between chronological age and dental age (by all three methods) was statistically evaluated by the Pearson Correlation Coefficient test (Figure 3). The Pearson Correlation Coefficient test (r) revealed the correlation between the chronological age and the Demirjian's 7 teeth 1976 method,

Demirjian's 8 teeth 2004 method, Willems method was 0.735, 0.839 and 0.836 respectively. r-value for the independent variable (chronological age) was 1. When compared, the Demirjian's 8 teeth 2004 method had the strongest association with an r-value of 0.839 followed by the Willems method with an r-value of 0.836, and lastly the Demirjian's 7 teeth 1976 method with r-value of 0.735. Thus, all three methods had a positive correlation with the independent variable. The p-value (Test of significance) was less than 0.01 thus proving the significance. The results prove beyond doubt that the objectives of the study are satisfied and both the statistical analysis (i.e.) Descriptive statistics and Pearson Correlation Coefficient have revealed that Demirjian's 8 teeth 2004 is the most accurate method employed in dental age estimation in the study population. It is the closest to the chronological age (independent variable) with a negligible margin of difference.

Discussion:

Dental age estimation is considered one of the most reliable age estimation methods in Forensics. Events such as mass disasters, organized crime, genocide, etc., are situations where age estimation can be of use to identify the victim's age. Age estimation also forms a critical aspect in several medico-legal situations like differentiating a minor from a major.

Demirjian's 7 Teeth 1976 Method: Demirjian's 7 teeth 1976 method was the updated version of Demirjian's 7 teeth 1973 method. The dental maturity scoring provided by this method was entirely based on the French - Canadian origin. In this study Demirjian's 7 teeth 1976 method was included as one of the dental age estimation methods to verify its significance to the current population. In the current study the age range was between 6-17 years as the 7 teeth method cannot predict an age beyond the upper limit of this study, which was by a study by Sobieka E et al. (2018).⁹ In this study, Demirjian's 7 teeth 1976 method estimated the age over 2.2 and 2.06 years in males and females respectively. Other studies which are similar to the current study are Koshy S et al. (3.04 and 2.82 years in males and females respectively)¹⁰ and Asab SA et al. (1.23 and 1.20 years in males and females respectively).¹¹

Demirjian's 8 Teeth 2004 Method: In Demirjian's 8 teeth 2004 method, the third molar was included to obtain a specific dental maturity score and percentile curves in the French population. This method - provides a maturity score for up to 18 years of age. According to Bunyarit SS et al. (2019), the development of the third molar was considered crucial for the dental age estimation in the midteens and early 20s since at this period all the other teeth would have completed root development. This period helps to differentiate a juvenile from an adult.¹²

Agrawal NK et al. (2018), studied both Demirjian's 2004 method and Willems method and found they applied to the Nepalese population.¹³ Also, Mankel H et al. (2018), Demirjian's 7 teeth 1973 method overestimated the age when compared with Demirjian's 2004 method emphasizing that Demirjian's 8 teeth method was more reliable in the Rajasthan population.¹⁴ Several studies worldwide were conducted using Demirjian's 8 teeth 2004 method and their results were concurrent with a high degree of accuracy in matching both the calculated dental age and the

chronological age, however the study by Bijjaragi SC et al. (2015) did not concur when the Demirjian's 8 teeth 2004 method was applied to the Tibetan population.¹⁵ Another study by Kiran CS et al. (2015) was performed using Demirjian's 8 teeth method and Demirjian's 8 teeth method with Indian specific regression formula. The study resulted in an overestimation of dental age (1.72 and 1.91 years in males and females respectively) when Indian-specific regression formulas were used but Demirjian's 8 teeth 2004 method resulted in an underestimation of the age by 0.84 and 0.83 years in males and females respectively in South Indian population.¹⁶

The present study chose to perform dental age estimation by the original Demirjian's 8 teeth 2004 method as the selected population is from South India. The current study underestimated the age by a marginal 0.02 years in males and 0.42 years in females with an overall discrepancy of 0.25 years. The dental age estimation was a near-perfect estimate of the chronological age.

Willems Method: In 2001 a new method was proposed by Willems which estimated the dental age by modifying Demirjian's method of dental age estimation.¹⁷ Mani SA et al. (2008), Willems method estimated the dental age more accurately than the Demirjian 7 teeth 1973 method in Malaysian population.¹⁸ Ramanan N et al. (2012), found Willems method was more reliable for dental age estimation in the Japanese population.¹⁹ Djukic K et al. (2014), found that the Willems method was more accurate in estimating the dental age than the Demirjian's 7 teeth 1973 method in the Serbian population.²⁰ Khoja A et al. (2014), stated Willems method was the most valid method for estimating the dental age in the Pakistani population when compared with Demirjian's 1973 method and Nolla's method.²¹

In the current study the Willems method of dental age estimation proved to be accurate in determining the age both in males and females. The results were consistent with other studies done by Mani SA et al., Ramanan N et al., Djukic K et al. and Khoja A et al. performed on different races of populations. In this study, the Willems method overestimated the age by 0.66 and 0.54 years in males and females respectively.

Study Limitation and Future Prospects: The current study has recorded that for those who had a missing third molar, the age estimation was more appropriate by using the Willems method, and for those who had eight teeth the Demirjian's 8 teeth 2004 method was suitable, however further studies can be designed to understand the accuracy of the above two methods in the clinical situation. Ozveren N et al. (2019), suggested that the Cameriere method more accurately estimated the age when compared to the Willems method in the Turkish population.²² Bala SB et al. (2016), also supported the idea that Cameriere's method was better when compared to Willem's method and Demirjian's 8 teeth 2004 method with Indian specific formula in the South Indian population.²³ Apart from the three age estimation methods adopted by this study other methods of age estimation like Nolla's method, Archarya's India-specific formula and Cameriere method can also be used in the same population, and their effectiveness in predicting the dental age can be evaluated.

Conclusion:

The current study is crucial for several Forensic situations as cited earlier and was conducted in the population of Tamil Nadu and Puducherry to evaluate the relevance and dependability of these three dental age estimation methods. As a general acceptance in Forensic Science, an error of up to 1 year is agreed as an error difference between the dental age and chronological age,¹⁰ however the present study resulted in establishing that the Demirjian's 8 teeth 2004 method was almost accurate in determining the dental age in males and females. The Willems method had a marginal discrepancy of 0.59 years in estimating the dental age against the chronological age. Finally, the result of Demirjian's 7 teeth method calculated the dental age with a wide range of different of 2.12 years which is almost double the acceptable error in Forensics. Thus, this study concludes by stating that the accuracy and reliability of dental age estimation and the interrelationship between the chronological age and dental age in Tamil Nadu and Puducherry population is best with Demirjian's 8 teeth method and Willems method, while Demirjian's 7 teeth method has failed to estimate the dental age in this population.

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ORIGINAL ARTICLE

Effect of Workshop on Student Knowledge of Ethical Issues in Publication

Vikram P,¹ Chandni G.²

Professor and Head,¹ Additional Professor.²

1. Department of Forensic Medicine, Kasturba Medical College, Manipal, Manipal Academy of Higher Education, Manipal.

2. Department of Anatomy, Kasturba Medical College, Manipal, Manipal Academy of Higher Education, Manipal.

Abstract:

The ethical issues involved in research or publications are not routinely taught in MBBS curriculum. This results in deficiencies in the knowledge. Present study was attempted to see whether a workshop on ethical issues related to publications increase awareness amongst MBBS students related to ethical issues in publications. Study was conducted on MBBS students who have presented research papers in any conference. Total of 20 students attended the workshop. Before conducting the workshop, the MBBS students were given a pre-test to test their knowledge in publication ethics. Later through the workshop they were sensitized regarding publication ethics. This was followed by the same post test. Pre and post test scores were compared using paired T test. Improvement in the post test scores were noted in all participants. Post test score were more than pre test scores for all questions ($P < 0.05$). There is a definite increase in awareness in ethical issues in publication after the conduct of workshop.

Keywords: Students; Knowledge; Publication; Curriculum; Ethics.

Introduction:

Behavior and attitudes which are gained by medical students throughout their whole formative training years lays the main foundation for their future practice in medicine. One of the essential behavior related to this is academic morality while doing medical research. The principal part of ethics in medical research is to safeguard the rights of participants and to maintain the integrity of the research study.¹

Publishing papers is the foremost process for sharing knowledge and promoting scientific progression. For publication it is needed that all people who are involved in it should remain honest and follow the guidelines and ethics of scientific integrity. Unfortunately, this does not happen always, there are many factors which can push authors in the direction of misconduct. These factors consist of: finance, the comfort of plagiarism, data fabrication and falsification and the concept of “publish or perish.”²

Various types of misconduct related to publication are: plagiarism, misappropriation, data fabrication and falsification, ghost author, authorship and conflict of interest. Plagiarism means using ideas and information from other person and not acknowledging him/her as a source. Misappropriation refers to stealing the ideas of others and using it as their own. Data fabrication means creating up data and report them. Data falsification means manipulating the research resources or changing or neglecting data as a result of which the research is not reported accurately. Ghost author means failure to put the name of

a person who has made significant contributions to the research or has written the manuscript. Authorship is another concern as some senior staff gets authorship because of their seniority and by influence. Some because of the concept of “publish or perish” gift the authorship which is called “gifted authorship”.³ Senior staff take advantage of junior staff and students who are not aware of authorship rights and guidelines.⁴ Some researcher gives authorship to head of departments as a matter of agreement or other senior authors just to rise the probability of getting the article accepted for publication.⁵ Doing a research is a very complex process and it cannot be done by one person alone. It's a group effort and when there is more than one individual involved in the process of research, the conflict of interest begins like who will be the first author? Who should get credit for what? What are the funding provisions and how should they be recognized?

There are studies which shows that 10% to 15% of all researchers are involved in certain type of misconduct at certain time in their professions.⁶ Presently undergraduate MBBS students undertake research more commonly. They present their papers in various conferences and also publish their research article in journals. This may be due to the motivation provided by their teachers.

Ethical issues involved in research or publications are not routinely taught in MBBS curriculum. This results in deficiencies in the knowledge related to ethics of publication. Training medical students regarding publication ethics is a requirement, and numerous efforts have been done to assign a place for it in undergraduate medical curriculum.⁷ Present study was attempted to see whether a sensitizing workshop on ethical issues related to publications increase awareness amongst MBBS students related to ethical issues in publications and to know the perception of students on the utility of sensitization workshop.

Materials and methods:

Study was quantitative interventional study done on 20 MBBS students of medical college. They were invited to attend a 1 day

Corresponding Author

Dr. Chandni Gupta

Email : chandnipalimar@gmail.com

Mobile No.: +91 9908339507

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Figure 1. Showing workshop being done on medical students who have attended the conference.

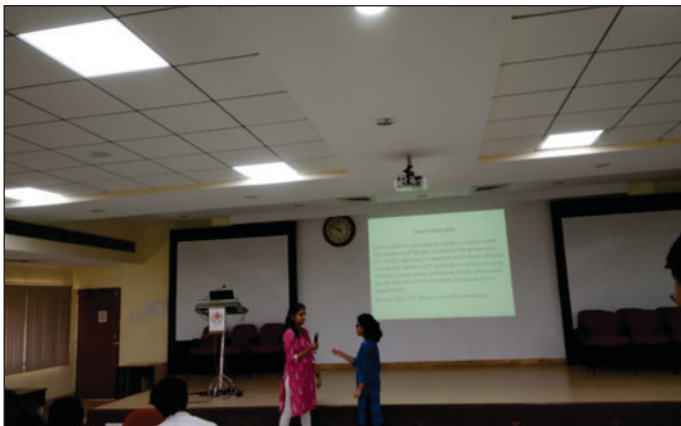


Figure 2. Role play being done by students to demonstrate a misconduct being done during publication.

workshop on publication ethics. Inclusion criteria: Students who have attended and presented paper in the conference. Exclusion criteria: Students who have not attended the conference.

Before conducting the workshop, the students were given a pre-test to test their knowledge in publication ethics. Later they were sensitized to the ethical issues in research publications by conducting a workshop on publication ethics which was the intervention Fig 1.

The workshop focused on various intricacies in publication ethics in the form of case scenarios and role play Fig.2.

This was followed by the same test which will determine whether the concepts related to publication ethics is understood by the students. Pre and post test scores were compared using paired T test. Later students were also asked about the utility of workshop using Likert's scale based question.

Results:

Comparison of pre and post test scores of students is shown in table 1. According to pre-test scores the students had some knowledge in the areas of data fabrication, falsification and plagiarism. However the knowledge related to 'Ghost author' was almost not there which was observed in the pre test scores done prior to the awareness workshop. Improvement in the post test scores were noted in all the 20 participants.

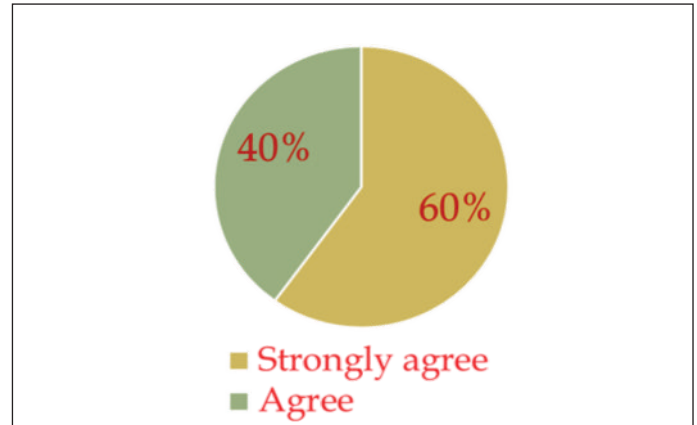


Figure 3. Showing the percentage of students who feel awareness in publication ethics has increased after the workshop.

Table 1. Comparison of pre and post test scores of students.

Sl No	Concept	Pre- test (n=20)	Post- test (n=20)	Mean± SD	P- value
1	Plagiarism	11 (55%)	20 (100%)	0.55±0.51	0.001
2	Misappropriation	7 (35%)	20 (100%)	0.35±0.48	0.000
3	Data fabrication	12 (60%)	20 (100%)	0.60±0.50	0.002
4	Data falsification	12 (60%)	20 (100%)	0.60±0.50	0.002
5	Ghost Author	1 (5%)	15 (75%)	0.05±0.22	0.000
6	Authorship (ICMJE)	5 (25%)	20 (100%)	0.25±0.44	0.000
7	Conflict of Interest	4 (20%)	20 (100%)	0.20±0.41	0.000

Percentage of students answering correctly the questions increased for all the questions when compared to pre-test questions (P<0.05). 100% students agreed that their awareness regarding ethics in publication increased after this workshop Fig 3.

Discussion:

Poor awareness of publication ethics may create problems where student faculty collaborate while doing publications. Hence it is important to train both sides. Unethical publication practices should be explained to all people who are involved in research activities, which should even include the college management authorities so that they can take appropriate action in circumstance of arguments.⁶

Jahanfar S et al. investigated and compared students' opinions concerning publication ethics in two medical universities. They found that students from Isfahan had more information in three areas: publication ethics, funding and authorship in comparison to students from the University of Kuala Lumpur. Finally he concluded that it is necessary for students to be trained on publication ethics to avoid academic dissatisfaction and conflict and he suggested that formal training should be added in their medical curricula.⁶

Lazaridou IZ et al. conducted a survey among undergraduate and postgraduate medical students. He gave them a questionnaire containing 9 questions out of which 5 were regarding students' views on current publication ethics. They found that students were having limited knowledge about redundant publications. Only 16% already had publication experience and only 18.5% had been taught about the relevant topics. He found that those who had been taught about relevant topics had a significantly

higher knowledge than those who had no relevant teaching. In his study he concluded that students had relatively good knowledge about publication ethics but incomplete awareness was noted in few areas. He also mentioned that education regarding publication ethics should be taught to medical students as part of their medical school curriculum.² In our study also we found that awareness regarding ethics in publication increased after the workshop.

Varghese J and Jacob M conducted a teaching session to medical students on matters associated to plagiarism. They also gave a test to evaluate their baseline knowledge regarding plagiarism and a survey to determine their attitudes towards it. Later they gave an interactive training session, in which they discussed several aspects of plagiarism. They found that the medical students' knowledge regarding plagiarism was limited. They also recommend that education regarding these aspects should be included in the medical curriculum, to tackle any type of academic misconduct.⁸ We found that awareness regarding ethics in publication increased after conducting the workshop in medical students and such sessions should be included in their medical curriculum.

Brkic S et al. conducted a 45 min lecture to young medical researchers on science ethics. He gave a questionnaire containing 13 question related to various types of plagiarism and self-plagiarism before and after the course. They found that there was progress in the understanding about plagiarism which ranged from 9.18- 42.86%. Finally he concluded that even a short lecture increased the students' awareness about many forms of plagiarism and training is the finest means in avoiding plagiarism.⁹ In our study also we found that awareness regarding ethics in publication increased after this workshop. Such type of training should be done regularly to prevent publication misconduct.

Marshall T et al. compared a group of students who attended an interactive session on plagiarism and a group of students who did not join the session. They found that the interactive seminar had a positive effect on students.¹⁰ In our study also there was an increase in awareness regarding ethics in publication among medical students increased after the workshop.

Conclusion:

There is a definite increase in awareness in ethical issues in publication after the conduct of sensitizing workshop. MBBS students should be taught about publication ethics in their routine curriculum.

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ORIGINAL ARTICLE

A Study on Relationship between Dermatoglyphics and Personality Traits

Priyanka R,¹ Kudtarkar AA,² Pradhan P.³

1. Department of Allied Health Sciences, Division of forensic sciences, Sri Ramachandra Institute of Higher Education and research Institute (Deemed to be university) Chennai.

2. Department of Forensic sciences, Jain Deemed to be university, Bangalore.

3. Department of Forensic Medicine and Toxicology, Sri Ramachandra Institute of Higher Education and research Institute (Deemed to be university) Chennai.

Abstract:

To draw correlation between the fingerprint pattern, ulna loop, and personality trait. Between the age of 18-24 years the fingerprint of ten digits were taken (plain and rolled print) and personality traits were examined. Frequency of fingerprint patterns are categorized. Ridge count were made for the frequently distributed pattern. The personality traits are classified from the score obtained by using a personality questionnaire. The relationship between personality traits and fingerprints are examined by using SPSS software. Ridge count of ulna loop pattern shows a significant ($P < 0.01$) relationship between left little finger (L5) of openness to experience and right middle finger (R3) of agreeableness in personality.

Keywords: Dermatoglyphics; Personality traits; Loop; Arch; Whorl; Ridge count.

Introduction:

Dermatoglyphics is the study of dermal ridge counts and figures on the fingers, palms, and soles.¹ Humans have always been intrigued by the skin carvings and ridges, which quite fascinatingly, follows some or other pattern. Skin ridges and carvings exclusively include fingerprints, palm prints, prints on the sole of foot. No one knows where these patterns have got their exquisite shapes. Speaking of fingerprints, around ten patterns have been identified and classified so far. The largest fingerprint database is created by Integrated Automated Fingerprint Identification System (IAFIS) available accounts for over a hundred million fingerprints. It is maintained by the Federal Bureau of Investigation (FBI). According to developmental biologists, prints are prenatal. Developed in mothers' womb during 13th to 18th week of pregnancy, they are largely influenced genetically.² The inheritance of dermal traits is considered to follow a classical polygenic model.³ Galton first determined three types of finger patterns, Whorl, Loop, Arch Henry later classified finger patterns into Whorl, Loop, Arch and Composites.⁴ Detailed examination of the friction ridge skin also reveals that ridge path, in most instances, is not continuous across the entire surface of a finger. Some ridges, called ending ridges, will flow and abruptly come to an end, while other ridges, called dividing ridges or bifurcations, will flow and separate into two separate and distinct ridges. Additionally, some ridges are as long as they are wide and are called dots.⁵ Personality theorists have given a great deal of attention to the relation between the real self and the ideal self with the implication that they are contrasting entities. The concept of an undesired self is introduced as a more

compelling contrast with the ideal self. Research on personality traits is core to many major disciplines, such as medicine, psychology and corporate management, whether for theoretical investigation or practical application.⁶ The big five factors are also increasingly being used in helping researchers understand the dimensions of psychological disorders such as anxiety and depression.⁷ Connection of fingerprints with brain. Fingerprints are closely related to genetics.⁸ To know one's self and others in a short period of time is not an easy task, and inducing the personality traits of others is an even more difficult undertaking. In the western world, studies on personality traits have a long and broad history.⁹ Personality which induces the person's behavior. Fingerprints has an uniqueness in each and every individual. The neural correlates to the various personality traits which has a profound relation with certain areas of human brain. Personality which helps a person to be counselled regarding their behavioral characteristics, inherent potentials and skills. When it comes to forensic science psychology plays a major role to determine what thoughts traits certain type of criminals belongs to. Fingerprint from the crime scene not only detect the individualism of a person it also reveals to which personality the person belongs. That helps the investigator to understand the personality trait from the fingerprint found during the scene of crime.

Materials and Methods:

Sampling in this study was conducted via the following steps: Research targets: The use of fingerprints involves personal privacy issues, and the agreement of the respondent with regard to using his/her fingerprints for research is difficult to obtain.

Thus, for the sake of convenience in collecting information, this study used non-probability proportional sampling methods. The main respondent targets were students their age ranged from 18-24 years in the continuing education division.

Questionnaire response process: Consents were taken from the authorities of the participating colleges while students were

Corresponding Author

Dr. R. Priyanka (Tutor)

Email : priyankatpt00@mail.com

Mobile No.: +91-9488969930, 8778234194

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briefed about the test and its importance. The personality questionnaires; the big five personality inventory¹⁰ (Table No.1) were administered. The process of filling out the questionnaires proceeded according to classes (as units) and was arranged according to students' class hours. After the fingerprints of the respondents had been collected into the fingerprint classification system, the questionnaires were filled out.

Scoring: A 5-point Likert scale was used for the personality trait questionnaire; 1–5 points were respectively assigned to the options of strongly disagree, disagree, neither agree, nor disagree, agree and strongly agree. To reverse score an item, change 1 to 5, 2 to 4, 4 to 2, and 5

Table 1. Big five inventory.

Personality Traits	Definition	Description
Openness to experience	A general appreciation for art, emotion, adventure, unusual ideas, imagination, curiosity, and variety of experience	Individuals who are highly open to experience tend to have distinctive and unconventional decorations in their home. They are also likely to have books on a wide variety of topics, a diverse music collection, and works of art on display
Conscientiousness	A tendency to show self-discipline, act dutifully, and aim for achievement	Individuals who are conscientious have a preference for planned rather than spontaneous behavior
Extraversion	The tendency to experience positive emotions and to seek out stimulation and the company of others	Extroverts enjoy being with people. In groups they like to talk, assert themselves, and draw attention to themselves.
Agreeableness	A tendency to be compassionate and cooperative rather than suspicious and antagonistic toward others; reflects individual differences in general concern for social harmony	Agreeable individuals value getting along with others. They are generally considerate, friendly, generous, helpful, and willing to compromise their interests with those of others.
Neuroticism	The tendency to experience negative emotions, such as anger, anxiety, or depression; sometimes called “emotional instability”	Those who score high in neuroticism are more likely to interpret ordinary situations as threatening and minor frustrations as hopelessly difficult. They may have trouble thinking clearly, making decisions, and coping effectively with stress.

Table 2. General average score in personality test.

Personality types	Percentage (%)
Openness to experience	40
Conscientiousness	10
Extraversion	5
Agreeableness	38.75
Neuroticism	6.25

Table 3. General distributions of fingerprints in fingers.

Fingerprints pattern	Total Number	Percentage (%)
Arch	36	4.5
Loop	542	67.75
27.75	27.75	27.75

Table 4. Distribution of patterns of fingerprint among personalities.

Patterns	Openness to experience	Conscientiousness	Extraversion	Agreeableness	Neuroticism
Loop	71.25	61.25	62.5	67.09	64
Whorl	25.62	33.75	30	29.03	22
Arch	3.12	5	7.5	3.87	14

Table 5. Distribution of patterns in both hands for openness to Experience personality

Patterns	R1	R2	R3	R4	R5	L1	L2	L3	L4	L5
Radial loop	0	9.375	6.25	0	0	3.125	21.87	0	0	0
Ulna loop	53.125	53.125	81.25	59.375	84.375	50	50	75	65.625	100
Whorl	46.87	37.5	6.25	40.62	6.25	37.5	25	21.875	34.375	0
Arch	0	0	6.25	6.25	9.375	9.375	3.125	3.125	0	0

Table 6. Distribution of patterns in both hands for agreeableness personality.

Patterns	R1	R2	R3	R4	R5	L1	L2	L3	L4	L5
Radial loop	0	9.67	0	0	0	3.22	12.90	0	0	0
Ulna loop	61.29	54.83	83.87	61.29	80.64	58.06	29.03	67.74	70.96	77.41
Whorl	38.70	29.03	16.12	38.70	19.35	58.70	58.70	25.80	29.03	16.12
Arch	0	6.45	0	0	0	0	19.35	6.45	0	6.45

Table 7. Descriptive Statistics for sample.

Personality	Finger	Mean	Std. Deviation	N
OE	L5	14.7500	1.50269	32
	Total	14.7500	1.50269	32
A	R3	10.2581	5.11187	31
	Total	10.2581	5.11187	31
Total	L5	14.7500	1.50269	32
	R3	10.2581	5.11187	31
	Total	12.5397	4.34714	63

Table 8. Standard Error for average ridge count.

Finger	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
L5	14.750	.661	13.427	16.073
R3	10.258	.672	8.914	11.602

Table 9. ANOVA Results for sample.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	317.715	1	317.715	22.696	.000
Within Groups	853.935	61	13.999		
Total	1171.651	62			

Procedure for taking plain and rolled fingerprints

- Initially, 39 inches from the floor are measured to make an individual to feel comfortable and then impression are taken.
- Individual hand is cleaned prior, in order to remove dirt or residue. when the fingers are moist alcohol / spirit is used to clean and when it is dry a lotion is used.
- Adequate amount of Printers black ink is taken and placed on the ink pad or plate.
- The printers Ink is evenly spreaded with roller to take a clear print.
- Rolled impressions were taken initially, by pressing an individual finger on the surface of the ink pad from nail to nail then rolling the fingers on the particular block in fingerprint sheet from uncomfortable position to the comfortable position.

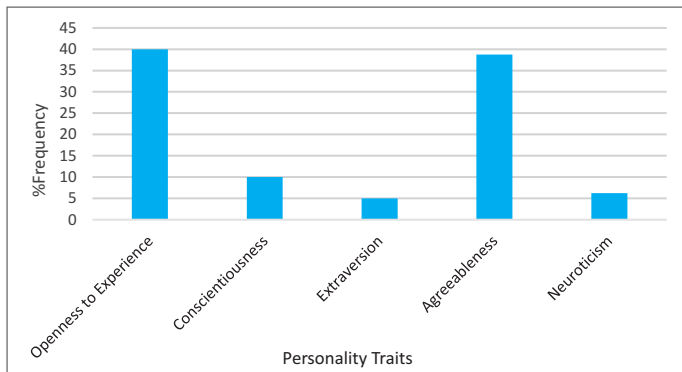


Figure 1. General average score in Personality Test.

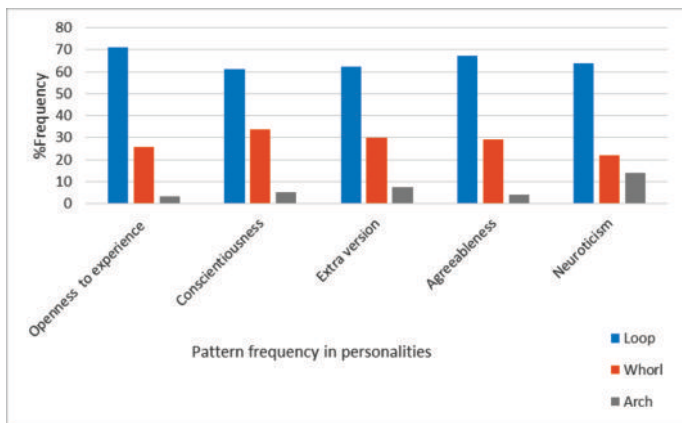


Figure 2. Fingerprint pattern frequency in different personality traits.

- Plain impressions for all the ten digits are taken by gently pressing the inked fingers against the fingerprint sheet.
- All the data and details should be entered properly in the card.

Procedure for ridge counting: An imaginary line is drawn between the point of core and delta, the ridges passing through the imaginary line, is counted and termed as ridge counting. Major rules of ridge counting;

- The ridges are counted between delta and core but the point of core and delta are not included in the count.
- The imaginary line from core to delta passes to the enclosure end/start it is considered as single ridge and when it passes through the center of enclosure it is considered as two ridges
- The bifurcation at the exact point of coincidence, two ridges are counted. When the imaginary passes through the center of the bifurcation a ridge count of 2 is considered.
- If a line touches the ridge dot a count of one ridge is made at the point.
- A wide space must intervene between delta and ridge count.

Experimental results:

Personality test: The general performance in the personality test revealed that openness to experience has the highest frequency in adolescents of (40%) followed by Agreeableness (38.75%), Conscientiousness (10%), Neuroticism (6.25%) and Extraversion (5%) (Table No: 2).

Fingerprint distribution and frequency of pattern: The

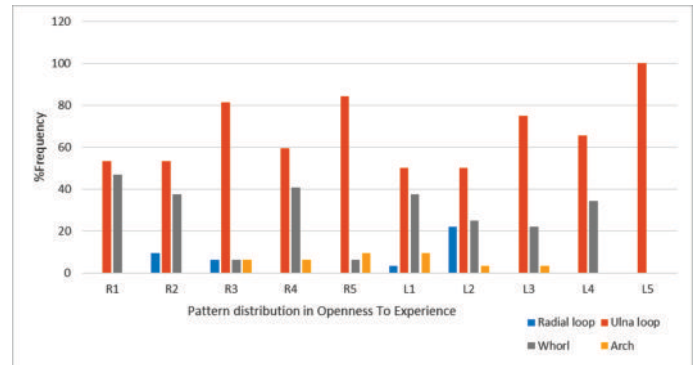


Figure 3. Fingerprint patterns of openness to experience personality.

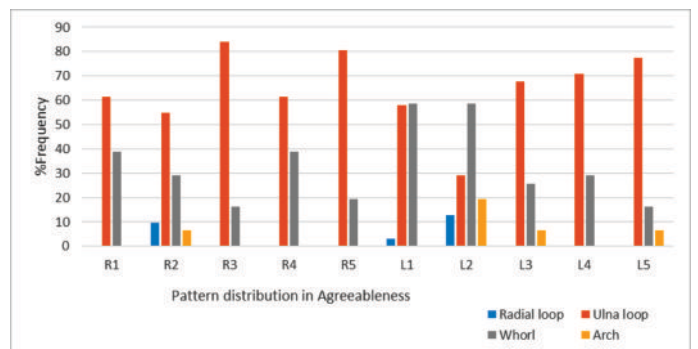


Figure 4. Fingerprint pattern of Agreeableness Personality.

distribution of fingerprint pattern among students differs from personality traits, analyses revealed that loop pattern is the most predominant pattern (67.75%), whorl showed moderate frequency of (27.75%), Arches were the least common appearing patterns (4.5%) in students who performed in each aspect of personality test (Table. 3). Frequency of loops was found to be higher in openness to experience (71.25%) followed by agreeableness (67.09%) when comparing to other personalities (Table No: 3 and 4). Fingers from both right and left hand of students those have high score in personality traits has taken to consideration to look for the frequency of pattern in fingers. Here, the little finger of left hand from openness to experience and the right second finger of agreeableness personality shows the frequency of ulna loop (Table No: 5 and 6).

Statistical analysis: The finger print pattern ridges were analyzed according to the suggestions recommended by (Cummins and Midlo 1961). SPSS 16 (SPSS INC. released 2007. SPSS (version 16.0) statistics for Windows, Chicago) was used for analyzing data. ANOVA Analysis was done for the data collected. The mean number of ridge counts for the L5 of students from openness to Experience personality trait was 14.750 ± 0.66 (SD = 1.50). and for R3 from agreeableness was 10.258 ± 0.67 (SD = 5.11). Analysis revealed that there is a significant mean difference 12.53 ± 1.58 (SD=4.34), $F(22.696) = .000, P < .001$ between the ulna loop ridge counts among two personalities (Table No: 5 & 6).

Abbreviations: R1- Right thumb finger, R2- Right index finger, R3- Right middle finger, R4 Right ring finger. R5 Right little finger. L1 – Left thumb finger, L2- Left index finger, Left middle Finger, L4 Left ring finger, L5 Left little finger. OE- Openness to Experience, A- Agreeableness.

Discussion:

Dermatoglyphics has been reported to have a remarkable relationship with mental related syndromes (Sardool, 2005; Rosa et al., 2001) and the cognitive science approach relates personality traits to brain function (hardware), virtual symbolic software (information-processing), and self-knowledge (intentions, motives, goals (Matthews, 2008) the study focused on association between dermatoglyphics and personality traits in adolescents. The result of this study shows that openness to experience has the highest frequency of (40%) followed by agreeableness (38.75%), conscientiousness (10%), neuroticism (6.25%) and Extraversion (5%). Analysis of the frequency of fingerprint patterns from this study showed that whorl and ulnar loop were the most occurring patterns followed by arch and radial loop. This is in consonance with the reports of Oladipo et al. (2009), Najafi (2009) and Nanakorn et al. (2011). There is the frequencies of ulna loop fingerprint patterns in left little finger (L5) and right middle finger (R3) From the highest frequency score of personality traits among student frequency of Ulnar loop on both the hands associated with the openness to experience and agreeableness as personality trait of individual. This agrees with the report of Adekoya et al. (2013) who reported a strong association with personality trait. Fingers ridge count in relation with personality trait has not been previously reported. From this study, the mean total ridge count for L5 and R3 of openness to experience and agreeableness were 14.750 and 10.258 respectively; however, there was a significant difference between mean total ridge count of the these two personality types. Ulna loop on little finger (L5) and right middle finger (R3) of specific ridge count in left and right hand can therefore indicate high openness to experience and agreeableness as personality.

Conclusion:

Dermatoglyphics has the connectivity with the neural function since inborn of an individual. Personality traits plays a vital role in categorizing people with highly developed personality that suits their innate potentials. From the in-depth review of past studies on personality, innovative behavior, creativity and their relationship; it can be concluded that most agreed and less controversial personality framework to measure the personality is "big five personality model" that contains five personality traits that are openness to experience, conscientiousness, extraversion, agreeableness and neuroticism.

This study revealed ulna loop on left little finger (L5) and right middle finger (R3) can therefore indicate that openness to experience and agreeableness as personality. The hierarchy of personality also correlated with the average total ridge count for L5 and R3 to look for the significance. It has therefore shown that dermatoglyphics has significant relationship with personality.

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ORIGINAL ARTICLE

Comparative Evaluation of Gunshot Residue Collection Techniques: A Preliminary Study

Parmar A,¹ Parvathy H,² Maity P,² Babu RG.¹

1. Ballistic Research Centre and Testing Range, National Forensic Sciences University, Gandhinagar.

2. School of Engineering and Technology, National Forensic Sciences University, Gandhinagar.

Abstract:

The collection and evaluation of GSR distributed in a firearm-related scene is crucial in the resolution of most crime cases involving firearm. The study was conducted in an indoor firing range (Ballistic Research Centre and Testing Range) with a controlled room temperature and humidity of 30°C and 56% respectively. Firing was performed using three different long range firearms; AK-47 rifle (7.62 × 39mm calibre), Self-Loading Rifle-SLR (7.62 × 51mm calibre) and Carbine rifle (9 × 19mm calibre). A total of 60 rounds comprising 20 shots each from AK-47, SLR and 9mm Carbine rifle were performed. Samples were further subjected to qualitative and quantitative examination using Energy Dispersive X-Ray Florescence (EDXRF-7000, Shimadzu) and Mass Spectroscopy. The results of the study analysis indicated that, the best collection technique that may enhance quantification of enough GSR deposit was in the order of; barrel was > hand swab > GSR at an angle of 90° > GSR at an angle of 45°. The simultaneous presence of Pb, Ba, and Sb which serves as a requirement to fix the identity of GSR is most likely to be sufficiently detected in GSR samples collected through barrel wash relative to hand swab of the shooter.

Keywords: Gunshot residue; EDXRF; 9mm Carbine; AK-47; Self loading Rifle (SLR); Mass spectroscopy.

Introduction:

The discharge of firearm results in the formation and distribution of particles or residues called gunshot residues (GSR) also termed cartridge discharge residue (CDR) or firearm discharge residue (FDR). Basically, the residues (GSR) comprise unburned and partially burnt propellant charge, and particles originating from several components of the firearm ammunition¹ used in the firing such as; the ammunition primer, the cartridge, the firearm, and other additives included in the propellant charge.² Upon the discharge of a firearm, the formed GSR escapes through the opening in the firearm. Most of the particles or residues escape through the muzzle end and settles on surfaces and artifact that are close to the firing scene. Primarily, the exited GSR settles on the hands, hair, and clothes of the shooter whilst other particles remain deposited in the bore of the barrel and on the firearm. Particles that remain suspended in air (air-borne GSR) will further settle on persons and objects close to the firing vicinity.³

The collection and evaluation of GSR distributed in a firearm-related scene are crucial in the resolution of most criminal cases involving firearms. The examination of GSR aids in the estimation of the range of fire, evaluation of an entrance and exit wound, and also helps to eliminate a suspected firearm or individual from a firearm-related scene of the crime.⁴ The proper evaluation of GSR however, is contingent on a number of factors including but not limited to, the method employed for GSR

collection, the place of residue collection and attendant influence on residue collection.⁶ The techniques utilized for GSR sample collection is well documented.^{5,6} The ultimate purpose is to adopt the most appropriate collection technique that will enhance maximum collection efficiency and to eliminate the risk of sample contamination.^{7,8}

The detection of these entire molecular ion peaks through mass spectroscopy,⁹ characteristics of gunpowder compositions and marker could be considered as confirmed evidence for organic gunshot residue indicators as reported by other groups also.^{10,11}

Existing literature on the collection of GSR has been centered to either one or two collection methods, hence the efficiency and reliability of one collection technique over the other remains less explored. In the present paper, GSR from the hand of the shooter (hand swab), the bore of the barrel (barrel wash), and those distributed one meter (1m) away at an angle of 45° and 90° from the muzzle end of the firearm were collected and examined to ascertain which source and collection method is most reliable and efficient.

Materials and Method:

Experimental procedure: The study was conducted in an indoor firing range (Ballistic Research Centre and Testing Range) with a controlled room temperature and humidity of 30°C and 56% respectively. Firing was performed using three different firearms; AK-47 rifle (7.62 × 39mm calibre), Self-loading rifle-SLR (7.62×51mm calibre) and Carbine rifle (9 × 19mm calibre). The study subjects were GSR obtained from the shooters hand (by means of hand swab), bore of the barrel (by means barrel wash) and residues dispersed at 1m away at angle of 45° and 90° from the muzzle end.

Sample Collection: A total of 60 rounds comprising 20 shots each from AK-47, SLR and 9mm Carbine rifle were performed.

Corresponding Author

Abhijit A Parmar (Scientific Assistant)

Email : abhiparmar57@gmail.com

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Table 1. Summary of sample collection.

Description	Firearm		
	AK-47 Reference Velocity 700 ± 15m/s	SLR Reference Velocity 830 ± 15m/s	9mm Carbine Reference Velocity 430 ± 15m/s
Total number of shot	20	20	20
Duration of sample collection	After every single shot	After every single shot	After every single shot
Total number of samples	20	5	5

Table 2. Elemental Distribution of inorganic residue (EDXRF Data).

Collection method	Elemental Distribution (mean %)		
	Lead (Pb)	Antimony (Sb)	Barium (Ba)
9mm Carbine (9 × 19mm)			
Hand swab	0.037	0	0
Barrel wash	3.666	1.233	0
At 45°	0.017	0	0
At 90°	0.016	0	0
AK-47 (7.62 × 39mm)			
Hand swab	0.045	0	0
Barrel wash	9.588	1.255	4.747
At 45°	0	0	0
At 90°	0.021	0.191	0
SLR (7.62 × 51mm)			
Hand swab	0.072	0	0
Barrel wash	24.090	4.748	8.326
At 45°	0.115	0	0
At 90°	0.025	0	0.485

Summary of sample collection is explained in Table 1. Hand swab of the shooter was obtained using a biological cotton swab (with acetone) whilst GSR deposited in the bore of the barrel was obtained using Flannel gun clean cotton cloth (procedure known as barrel wash). Further, two (2) A4 sized blank sheet were placed 1m away from the muzzle end and at an angle of 45° and 90° to collect dispersed air-borne GSR.

Energy dispersive X-ray fluorescence (EDXRF) analysis: Samples were further subjected to qualitative and quantitative examination using energy dispersive X-ray fluorescence (EDXRF-7000, Shimadzu). For the purpose of the present study, three main inorganic elements (Lead, Barium and Antimony) were measured and reported. These elements were considered because; they serve as the main primer constituent in the lead-based ammunition which was used for the study.

Mass spectrometric analysis: To determine the presence of individual components of marker and gunpowder in the OGSR, mass spectral analysis of fresh gunpowder and swab OGSR particles collected from the four different sites was performed. OGSR particles were dissolved in acetonitrile and the filtrated clear solutions were injected into the mass spectrometer. Using positive ion electron spray ionisation mass spectrometry, the parent peaks of several gunpowder and marker components were observed. Electro spray ionization (ESI) mass spectra were measured using AB Sciex mass spectrometer (Model QTRAP 4500) under positive ion mode with de-clustering potential of 50-130 V, cell exit potential of 10 V and capillary voltage of 5500 eV (10).

Results and discussion:

Qualitative and quantitative result: Lead containing ammunition was utilised for the present study, hence the simultaneous

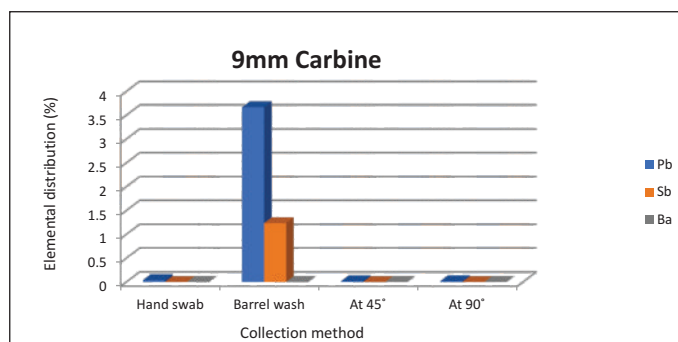


Figure 1. GSR quantification from 9mm carbine.

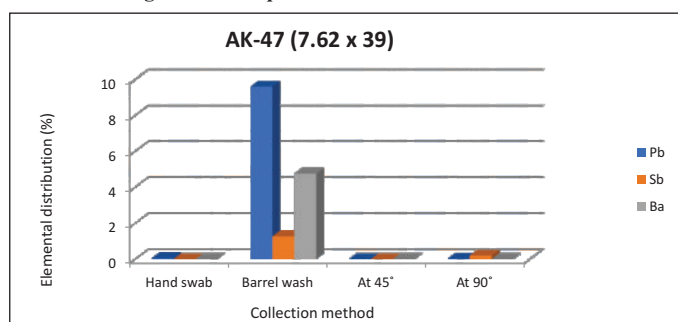


Figure 2. GSR quantification from AK-47 rifle.

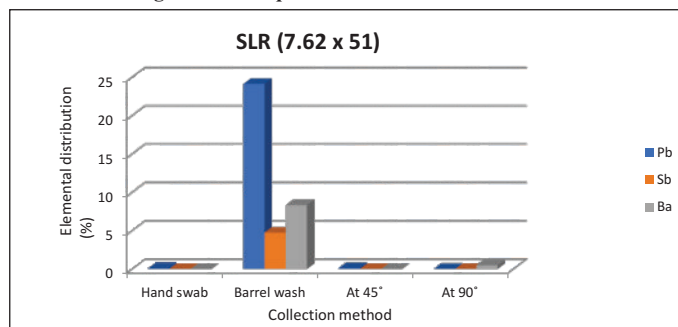


Figure 3. GSR quantification from Self-loading rifle.

presence of Pb, Ba and Sb were considered to fix the identity of GSR. The mean distribution (%) of the inorganic metal element (Pb, Ba and Sb) present in GSR was considered to ascertain whether there would be one collection technique that was sufficient for GSR deposit quantification. The results (Table 2, Figure 1, 2 and 3) of the study analysis indicated that, the best collection technique that may enhance quantification of enough GSR deposit was in the order of; barrel wash > hand swab > GSR at an angle of 90° > GSR at an angle of 45°. Both Pb (3.666%) and Sb (1.233%) were detected in GSR collected through barrel wash for 9mm carbine rifle. Only Pb was present from the remaining collection technique, hand swab (0.037%), GSR from 45° (0.017%) and GSR from 90° (0.016%).

Further, analysis of GSR sample from AK-47 rifle revealed the presence of Pb (9.588%), Sb (1.255%) and Ba (4.747%) from barrel wash collection technique. The qualitative result was same for self-loading rifle. The quantity of Pb (24.090%), Sb (4.748%) and Ba (8.326%) obtained by barrel wash from self-loading rifle was higher relative to GSR samples from Ak-47 rifle. The quantitative variation may be attributed to the differences in the cartridge case length. Approximately, the length of an AK-47

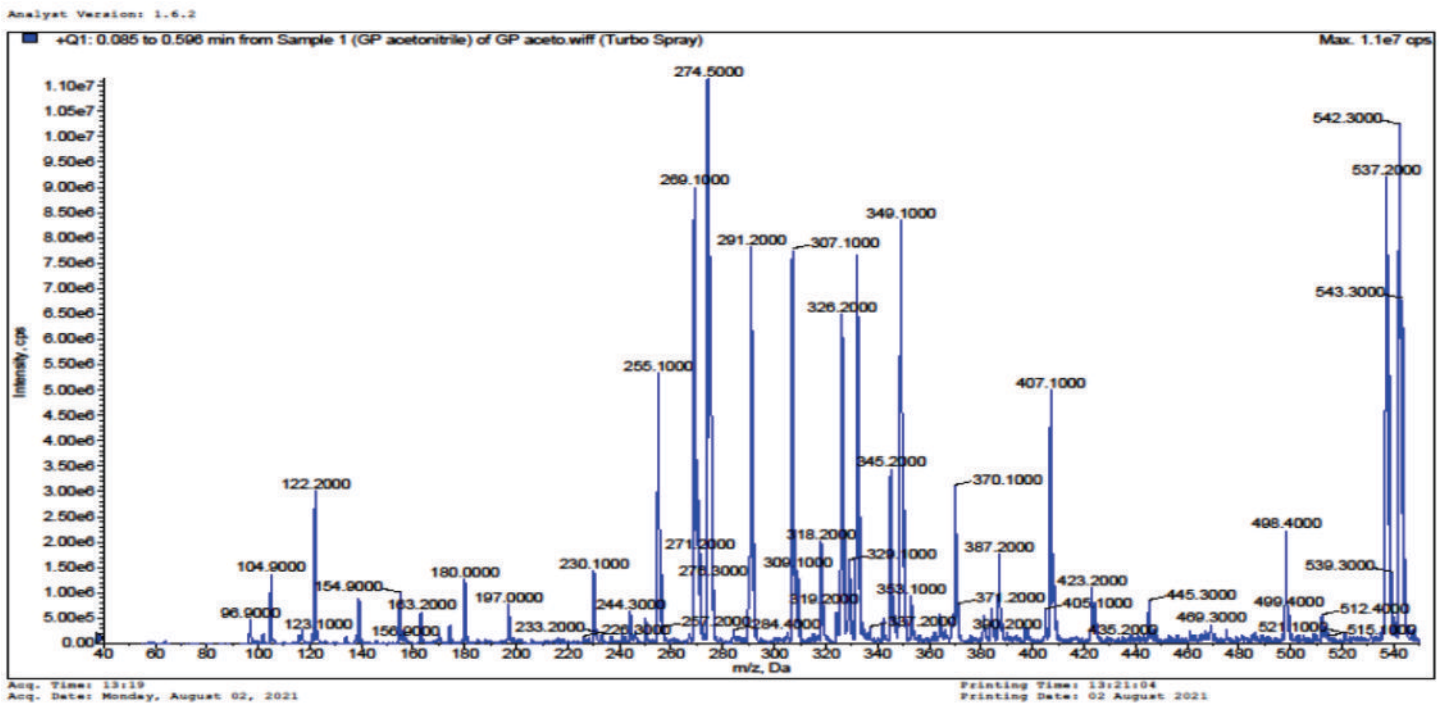


Figure 4: Positive ion ESI Mass spectra of GSR particles of gunpowder.

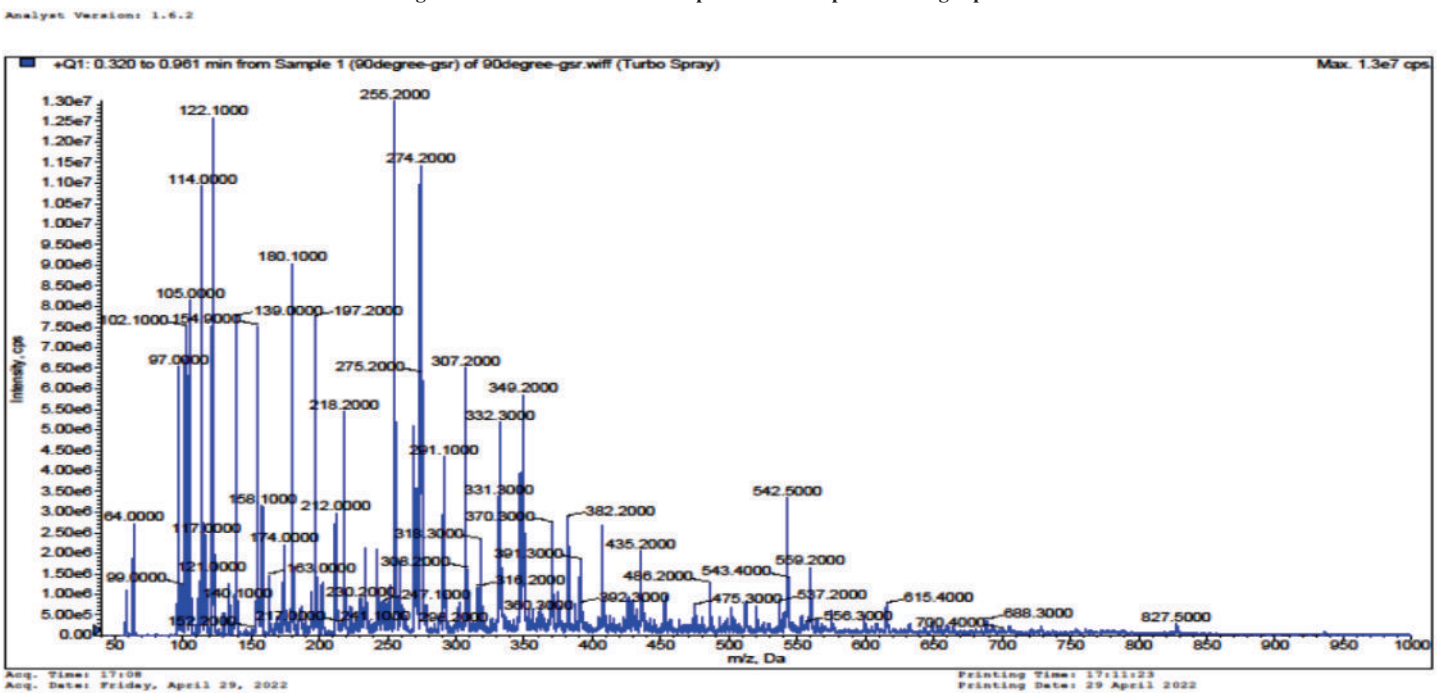


Figure 5: Positive ion ESI Mass spectra of GSR particles sample collected from 90°.

cartridge case (39mm) is 12mm less than the SLR counterpart (51mm). Regardless of the ammunition type utilised, barrel was as a collection technique has proven to be robust and superior over the conventional hand swab technique as well as the newly introduced method (GSR collected at 45° and 90°). The findings albeit preliminary, will guide the decisions of GSR examiners on the best method to adopt for GSR collection. GSR samples obtained from barrel wash are less likely to be contaminated compared to hand swab from the shooter, hence the need to obtain GSR if possible, from both the barrel and hands of the shooter.

Results from the dual collection technique will provide sufficient evidence to fix the identity of GSR and to help resolve firearm-related crime cases. The mass spectral analysis of fresh gunpowder conclusively confirms the presence of nitroguanidine (Flash Suppressor, 104.9), nitrobenzene (Explosive, 123), methyl phthalate (Plasticizer, 180), 2-amino-4, 6-dinitrotoluene (Flash Suppressor, 197), ethyl centralite (Stabilizer, Plasticizer, 268.5), dimethylphthalate (Plasticizer, 306.4) among other peaks (Figure 4 to 7).

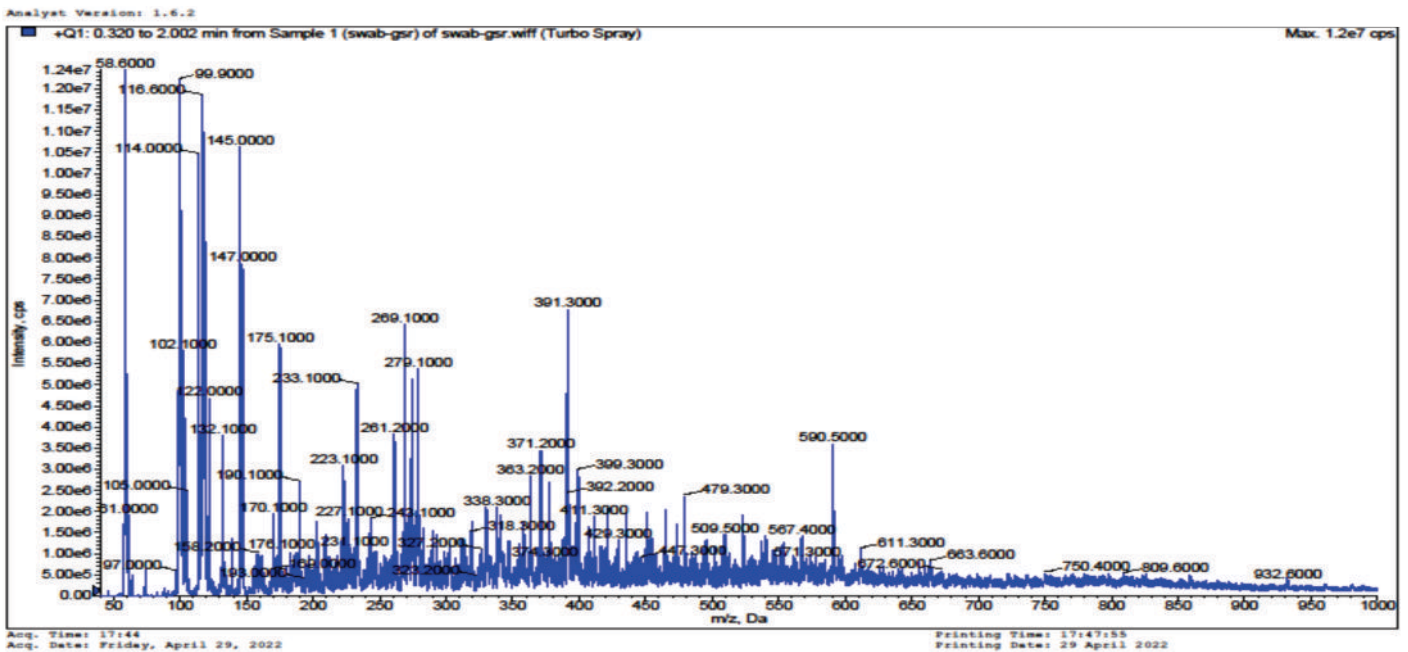


Figure 6: Positive ion ESI Mass spectra of GSR particles sample collected from swab.

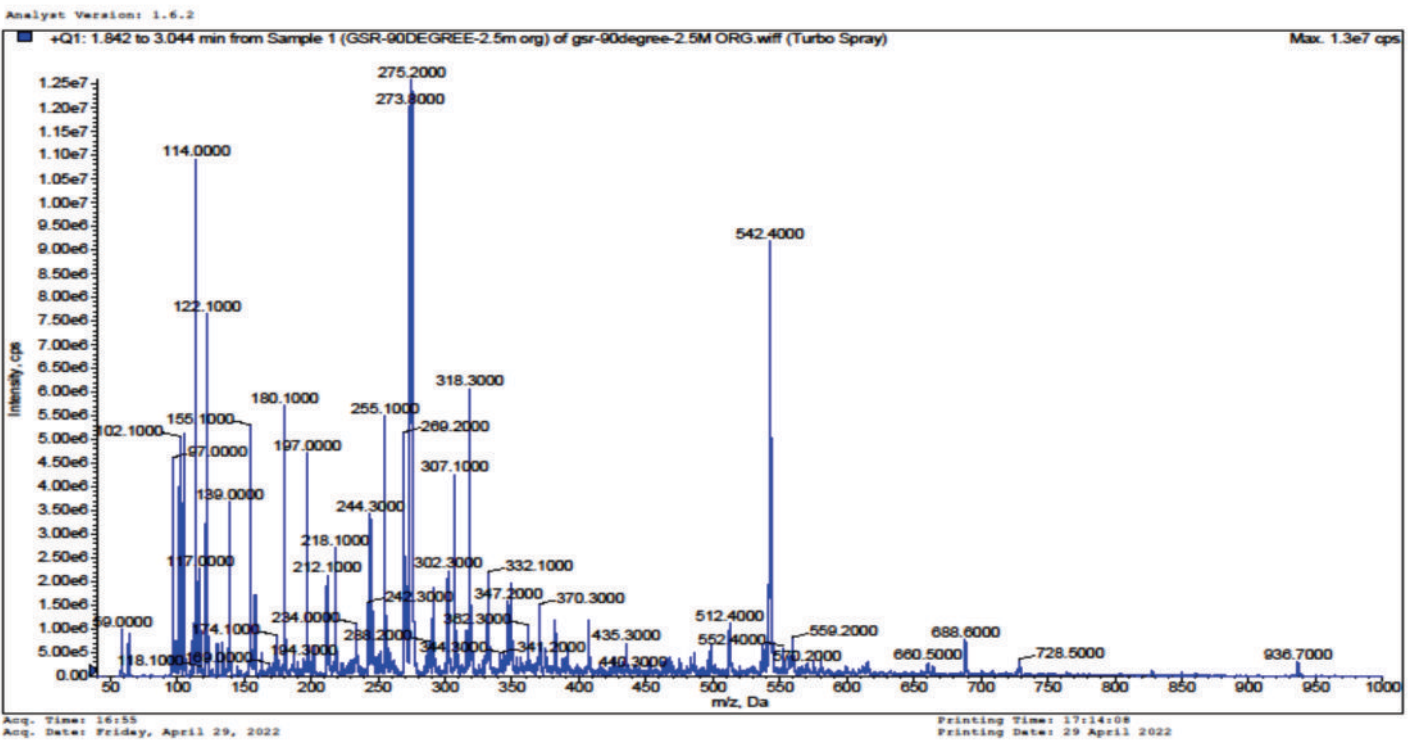


Figure7: Positive ion ESI Mass spectra of GSR particles from 45°.

Conclusion:

The simultaneous presence of Pb, Ba, and Sb which serves as a requirement to fix the identity of GSR is most likely to be sufficiently detected in GSR samples collected through barrel wash relative to hand swab of the shooter. GSR examiners must thus make it a routine practice where necessary to simultaneously obtain GSR samples from both barrel wash and hand swab to efficiently quantify GSR for the purposes of crime resolution. Analysis of organic residues by mass spectrometry provides

additional support for this study. This study shows that to identify the simultaneous presence of Pb, Ba, and Sb which serves as a requirement to fix the identity of GSR is most likely to be sufficiently detected in GSR samples collected through barrel wash relative to hand swab of the shooter. GSR examiners must thus make it a routine practice where necessary to simultaneously obtain GSR samples from both barrel wash and hand swab to efficiently quantify GSR for the purposes of crime resolution. Analysis of organic residues by mass spectrometry provides the

sure sign of firing we can also analyze gunshot residue from intermediate target. To identify shooter in to detect wound pattern from bullet point view can use gunshot residue as prime evidence in wound ballistics.

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Availability of data and material: It shall be available from the corresponding author on reasonable request.

Ethical Clearance: Not Required.

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ORIGINAL ARTICLE

Estimation of Stature from Odontometry and Skull Anthropometry – A Prospective Clinical Study

Lomi M,¹ Boopathi D,² Daniel J.³

Postgraduate Scholar,¹ Senior Lecturer,² Professor.³

1. Mahatma Gandhi Postgraduate Institute of Dental Sciences and Hospital.

2. Department of Oral Medicine and Radiology, Indira Gandhi Institute of Dental Sciences, Sri Balaji Vidyapeeth.

3. Department of Oral Medicine and Radiology, Mahatma Gandhi Postgraduate Institute of Dental Sciences and Hospital.

Abstract:

Stature estimation is one of the important and accurate methods used for person identification. It is the height of a person in the upright posture is shown to have a definite and proportional relationship with many parts of the human body such as the cranial and facial bones, long bones, trunk, and foot bones. Teeth are extremely durable even at high temperatures and may be identified even when the rest of the body has undergone decomposition. This study was done to validate the use of odontometric and skull measurements for stature estimation. To evaluate and correlate stature with odontometric parameters such as maxillary Intercanine width (ICW) and Interpremolar width (IPW) and skull anthropometric parameters such as diameter of the head (HD) and circumference of the head (HC) and to obtain a regression equation of each correlating parameters separately and in combination with other parameters. In this present study, the stature was correlated with several odontometric and skull dimensions. Of which, head diameter and head circumference had highly statistically significant value of 0.001 and 0.000 respectively. On combining odontometric values along with the skull dimensions, we found that p value of ICW+HC, ICW+HC+HD, IPW+HD+HC and ICW+IPW+HD+HC was 0.04, 0.008, 0.007, and 0.002 respectively. This study results have shown that odontometric measurements when combined with head circumference and diameter can give more accurate estimate of stature and help in person identification.

Keywords: Stature estimation; Odontometric parameters; Forensic dentistry; skull measurements; Person identification.

Introduction:

Identification of human becomes difficult when the body is heavily mutilated or destroyed due to accidents, natural calamities (such as mass disaster, massive burn, and airplane crash) or during war. It is also difficult when dead bodies are heavily decomposed and mutilated with fragmentary remains. Anthropometry deals with expressing human form in numbers and has been widely used in forensic identification.¹ Stature is considered to be one of the “big four” (identifying age, sex, stature and ancestry or race) of Forensic anthropology. It is the height of a person in the upright posture and is shown to have a definite and proportional relationship with many parts of the human body such as the cranial and facial bones, long bones, trunk, and foot bones. Teeth are extremely durable even at high temperatures and may be identified even when the rest of the body has undergone decomposition.² Thus, the odontometric parameters hold reliability and are an invaluable tool in forensic science.³ With this background a study was done to further validate estimation of stature from odontometry and anthropometry.

Aim and Objective: 1. To evaluate and correlate stature with odontometric parameters (maxillary Intercanine width and

Interpremolar width) and skull anthropometric parameters (diameter of the head and circumference of the head).

2. To obtain a regression equation of each correlating parameters separately and in combination with other parameters.

Materials and methods:

This cross-sectional study included 40 subjects with equal number of male and female of age ranging from 18-30 years from the out patient department of our Institution.

Inclusion criteria: 1. Subjects with healthy periodontium, non-carious, non-restored, intact satisfactorily aligned maxillary teeth. 2. Subjects with full set of completely erupted maxillary and mandibular teeth at least up to 2nd molar.

Exclusion criteria: 1. Subjects with history of orthodontic treatment, maxillofacial surgery or trauma, trauma or surgery to the skull, oral destructive habit.

2. Subjects with history or clinical features suggestive of endocrinal disorders, metabolic disorders, developmental disorders, or history of prolonged illness. After taking informed and written consent from the participants, impression of maxillary arch was made using alginate (irreversible hydrocolloid material) and cast was poured with dental stone (type 3) using the same water powder ratio everytime.

Cleaned and dried casts were then used to measure the Intercanine width and Interpremolar width using manual divider with very fine tips, which was then coincided with units on a calibrated steel scale to obtain values (fig:1,2).

Corresponding Author

Dr. Durgadevi Boopathi

Email : theoralphysician4895@gmail.com

Mobile No.: +91 8838418036

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Table 1: Descriptive statistics of the study variables.

Variable	N	Minimum	Maximum	Mean	Std. Error	SD
Age	40	18	30	23.45	.463	2.926
ICW	40	29	39	33.98	.355	2.247
IPW	40	38	48	42.08	.364	2.303
Head Diameter	40	290	370	331.00	2.746	17.365
Head Circumference	40	490	580	530.88	3.480	22.011
Height	40	1480	1810	1628.35	11.885	75.166

Table 2: Pearson correlation coefficient for study variables against height.

Parameter	Correlation coefficient (r)	P value
ICW	0.213	0.188
IPW	0.207	0.201
HD	0.508	0.001*
HC	0.690	0.000
ICW+IPW	0.212	0.121
ICW+HD	0.342	0.061
ICW+HC	0.542	0.04*
IPW+HD	0.435	0.052
IPW+HC	0.489	0.06
ICW+IPW+HD	0.385	0.064
ICW+IPW+HC	0.472	0.088
ICW+HD+HC	0.489	0.008*
IPW+HD+HC	0.492	0.007*
ICW+IPW+HD+HC	0.580	0.002*

Inter canine width (IC width): The horizontal distance between the cusp tips of maxillary right canine to the cusp tip of left canine² (fig:1).

Interpremolar width (IP width): The horizontal distance between the buccal cusp tips of maxillary first premolar from right side to left side.²

Head circumference (maximal fronto-occipital circumference): It was measured by placing non stretchable calibrated tape on the occipital prominence and the supraorbital ridges while viewing the subject laterally also to ensure proper placement of the tape. In cases of some hairstyles in males, we drew the tape tightly and compressed the hair as much as possible while in females, we asked the participants to lift their hair in the occipital area and the tape was placed against the skin and not over the lumps of hair (Evereklioglu et al.)³ (Fig:3).

Head diameter (anteroposterior diameter of the head): Supraorbital ridges were palpated and the midpoint was marked. Similarly, the deepest point on the external occipital protuberance was marked and the distance between the two was measured using a non stretchable measuring tape.³

Height (stature): It was measured as the vertical distance from the vertex to the floor. Measurement was taken using anthropometer by making the participant stand erect on a horizontal plane barefooted. Anthropometer was placed in straight vertical position behind the subject with the head oriented with ala tragus line parallel to floor and shoulder blocks and buttocks touching the vertical limb of the instrument. The movable rod of the anthropometer was brought in contact with the vertex midsagittal plane² (fig:4).

All the measurements were done by a single examiner to eliminate interobserver error. A linear regression equation was derived as $y = mx + c$, Where y = height m = regression

Table 3. Value of constant (c) and regression coefficient (m) for each parameter and regression formulae.

Parameter	Constant (c)	Regression coefficient (m)	t	P	Equation
ICW	1386.812	7.109	1.341	0.188	$Y=7.109(X)+1386.812$
IPW	1344.706	6.741	1.301	0.201	$Y=6.74(X)+1344.7$
HD	900.03	2.2	13.63	0.001	$Y=2.2(X)+900.03$
HC	378.23	2.35	34.448	0.000	$Y=2.35(X)+378.23$
ICW+IPW	1324.01	4.442 3.646	1.00	0.377	$Y=[4.44(X1) + 3.646(X2)] + 1324.01$
ICW+IPW+HD	841.346	7.870 -5.881 2.317	4.782	0.007	$Y= [7.870 (X1)-5.881 (X2) + 2.317(X3)] + 841.34$
ICW+IPW+HD+HC	349.184	4.877 -4.698 .669 2.052	8.553	0.000	$Y= [4.877 (X1) - 4.69 (X2) + 0.669 (X3) + 2.052(X4)] + 349.184$
ICW+HD	800.59	3.899 2.101	6.89	0.003	$Y= [3.899 (X1) + 2.101 (X2)] + 800.59$
ICW+HC	337.93	1.87 2.31	16.73	0.000	$Y= [1.87 (X1) + 2.31 (X2)] + 337.93$
IPW+HD	901.112	-0.45 2.203	6.446	0.004	$Y= [-0.45 (X1) + 2.203 (X2)] + 901.112$
IPW+HC	381.527	-0.131 2.358	16.772	0.000	$Y= [-0.131 (X1) + 2.358(X2)] + 381.52$
ICW+IPW+HC	366.172	3.805 -2.765 2.353	11.15	0.000	$Y= [3.80 (X1) - 2.765 (X2) + 2.353(X3)] + 366.172$
ICW+HD+HC	311.62	1.683 0.479 2.074	11.33	0.000	$Y= [1.68 (X1) + 0.479 (X2) + 2.074(X3)] + 311.62$
IPW+HD+HC	371.09	-1.11 0.551 2.113	11.26	0.000	$Y= [-1.11 (X1) + 0.551 (X2) + 2.113(X3)] + 371.09$

coefficient x = measurement of parameter c = constant.

Results:

Table 1: Shows minimum and maximum values with mean and standard deviation of age, each odontometric parameters, skull anthropometric parameters, height (in mm).

Table 2: Shows the correlation coefficient between height and study variables/ parameters. The correlation coefficient for HD, HC, ICW+HC, ICW+HD+HC, IPW+HD+HC and ICW+IPW+HD+HC are 0.508, 0.690, 0.542, 0.489, 0.492, 0.580 respectively with p values of each < 0.05 suggestive of statistically significant. P-values of other parameters greater than 0.05 suggestive of being non significant.

Table 3: Shows value of constant (c) and regression coefficient (m) for each parameters and regression formulae. The formulae derived for all parameters/variables are given in the table. All other parameters/variables except ICW, IPW and ICW+IPW were statistically significant.

Discussion:

Identification of humans by using stature has been more easy and precise since then the missing persons of only that stature need to be considered.⁴ But due to the patterns in mutilation of body, it may not be directly measured and correlated. The dimensions of tooth and skull are also genetically determined as other bones of the body. They are unique for each race and geographical area since they are based on environmental variations as well.⁵



Figure 1. Measuring intercanine width in study model.

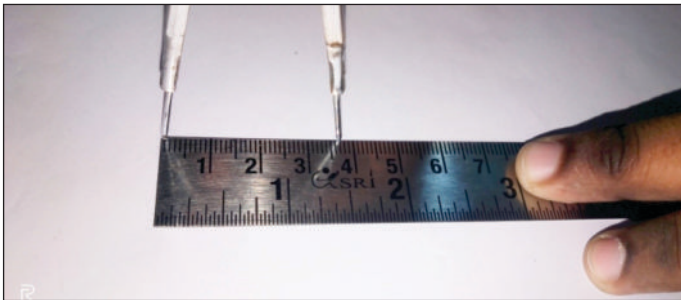


Figure 2. Measuring interpremolar width using calibrated scale.



Figure 3. Measuring head circumference using tape.



Figure 4. Measuring the height (stature) of the subject.

Odontometric dimensions are not affected by mutilation, fire etc.,. Previously the stature was estimated using other parameters such as metacarpals and foot measurements. But since the deterioration status of teeth is much less, the trend has been shifted to odontometric measurements.

In this present study, the stature was correlated with several odontometric and skull dimensions. Of which, head diameter and head circumference had highly statistical significant value of 0.001 and 0.000 respectively. This is in accordance with the previous study by Harsha Bhayya et al. (2018)⁶ where the head diameter and head circumference was correlated to height on skulls, found similar highly significant values. Our study was done on living subjects, thus increasing the adaptability and reliability of the parameters. Another study used cephalometric radiographs and study casts for head circumference and odontometric measurements amongst ample sample size and found head circumference had strongest correlation in estimating stature.⁷

On combining odontometric values along with the skull dimensions, we found that p value of ICW+HC, ICW+HC+HD, IPW+HD+HC and ICW+IPW+HD+HC was 0.04, 0.008, 0.007, and 0.002 respectively. Almost around fifteen combinations of

parameters were done and the regression formula was derived for all parameters and tabulated in Table 3.

In a study done by Bharath Rao et al.,⁸ wherein odontometric parameters were used for stature estimation amongst 120 living subjects of three Asian ethnicities - Malay, Indian and Chinese. The odontometric parameters assessed was intercanine and interpremolar width, arc length and mesiodistal dimension of the six anterior teeth. They found that only arc length was significantly associated with height. Our study has contradicted this and showed that when combined with skull dimensions, odontometric parameter can be of higher significance and can give more accurate estimate of height.

The unique strength of this study is that we have included all combinations of skull dimensions (head circumference and head diameter) and odontometric parameters of intercanine width ICW, interpremolar width IPW, and we found that all combinations were statistically significant but highly significant values of 0.000 was achieved with these following combined measurements - ICW+HC, IPW+HC, ICW+IPW+HC, ICW+HD+HC, IPW+HD+HC.

Stature estimation has been studied from other dimensions also, rarely, such as the study done by Fatemeh Navaei et al. (2018),⁹ amongst 200 Iranian young adults of age range 20-25 and found that total facial height had strongest correlation with stature among males and facial breadth and upper facial height too can be used for formulating stature. The only limitation in these studies were that, any change in facial measurements due to tissue injury, bone injury can lead to altered results. This was surpassed in our study since it focused on odontometric and skull dimensions, which is more stable and unaffected by minor injuries.

There are studies which estimated stature from arch length. More recently, Teja et al. calculated the stature estimation from hand length and middle phalange length measurement and Carrea's index in mandibular arch from the study casts. P values of 0.002 and 0.001 were found for right and left side mandibular region respectively. This study was done amongst 150 samples of mixed north Indian population. Pearson's correlation was found to be strong but stated that the index can be used as an auxiliary tool.¹⁰

This was previously supported by Sruthi R et al.¹¹ where same Carrea's index was compared to the real stature and found a strong correlation, valid on male samples in a mixed population of south India. These two studies of Indian population add to an impression that Carrea's index as a prediction tool may not give accurate estimations. This is important because even though the mandibular arch and teeth are taken for forensic estimations, for stature it may not give adequate results.

Most recent work from Soorya and Yuvaraj et al. (2021)¹² amongst 30 female subjects, found that maxillary intercanine distance correlation coefficient to be - 0.056, hence having no correlation and for mandibular intercanine distance, the correlation coefficient was found to be 0.415, hence having moderate correlation. They concluded that the maxillary intercanine distance does not have any correlation with stature but the mandibular intercanine distance showed moderate correlation to the stature of the female subjects examined. This

was in concordance with our study, which showed a p value of 0.188 for maxillary intercanine width alone.

There have been few studies done previously using odontometric measurements for stature estimation.¹³⁻¹⁵ But our study holds strong validation in selection of parameters and dental arch. More combinations and additions of parameters were done in order to increase the accuracy of stature estimation and to achieve strong correlation and statistically significant results.

The limitation of this study is that the sample size was less. Even though the reduction of sample size has been compensated by multiple permutations and combinations of parameters, the need for the study to be run on mass samples cannot be ignored.

Conclusion:

The odontometric measurements and skull dimensions are two most static and reliable parameters that help in stature estimation. Natural calamities, assaults, mass road traffic accidents may destroy the body to a greater extent. Stature estimation is an important aspect of person identification. Whereas other parameters can be unreliable due to high chance of deterioration, odontometric measurements when combined with head circumference and diameter can give more accurate estimate of stature and help in person identification.

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ORIGINAL ARTICLE

The Morphological Differences between Acute Tubular Necrosis and Autolysis: An Autopsy Study

Castelino KP,¹ Devaraju S,² Bhat A,³ Thattil AMT.⁴

1. Department of Forensic Medicine and Toxicology, Father Muller Medical College, Mangalore.

2. Department of Pathophysiology, College of Medicine - American University of Antigua, Osbourn, Antigua & Barbuda.

3. Department of Pathology, Father Muller Medical College, Mangalore.

4. Department of Community Medicine, Father Muller Medical College, Mangalore.

Abstract:

The post-mortem identification of acute tubular necrosis (ATN) and autolysis poses a considerable challenge due to overlapping pathological features. This study was therefore conducted with the objective of identifying morphological characteristics that will assist in differentiating between ATN and autolysis in post-mortem renal specimens. This analytical study included all samples received by the department of Pathology from individuals who were clinically diagnosed as ATN and satisfying defined biochemical parameters. Age and sex matched control specimens were chosen from healthy individuals who suffered an accidental or sudden death and who satisfied defined exclusion criteria. A total of 82 samples were included. There were samples from 25 males and 16 females in each group. The mean age of the cases was 42.12 ± 18.27 years while the mean age of the control group was 49.65 ± 16.64 years. The gross weight of the kidneys was not found to be significantly different between the two groups. Three morphological characteristics were found to significantly vary between the cases and controls: cell vacuolation ($P=0.029$), hematopoietic cells in the vasa recta ($P=0.003$) and tubular epithelial whorls ($P=0.0002$). Of these, tubular epithelial whorls were found to have the highest validity (sensitivity=0.88, specificity=0.92). Tubular epithelial whorls can be used independently or in conjunction with other morphological criteria in order to accurately identify ATN in post-mortem renal tissue.

Keywords: Acute tubular necrosis; Autolysis; Autopsy; Histology; Ischemia; Tubular epithelial whorls; Kidney; Renal; Vacuolation.

Summary Box:

The post-mortem differentiation of ATN and autolysis is challenging due to overlapping features. This study finds that tubular epithelial whorls can be used independently or in conjunction with other morphological criteria in order to accurately identify ATN in post-mortem renal tissue. This will enable a post-mortem diagnosis to be made in cases of unknown death and/or in previously undiagnosed individuals.

Introduction:

Acute tubular necrosis (ATN) is a clinico-pathologic entity that is clinically associated with decreased renal function and is often characterized by morphologic evidence of tubular injury. ATN is the most common cause (50%) of acute renal failure and can be due to various factors. The two major causes of ATN are ischemia and nephrotoxicity. These categories include the insult due to ischaemia, toxins, urinary obstruction, rhabdomyolysis or drug hypersensitivity reactions. The histologic features of ATN are variable, depending on the duration and type of insult. Early changes can be subtle and include attenuation or flattening of the proximal tubular epithelial cells, cytoplasmic sloughing, loss of the PAS-positive brush borders, and dilated tubular lumens.¹

Corresponding Author

Dr. Anissa Mary Thomas Thattil (Assistant Professor)

Email : thomas.anissa@gmail.com / thomas.anissa@fathermuller.in

Mobile No.: +91 9108151069

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Prolonged or severe ATN is characterized by necrosis or apoptosis of individual cells, nuclear loss, and cellular detachment from the tubular basement membranes and sloughing of cells into the tubular lumen. Other histologic changes include swelling of tubular epithelium with cytoplasmic vacuolization, loss of brush border in proximal segments, formation of tubular casts, collapse of glomerular tufts and interstitial edema.¹ Ischemic ATN typically shows sub-lethal injury along with multiple patchy segments of epithelial necrosis with large skip regions, there might also be signs of regeneration such as flattened epithelial cells with mitotic figures and hyperchromatic nuclei.² Toxic ATN is more likely to show overt necrosis, which can be distinctive in cases of poisoning.³

Autolysis is representative of post-mortal disintegration of cells and is characterized by the disintegration of intracellular matter, and absence of cell and tissue architecture. This process is initiated by autolytic enzymes present in the lysosomes of viable cells.⁴

The histopathological features of ATN overlap with those of autolysis seen postmortem and are thus difficult to differentiate. The presence of reliable criteria will enable a postmortem diagnosis to be made in cases of unknown death and/or in previously undiagnosed individuals. There is paucity of evidence that shows that the tubular epithelial whorl can be used in the diagnosis of ATN in conjunction with the established criteria.⁵ Our study thus attempted to describe and highlight the histopathological differences between ATN and autolysis, with a special focus on tubular epithelial whorls.

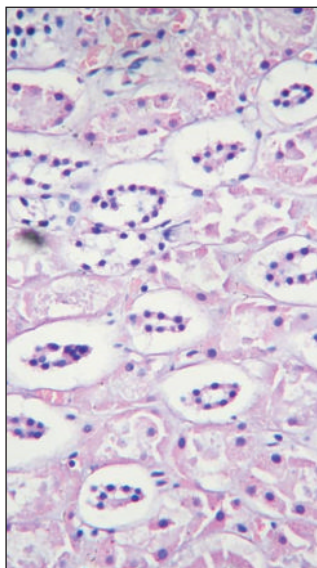


Figure 1. (400X, Haematoxylin and eosin stain) Image showing flat cells with dark nuclei.

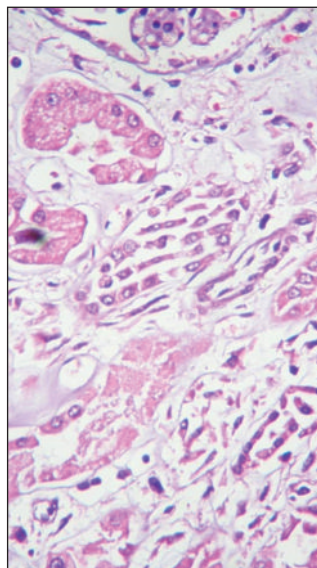


Figure 2. (400X, Haematoxylin and eosin stain) Epithelial whorls (black arrow) and cytoplasmic vacuolation (yellow arrow).

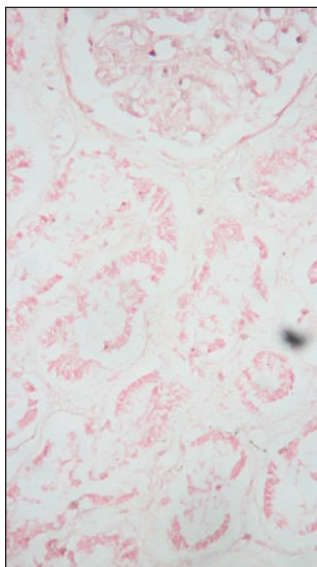


Figure 3. (400X, Haematoxylin and eosin stain) the tubules show autolytic changes with sparing of glomerulus.

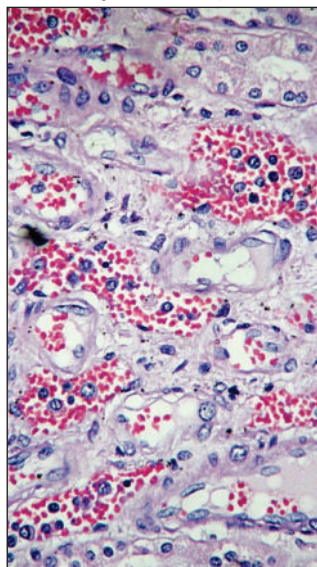


Figure 4. (400X, Haematoxylin and eosin stain) Image shows haematopoietic cells in vasa recta.

Materials and methods:

Selection of cases: This study was conducted in a medical college hospital in Mangalore city located in southern India. All the histopathological specimens which were received by the department of Pathology during the period between 2017 and 2019, from patients who were clinically diagnosed as ATN and, which also satisfied defined biochemical parameters were included in the study. The inclusion criteria were: urine output of <500ml or <0.5ml/kg/hour for 6-12 hours, or creatinine > 1.5 times above the baseline in the last 7 days or an increase in creatinine by ≥ 0.3 mg/dl within 48 hours.⁶ Cases with a history of ingestion of a nephrotoxin or nephrotoxic drugs, presence of comorbid conditions such as diabetes, hypertension, autoimmune

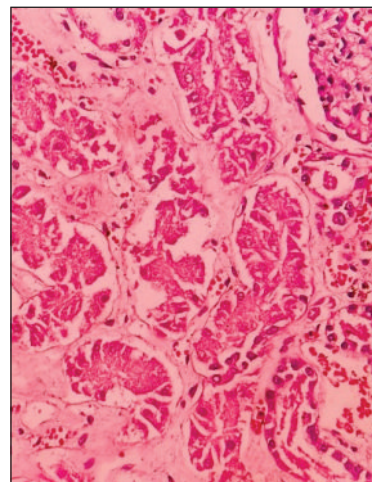


Figure 5. (400X, Haematoxylin and eosin stain) Image shows features of acute tubular necrosis.

disorders and, a history of renal transplant or renal surgery were excluded from the study.

Selection of controls: Pair matching of the specimen source was done based on age and sex. Specimens were taken from healthy individuals who suffered accidental or sudden deaths, including non-nephrotoxic drugs. Samples from individuals who had hypovolemic shock, history of burns, sepsis, radionuclear imaging, pancreatitis, comorbid conditions such as diabetes, hypertension, raised creatinine levels of >1.5 mg/dl, elevated serum amylase levels (indicative of chronic kidney disease), hyperkalemia, history of renal any renal disease or renal surgery were excluded from the study.

Preparation of tissue and staining: Histopathological samples satisfying the above-mentioned criteria were retrieved and de-linked using unique identification numbers allotted by the investigator. The retrieved specimens were formalin fixed, and the Hematoxylin and Eosin (H&E) stained sections were examined under 10x objective and 40x objective. The department of Pathology took two to four sections from each kidney for histopathological examination. Whenever required, further sections were taken and special staining with periodic acid-schiff (PAS) was performed for better visualization of the glomerular structure. The evaluation area included a minimum of 20 high power fields including both cortex and medulla.

Morphological criteria of specimens: All quadrants of the specimen were examined systematically in a clockwise manner using a light microscope and eyepiece graticle (Olympus Corporation, Tokyo, Japan). The tissue sections were examined for signs of tubular injury (cellular swelling and vacuolation, cell membrane blebbing, desquamation, tubulorrhexis, luminal eosinophilic cast) and evidence of regeneration (tubular epithelial whorls, epithelial flattening with mitotic figures and hyperchromatic nuclei) in addition to evidence of interstitial inflammation and edema and autolysis in adjacent structures. The weight of the kidney was also recorded.

Statistical analysis: The data was entered into a Microsoft Excel sheet and analyzed using Statistical Package for Social Science (SPSS) v.20. Descriptive statistics such as frequency, percentages

Table 1. Causes of death among the two groups (n=82).

Cause of death	Cases Frequency (%)	Controls Frequency (%)
Cardiac	4 (9.8)	15 (36.5)
Gastrointestinal	4 (9.8)	2 (4.9)
Blunt force trauma	8 (19.5)	9 (22.0)
Burns	13 (31.7)	2 (4.9)
Poisoning	5 (12.2)	3 (7.3)
Septicemia	3 (7.3)	5 (12.2)
Asphyxiation by hanging	1 (2.4)	3 (7.3)
Respiratory	3 (7.3)	2 (4.9)

Table 2. Morphologic findings of renal specimens (n=82).

Presence of characteristics	Controls n (%)	Cases n (%)	P value
Cell swelling	35 (85.4)	40 (97.6)	0.109 [^]
Cell vacuolation	33 (80.5)	40 (97.6)	0.029 ^{*^}
Blebbing	33 (80.5)	34 (82.9)	1.0
Loss of polarity	37 (90.2)	38 (92.7)	1.0 [^]
Desquamation	36 (87.8)	41 (100.0)	0.055 [^]
Luminal casts	19 (46.3)	27 (65.9)	0.119
Dilation of Bowman's space	32 (78.0)	35 (85.4)	0.569
Tubular inflammatory cells	8 (19.5)	15 (36.6)	0.139
Interstitial inflammatory cells	16 (39.0)	18 (43.9)	0.823
Interstitial edema	40 (97.6)	41 (100.0)	1.0 [^]
Mitotic figures	8 (19.5)	5 (12.2)	0.547
Tubular epithelial whorls	3 (7.3)	36 (87.8)	<0.0001 [*]
Prominent juxta-glomerular apparatus	41(100.0)	41 (100.0)	-
Flat cells with hyperchromatic nuclei	34 (82.9)	38 (92.7)	0.312 [^]
Hematopoietic cells in vasa recta	17 (41.5)	31 (75.0)	0.003 [*]
Tubulorrhexis	29 (70.8)	29 (70.8)	-

*P value significant at $\alpha=0.05$

[^] Fisher's exact test used

and measures of dispersion were used to describe categorical data. The frequency and distribution of each parameter in both the groups were noted and differences between the means were compared using student-t test and Chi-square test for non-parametric and parametric values respectively. A p-value of <0.05 was considered statistically significant. The sensitivity and specificity of significant findings were also calculated.

Results:

Our study examined a total of 82 histopathological samples (41 cases and 41 controls). The mean age of the individuals who were diagnosed with ATN ante-mortem was 42.12 ± 18.27 years (minimum: 9 years, maximum: 76 years) while the mean age of the control group was 49.65 ± 16.64 (minimum: 17 years, maximum: 77 years). The age distribution and post-mortem interval between the two groups was not found to be significantly different (student t-test $P=0.054$, Mann-Whitney U test $P=0.210$ respectively). Each group comprised of 25 males and 16 females. The most common cause of death among the cases were burns (31.7%), blunt force trauma (19.5%) and poisoning (12.2%) while cardiac causes (36.5%), blunt force trauma (22.0%) and septicemia (12.2%) were found to be common causes of death among the controls. Table 1 details the causes of death in each group.

The mean weight of the left and right kidneys among the cases was 139.14 ± 43.37 grams and 151.90 ± 52.10 grams respectively, while among the controls, the mean weight of the left kidney was 131.09 ± 27.49 grams and right kidney was 141.00 ± 30.29 grams.

The weights were not significantly different between the two groups.

Morphological characteristics such as cell swelling, flat cells with hyperchromatic nuclei (Figure 1), cell vacuolation (Figure 2), blebbing, loss of polarity, desquamation, mitotic figures, and tubulorrhexis were observed in tubular epithelial cells. Dilation of Bowman's space, tubular and interstitial inflammatory cells, interstitial edema, tubular epithelial whorls (Figure 2), presence of prominent juxta-glomerular apparatus (Figure 3) and hematopoietic cells in vasa recta were observed in the glomerulus (Figure 4), while luminal casts were observed in the tubular lumen. Table 2 details the morphologic findings of the two groups, while Figure 5 shows features of ATN.

The features that showed significance were further analyzed for sensitivity and specificity. The presence of cell vacuolation was found to be 54.80% sensitive and 88.90% specific, hematopoietic cells in the vasa recta was 64.60% sensitive and 70.60% specific, and tubular epithelial whorls was 88.40% sensitive and 92.30% specific in identifying ATN.

Discussion:

The diagnosis of ATN post-mortem has always been a challenge due to its similarities with characteristics of autolysis. A clinician's judgement on causation of disease is usually clear-cut when the individual has a well-documented medical history. However, difficulties arise in the face of poorly maintained medical documents, in situations of severe underlying disease, multiple possible explanations for death and in case of unidentified bodies.⁷ In such instances, autopsy provides the missing answers to questions that cannot be answered by clinicians. In other instances, autopsies provide confirmation of the accuracy of the clinical diagnosis of ATN; this valuable data will also bolster mortality statistics and aid in research. Such data can also assist in advancing the cause of medicine and in identifying and formulating guidelines aimed at the prevention of ATN.

This study has identified three morphometric features that were found to statistically vary between ATN and control samples of renal tissue: cell vacuolation, hematopoietic cells in vasa recta and tubular epithelial whorls. A study conducted in 2009 found that tubular epithelial whorls were highly specific (100%) to ATN tissue samples, which corroborates our study findings.⁵ Literature states that the kidneys in ATN increase in size and weight; a finding that might be masked by pre-existing renal disease, which might explain why this study did not find a statistical difference between the two study groups.⁸

In ATN, some of the main pathological findings include tubular epithelial cell detachment from the basement membrane, sloughing of cells into the lumen of the tubule, blebbing of the plasma membrane, loss of brush border and presence of tubular casts.^{9,10} This was however, not found to be of significance in our study.

In conclusion, the lack of specific and sensitive morphologic factors has been a stumbling block in the differentiation of autolysis and ATN. However, tubular epithelial whorls, either alone or in conjunction with other factors such as cell vacuolation

and the presence of hematopoietic cells in the vasa recta can be used to accurately identify ATN in post-mortem samples. The post-mortem diagnoses of ATN may be confirmed as contributing to cause of death and/or to ascertain previously undiagnosed cases of ATN postmortem.

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Data availability statement: The de-identified data will be available upon reasonable request from the corresponding author at thomas.anissa@fathermuller.in.

Ethical approval: Institutional ethical approval was obtained before initiation of the study (4396/2017).

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ORIGINAL ARTICLE

Descriptive Study of Victims and Offender Characteristics among Orphan Children in Comparison with Children under Parenthood

Thakur S,¹ Sehrawat SS,² Kaur G,³ Bhargav V,⁴ Singh P.⁵

M.Sc. Forensic Science,¹ PhD Scholar,² Assistant Professor,³ Assistant Professor,⁴ Research Associate.⁵

1. Chandigarh University, Mohali.

2. Department of Hepatology, PGIMER, Chandigarh.

3. Department of Forensic Science, RIMT University, Mandi Gobindgarh.

4. Department of Forensic Science, Rayatbhara University, Mohali.

4. Department of Anatomy, PGIMER, Chandigarh.

Abstract:

Orphans are often predisposed to behavioral issues and emotional distress due to a lack of nurturing and affectionate care. The interplay between victimization and perpetration tendencies can significantly contribute to behavioral problems and emotional turbulence. Children demonstrating challenges in behavior, such as hyperactivity and a deficit in pro-social conduct, are particularly susceptible to assuming dual roles as both victims and offenders. Childhood stands as a critical developmental stage that can influence the path toward criminal behavior or victimization. The absence of a supportive figure leaves these children without an outlet to express their sorrow, resulting in an exacerbated sense of helplessness. A descriptive analysis of victim-offender attributes among orphans and children under parental care was undertaken. This study encompassed two surveys: one assessing victim characteristics (utilizing a self-esteem survey) and the other exploring offender traits (through an aggression survey). A total of 57 children participated, comprising 22 orphans and 35 non-orphans (under parental care). The collected data, when analyzed in percentages, revealed prevalent victim-offender characteristics across the sampled children. Comparatively, the orphaned group exhibited a higher prevalence of victim-like traits in contrast to children under parental care.

Keywords: Victim, Offender, Victimization, Psychological problems, Traits.

Introduction:

Orphans are particularly prone to behavioral and emotional disruptions due to a deficiency in affection and caregiving.¹ Both traits of victimization and perpetration are linked to their behavioral patterns. Children grappling with behavioral challenges like hyperactivity and a lack of pro-social conduct often find themselves in dual roles as both victims and perpetrators.² The phase of childhood significantly shapes the future trajectory of these individuals. Orphans, defined as individuals under 18 who have lost one or both guardians,³ face disparities stemming from the absence of parental guidance and support. They grapple with financial hardships, social isolation, psychological issues, and learning limitations.

This demographic is highly vulnerable, confronting threats such as violence, disabilities, abuse, and mental health concerns. While parents primarily influence the moral, social, emotional, religious, and intellectual development of their children, they demonstrate lower inclinations towards aggression and depression.⁴ Consequently, orphans are perceived as an

exceptionally vulnerable group, exposed to a gamut of risks including violence, disabilities, abuse, and mental illness. Vulnerability is described as an individual's susceptibility to negative developmental outcomes in high-risk circumstances or displaying traits of potential offenders.⁵ Childhood stands as a crucial stage where individuals may lean towards becoming either perpetrators or victims.⁶

Studies indicate that orphaned children endure notably higher levels of depression compared to those with disabilities.⁷ Lacking someone to share their sorrows with intensifies their feelings of helplessness. The absence of support during the grieving process and inadequate assistance in adjusting to a life without their parents may lead to depressive episodes.⁸

Aggression is a learned behavior characterized by any deliberate action resulting in physical or mental harm to another person. Hostility and outrage among youngsters represent significant concerns, often emerging due to life stressors like the loss of guardians or separation. Moreover, children might act out when unable to express their frustrations. Symptoms of childhood aggression encompass fighting, disobedience, destructive behavior, verbal hostility, and bullying, posing a high risk for substantial disturbances in adulthood, including criminal behavior, substance abuse, and mental illness.⁹

Children residing in orphanages frequently endure mistreatment, facing verbal abuse or subjected to severe disciplinary measures involving frequent or intense physical punishments. These

Corresponding Author

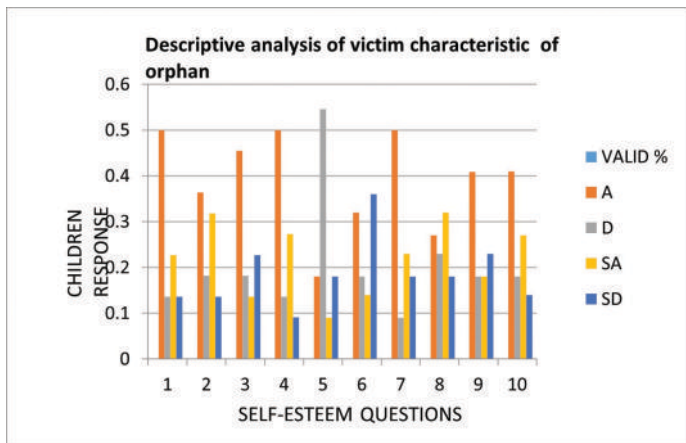
Surender Singh Sehrawat

Email : surendersehrawat6@gmail.com

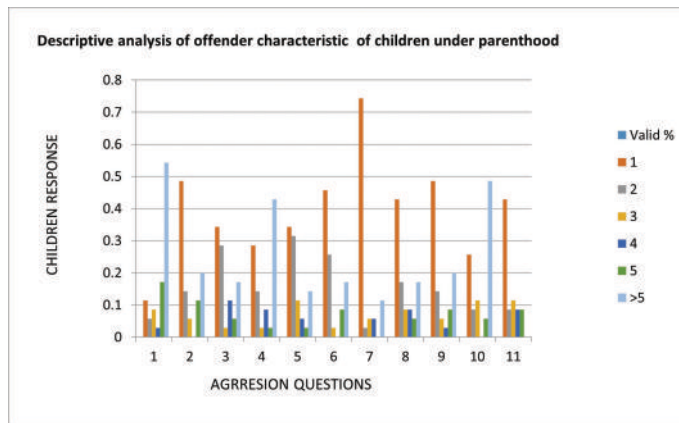
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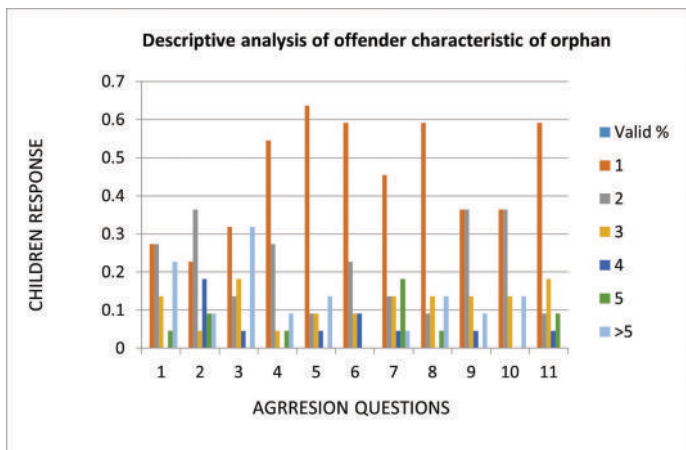
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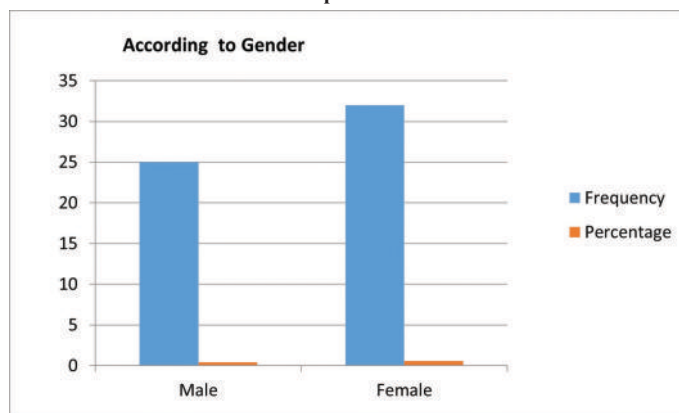
Graph 1. Descriptive distribution of victim characteristics of orphan (for victim characteristics: self-esteem scale).



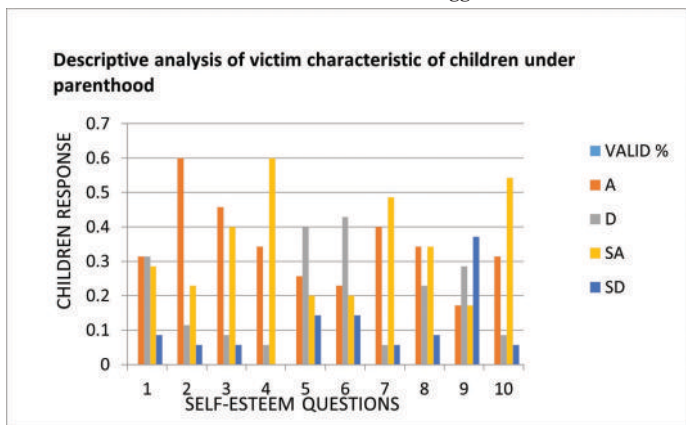
Graph 4. Descriptive analysis of offender characteristic of children under parenthood.



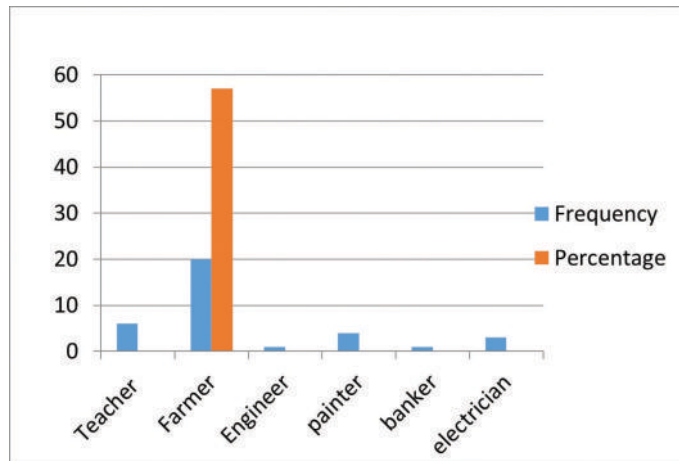
Graph 2. Descriptive analysis of offender characteristics of orphan. For offender characteristic will take aggression scale.



Graph 5. Distribution of children in the survey according to their gender.



Graph 3. Descriptive analysis of victim characteristics of children under parenthood.



Graph 6. Distribution of children characteristics on the basis of occupation of their parents.

experiences can foster tendencies toward aggression and disobedience.^{10,11} This study aims to establish a baseline, evaluating the inclination of orphaned children to display either victim or offender characteristics based on their environmental conditions.

Materials and methods:

A. Orphanage facility and Educational Institution: Specific

orphanage residences and educational institutions were deliberately chosen from the regions of Chandigarh and Mohali in Punjab. The selected orphanages encompass esteemed facilities such as Kanya Savroop Orphan Home in Kharar, Bal Niketan Society in Chandigarh, and the Government Model School in Kharar, among other notable establishments.

B. Respondent's selection: In this study, a total of 22 children without parental care and 35 children under parental guidance were selected from the previously mentioned orphanage

residences and educational institutions, utilizing convenience sampling methods. The age range of the surveyed children spanned from 10 to 18 years old. Among the orphaned participants, there were 13 females and 9 males, while in the non-orphaned (parented) group, there were 19 females and 16 males. Two distinct questionnaires were employed for the purpose of this study.

Personality traits : Self esteem scale: The Self-esteem scale consists of 10 items meticulously crafted to evaluate an individual's holistic perception of self-worth, encompassing a spectrum of both positive and negative emotions regarding one's self. This scale is regarded as unidimensional, signifying its focus on measuring a solitary construct. Respondents are required to furnish responses to all items utilizing a 4-point Likert scale, expressing their agreement or disagreement, ranging from 'strongly agree' to 'strongly disagree.'

Aggression scale: The aggression scale serves as an instrument designed for quantifying instances of aggressive behavior. Consisting of 11 distinct items, it functions as a pivotal tool in the data collection process. In order to evaluate the characteristic of being an offender, our study will leverage 'the aggression scale: A self-report measure of aggressive behavior for young adolescents,' authored by Pamela Orphanas and Ralph Frankowski. In both the questionnaire, few socio – economic direct questions were included that related to objectives used for reliable scoring and results.

Methodology: To acquire pertinent data from the participants, initial permissions were diligently obtained from the authorities governing the orphanage home and the school principal. Participants were provided assurances that the assessment's intent was purely academic and that their responses would be handled with utmost confidentiality. Prior to the survey, efforts were made to establish both rapport and essential rapport with the respondents. Subsequently, the self-esteem scale and aggressive behavior scale were administered to the participants, who were instructed to peruse the provided guidelines before initiating their responses. They were explicitly advised against omitting any item within the scales and were encouraged to respond to all items, emphasizing that there existed no right or wrong answers. Any queries or difficulties encountered by the respondents were meticulously addressed. No time constraints were imposed on the participants for completing the scale items. Upon completion of their tasks, the filled-in questionnaires were collected from the participants.

Data analysis: An analysis was conducted based on the responses of the 57 children who participated in the survey under their consent. Two distinct scales were utilized: the self-esteem scale to assess victim characteristics and the aggression scale to evaluate offender characteristics. Each child's response was meticulously analyzed and compared across various parameters. Factors such as gender, age, and parental occupation status were meticulously compared and subjected to analysis, subsequently represented in graphical formats, illustrating the percentages [Graphs 1-6].

Results and Discussion:

The study was conducted among children from both an

orphanage home and a school, focusing on their victim and offender characteristics. A descriptive analysis was conducted, segregating the study based on various parameters to extract observations and formulate conclusions. The sample comprised 57 children, with 22 (39%) being orphans and 35 (61%) non-orphans, falling within the age group of 10-17 years. The number of girls (n=32) in the sample outnumbered the boys (n=25). Observations revealed a higher prevalence of victim characteristics among orphans, with 50% agreeing, 14% disagreeing, 23% strongly agreeing, and 14% strongly disagreeing with the self-esteem survey. Comparatively, children under parental care exhibited fewer victim characteristics, with 31% agreeing, 31% disagreeing, 29% strongly agreeing, and 9% strongly disagreeing.

In contrast, offender characteristics were more prevalent among children under parental care. On the aggression scale, the majority of children under parental care exhibited offender characteristics: 11% exhibited such behavior once, 6% twice, 9% thrice, 3% four times, 17% five times, and a substantial 54% more than five times. For orphans, the distribution was different: 27% exhibited such behavior once, 27% twice, 14% thrice, 0% four times, 5% five times, and 23% more than five times.

Regarding age distribution, the majority of the 57 surveyed children fell within the 10 to 17 age range, with 2% at age 10, 7% at age 12, 26% at age 13, 23% at age 14, 26% at age 15, and 12% at age 17.

Of the total 57 children, 44% were male, and 56% were female. Among orphans (22 in total), 41% were male, and 59% were female. In the non-orphan group (35 in total), 48% were male, and 52% were female. In terms of parental occupation, the majority of parents were reported as farmers (57%), followed by 17% as teachers, 11% as painters, 9% as electricians, 3% as bankers, and 3% as engineers.

Conclusion:

This study delineates distinct victim and offender traits in orphans compared to children under parental care. Orphans manifest heightened victim characteristics, signifying the profound impact of parental absence on their emotional well-being. Conversely, children under parental guidance exhibit diminished victim traits but display more pronounced offender characteristics, potentially influenced by familial dynamics. The age bracket of 10 to 17 years underscores a pivotal developmental phase influencing behavior. A marginal female predominance in the sample and among orphans accentuates the necessity for tailored gender-specific approaches. Diverse parental occupations suggest multifaceted influences on children. In summary, targeted interventions addressing specific needs hold paramount importance for nurturing emotional development and mitigating adverse traits in both orphaned and non-orphaned children. Further focused research remains imperative for providing effective support.

Future direction: There remains a dearth of comprehensive research conducted on this subject in India so far. Consequently, there is an urgent requirement for more exhaustive studies focusing on victim-offender characteristics. Furthermore, to

alleviate the adverse impact of these issues on children's development, there is a vital necessity to devise customized interventions within school environments and orphanage residences.

Ethical clearance: The collected sample taken from orphan homes and from schools with consent.

Source of funding: Self

Conflict of interest: Nil.

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CASE SERIES

Manner of Death in Electrocution: A Case Series

Kaushik R,¹ Dhattarwal SK,² Verma V,¹ Singh P,¹ Kumar P,¹ Kumar S,¹ Parkash A,¹ Tyagi A.¹

Resident,¹ Senior Professor and Head.²

1,2. Department of Forensic Medicine and Toxicology, Pt. B. D. Sharma PGIMS, Rohtak.

Abstract:

Electrocution is defined as death caused by the passage of current through the body. The cause of death in a case of electrocution are many depending on the organ system it affects like nervous system, cardiovascular system and thermal injury to the body. However, when it comes to decide the manner of death, the type, pattern and distribution of injury over the body along with the circumstantial evidences collected helps in designating the manner of death as suicidal, homicidal or accidental. The authors discussed here three cases of electrocution with three different manners of death. The type of burns sustained over the body and the area affected are related with the manner of death in tabulated form. Most of the electric injuries sustained at home, are accidental in manner. However, suicidal cases by the electrical injuries are not uncommon but rarely homicidal.

Keywords: Electrocution; Suicide; Flash burn; Charred; Manner of death.

Introduction:

Manner of death as defined in literature as how an injury or disease came about that result into the physiological derangement in the body.¹ Medicolegal autopsy and circumstantial evidences are the two main pillars over which investigating authorities rely, that tells the cause and manner of death. There are various cases brought by the investigating authorities in which it is difficult to ascertain manner of death like decomposed dead bodies, charred bodies and bodies that are extensively mutilated. Electricity related death also falls into such category. Most of the electric injuries sustained at home, are accidental in manner. However, suicidal cases by the electrical injuries are not uncommon but rarely homicidal. Fatality of the electric current depends on the type of current, amount of voltage, age of the affected individual and resistance offered to the current. The effects over the body after passing electric current are vast that ranges from no external injury to charring of the body. The fatality of the electric current however doesn't relate with the external findings over the body because a person can succumb to death due to ventricular fibrillation without any external injury over the body. Death by electrocution can be divided into domestic, industrial and lightning stroke. The authors have done three cases of electrocution in which there are different manners of death and pattern and distribution of injuries sustained over the body lead the author to designate the manner of death. However, circumstances of victim during the electrocution defines the pattern, distribution, manner and even severity of injuries sustained after electrocution. In an extensively burnt body of electrocution, it is difficult to tell the manner of death by the

autopsy surgeon but investigating authority with the help of Forensic scientists can relate the manner of death with crime scene and can easily rule out homicide. In the present paper, authors have discussed three different cases in which manner of death was decided on the basis of pattern and distribution of electric injuries sustained.

Case studies:

In this the authors have discussed three cases of electrocution which were brought by the investigating authority for medicolegal autopsy. In India, consent of relatives is not necessary for conducting autopsy in medicolegal cases. The particulars of deceased are not revealed in this case series and kept confidential with the authors. So ethical clearance is not necessary for this case series.

1. Suicidal electrocution: A dead body of middle-aged male individual was brought in the mortuary for medicolegal autopsy. As per history, the deceased had tried to strangle himself by using the electric wires at home. The wire was plugged in and the circuit was complete at the time he encircled the electric wire around his neck and at the same time he switched on the button making the circuit complete and electric current started running in the wire and he was electrocuted by the wire. On local examination of the neck, there were superficial burns present all around the neck and no other injury was present over the body. On dissection of neck, the underlying soft tissues were pale and no ecchymosis was appreciable. The hyoid bone and thyroid cartilage were intact. All other organs were intact. The cause of death was given as electric injuries which were antemortem in nature and suicidal in manner (Fig 1 to 3).

2. Accidental electrocution: A dead body of a carpenter was received in the mortuary for medicolegal autopsy. While working at his workplace he was using the electric saw machine from which he got shock by electric current. On examination, an electric entry mark was found over the palmar aspect of right hand in the form of a well-developed oval shaped with shallow crater, bordered by raised areola of blanched skin around a part of

Corresponding Author

Dr. Priti Singh

Email : pritisangwan95@gmail.com

Mobile No.: +91 9728609176

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its circumference and the underlying soft tissue was pale (Fig 4). On further examination, the exit mark of electric current was present in the form of multiple superficial slit lacerations over the plantar aspect of left foot with evidence of melted keratin at places (Fig. 5).

3. Homicidal Electrocution: A dead body of an adult male individual was received for medicolegal autopsy. On examination, deceased was wearing a khaki-coloured full sleeved shirt and a blue coloured jacket which were burnt at places and adhered to the underlying skin of anterior chest wall. Rest of the body was naked. Superficial to deep burns were present over the neck, anterior aspect of chest wall, anterior abdominal wall, anterior aspect of both lower limbs involving the plantar aspect of both feet, ventral and dorsal aspect of left hand sparing the bilateral soles. The red line of inflammation was not present between burnt and unburnt surface area. Deep burns with superficial charring and intervening pale areas suggestive of post mortem burn, was present over the back, posterior aspect of right arm, right gluteal region and posterior aspect of right thigh with evidence of heat rupture over the anterolateral aspect of upper one third of right thigh. Total burnt surface area constitutes about 90 to 95 percent of total body surface area. On dissection of neck, left greater horn of hyoid bone was found detached from the body with infiltration of blood in fracture ends (Fig 6 and 7).

Interpretation and analysis: We use the concept of 'pattern of injury' to describe the individualisation of a particular injury to a particular object.¹ Distribution of injury means the area injured or affected over the body. Pattern and distribution of electric injuries over the body can decide the manner of death as we have seen in three different cases summarised in the table below.

Sr No.	Type of burn	Manner of Death	Area Affected
Case no. 1	Spark Burn; Antemortem (vital reaction present)	Suicidal	Localised; Encircling the neck
Case no. 2	Flash Burn; Antemortem (vital reaction present)	Accidental	Localised; Entry and exit wound of current appreciable
Case no. 3	Superficial charring; post mortem heat rupture with no evidence of vital reaction	Homicidal	Generalised; Over the posterior aspect of body involving both soles

Discussion:

The passage of electric current through human body is capable of producing a wide range of effects, varying from insignificant localised muscular spasm and little or no contact burns to instantaneous death with little or no burns or extremely severe burning. Fatal electrocution may be divided into three groups, according to the voltage involved: domestic, industrial and lightning stroke. Fatality after electrocution depends not only on the current but also on the factors related to the victim which are: Resistance of the body tissues, area of contact of the body, duration of contact, earthing/insulation, physical condition of the individual etc.²

According to literature, the examination of the scene may be much more important than the post mortem of the body. The clothing, including shoes, gloves and headgear should be examined for burns. In cardiac arrhythmia victim will be pale, and in respiratory paralysis cyanosed.³



Figure 1.



Figure 2.



Figure 3.



Figure 4.



Figure 5.



Figure 6.



Figure 7.

When a current passes, there may or may not be a visible lesion, depending upon: the density of the current passage in terms of skin area and the conductivity, usually varying with the moisture content and pressure of contact. Much of this damage seen at autopsy may have occurred post-mortem, if death from cardiac arrest occurs early in the event and, where the victim is alone, there is no one to remove his body from the source of the current. It has been conclusively shown by Polson and others that post-mortem burns can be inflicted on a dead body, the appearances being similar in terms of blistering and burning, though the red flare of 'vital reaction' will be absent if death has occurred sometime before.⁴

In all cases of suspected electrocution, there should be an examination of the alleged source of the electrical current including electrical devices the individual was handling at the time of death. In low-voltage electrocutions, examination of the device rather than examination of the body will often provide the cause of death, because burns may not be present. Thus, one can make a diagnosis of electrocution without an electrical burn, based on the circumstances of the death, negative autopsy findings and the examination of the electrical device in use. In high-voltage electrocution, tissue from the victim may be adherent at the point of contact with the source of the current (e.g., a metal ladder).⁵ Parakkattil et al reported a case of accidental high-voltage electrocution where the atypical exit wounds present in the legs could only be satisfactorily explained after corroborating it with the crime scene evidence. Moreover, contrary to the usual scenario, earthing in this case was spread over a wide area of the legs and feet. Cause of death after electric injury as described in literature are ventricular fibrillation, titanic asphyxia, respiratory arrest, cerebral anoxia, neurological damage.⁶

Most deaths from electricity are from cardiac arrhythmias, usually ventricular fibrillation ending in arrest. This is caused by the passage of current through the myocardium, especially in the superficial epicardial layers and possibly across the endocardium. The current has a profound effect directly upon the myocardial syncytium, the possible dislocation of the pacemaker nodes and conducting systems being ill understood. When death occurs from cardiac arrest, the body remains either pale or only slightly congested, the autopsy appearances being unhelpful apart from the presence of any external electrical marks. The second (and far less common) mode of death is respiratory arrest, in which the passage of current through the thorax causes the intercostal muscles and diaphragm to go into spasm, or become paralysed. In either case, respiratory movements are inhibited

and a congestive-hypoxic death occurs. The brainstem is affected rarely, when the current enters through the head. Either cardiac arrest or respiratory paralysis can then supervene.⁷

The mode of death in most cases of electrocution is ventricular fibrillation due to the direct effects of the current on the myocardium and cardiac conducting system. These changes can be reversed when the current ceases, which may explain some of the remarkable.⁸ The findings at autopsy vary from no external injury to even complete charring of body. However, much of the reliability to know the cause, manner and mode of death is on circumstantial evidences.

Conclusion:

Electrical burns are usually accidental resulting from defective appliances or negligence in the equipment. They may be produced from application of live wire during convulsive therapy of mentally diseased patients. Homicidal electric burns may occur during theft and suicidal electric burns are rare.

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CASE SERIES

Curious Cases of Spontaneous Hepatic Rupture – An Autopsy based Case SeriesPatil PA,¹ Sangle DJ,² Mukherjee AA.³Assistant Professor,^{1,2} Professor and Head.³

1-3. Department of Forensic Medicine and Toxicology, Government Medical College, Nagpur.

Abstract:

Spontaneous abdominal haemorrhage is defined as the presence of Intra-abdominal haemorrhage from non-traumatic and non-iatrogenic causes. Spontaneous hepatic rupture is one of the rare cause of intra-abdominal haemorrhage. Literature notifies causes of spontaneous hepatic rupture as hepatic adenoma, hepato-cellular carcinoma, HELLP syndrome (Hemolysis, elevated liver enzymes and low platelets) in pregnant females, cysts, haemangiomas, coagulopathies, banned substance abuse etc. Imaging techniques like Focused Abdominal Ultrasonogram for trauma (FAST) and Computed Tomography are standard imaging techniques for diagnosis of spontaneous hepatic rupture. Angiographic coiling, hepatic artery ligation, peri-hepatic packing, liver resection, liver transplantation are the management interventions to reduce morbidity and mortality in these cases. The present case series reports autopsy based examination of three rare cases of spontaneous liver rupture. An attempt to probe the cause of spontaneous liver rupture is made via meticulous autopsy examination.

Keywords: Spontaneous hepatic rupture; Focused abdominal ultrasonogram; HELLP syndrome; Autopsy.

Introduction:

Hepatic rupture is usually a traumatic phenomenon. Spontaneous abdominal haemorrhage is defined as presence of intra-abdominal haemorrhage from non-traumatic and non-iatrogenic causes.¹ Spontaneous atraumatic hepatic rupture is a rare event, most often associated with benign and malignant hepatic neoplasms.² Common sources of spontaneous abdominal haemorrhage are visceral (hepatic, splenic, renal and adrenal), gynaecologic, coagulopathy-related and vascular).¹ Frequently associated with severe pre-eclampsia or HELLP syndrome (a group of symptoms that include haemolytic anaemia, hepatic enzymes increases and thrombocytopenia).³ This article presents an autopsy based case series of three unusual cases of spontaneous hepatic rupture without any obvious cause as noted in literature.

Case Scenario I: 51 year old female brought to the mortuary with an alleged history of sudden deterioration of health at her residence according to requisition forwarded by the police officials.

Clinical records: Abdominal pain and emesis followed by giddiness and coma. Her biological parameters showed haemoglobin of 9 gm% associated with increase in liver enzymes – AST – 267 units, ALT – 517 units. Patient had a low GCS score. However, no non-invasive investigations were conducted. Her case records describe her death within 24 hours with the provisional diagnosis of systemic hypertension with congenital

kypho-scoliosis with acute coma with bilateral aspiration .

Autopsy: External examination – Features of Kyphoscoliosis are noted. Averagely built and averagely nourished, cold body. skin was dry and pale. Conjunctiva – pale.

Intravenous therapeutic puncture mark noted over anterior aspect of forearm.

Internal examination: Brain- 1. Diffuse subarachnoid haemorrhage was present as a thin film of blood over bilateral frontal regions, dark reddish in colour. 2. Rest of brain parenchyma is oedematous with flattening of gyri and loss of sulci and pale.

Lungs – Both the lungs were intact associated with flimsy pleural adhesions to the antero-lateral chest wall bilaterally, margins – rounded and blunted. Lower lobes of both the lungs showed multiple consolidations patches, on cut section – reddish, friable area noted with oozing of blood tinged fluid.

Heart – Intact, enlarged in size and shape, coronaries – intact, patent, left ventricular hypertrophy noted with left ventricular thickness – 2.5 cm. Multiple yellowish atheromatous plaques at the base of aorta.

Abdomen – Intact, 1500 cc of blood with blood clot noted.

Liver – Haematoma present over the right lobe below the glisson's capsule associated with breach in the capsule and a liver rupture of size 10 cm x 4 cm of right lobe. Rest of the liver parenchyma appeared fragile (As depicted in Image 1 of case 1). Rest of the organs were pale. Histo-pathological findings of liver showed sub-capsular haemorrhage with interstitial haemorrhage. Multi-focal areas of peri-portal coagulation necrosis and haemorrhage. Necrosis was found at the rupture site.

Case Scenario II: A 48 years old female was admitted at a tertiary care hospital for the treatment of seizures. However, due to heavy medical expenses, the patient was then transferred to a

Corresponding Author

Dr. P. A. Patil

Email : priyankapatil261221@gmail.com

Mobile No.: +91 9284539476

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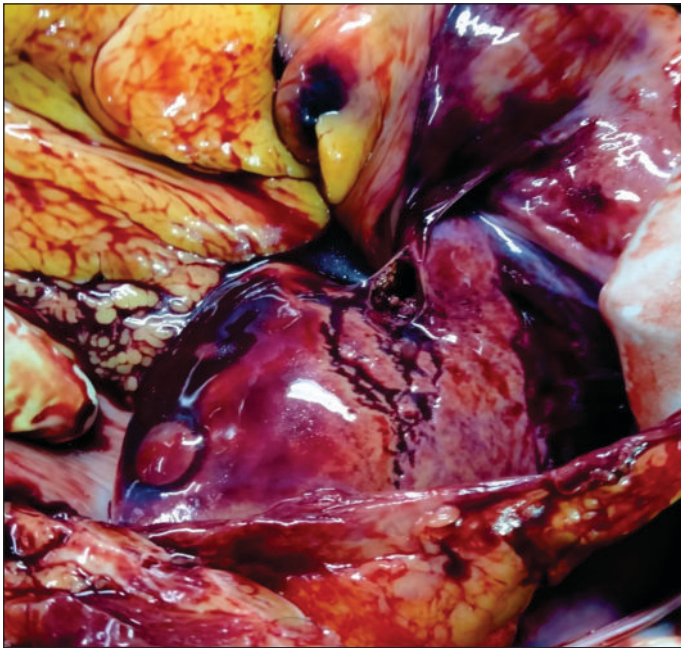


Figure 1.

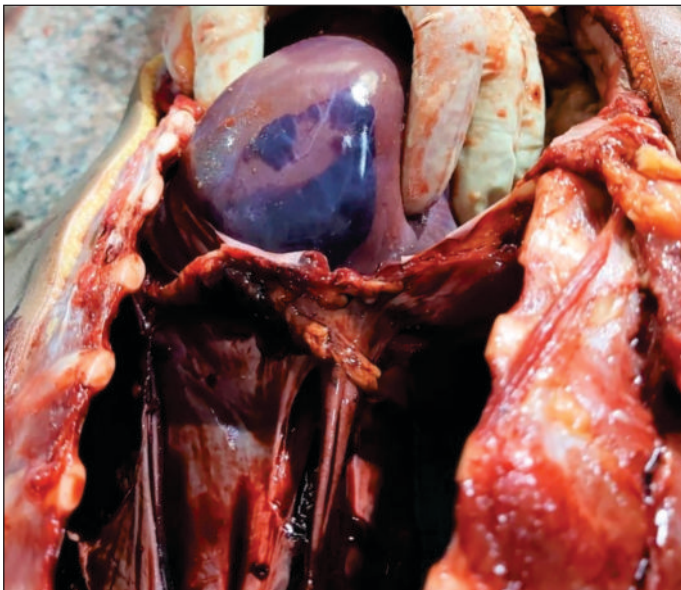


Figure 2.

government hospital through ambulance. Her husband was the only person accompanying the patient in the ambulance. When the patient was brought to government hospital, she complained of pain radiating to the right shoulder with abdominal tenderness in the right upper quadrant. Increased levels of AST (188 units), ALT (340 units) INR -1.5. However, before subjecting the patient to CT scan or any other investigations, she succumbed.

The maternal relatives were concerned and raised an allegation that the husband resorted to violence while in the ambulance. The concerned case entered into the medico-legal purview.

External examination – Averagely built, averagely nourished, cold body. Skin was dry and pale. Conjunctiva – pale. Oozing of blood tinged fluid through nostrils and mouth. Intravenous

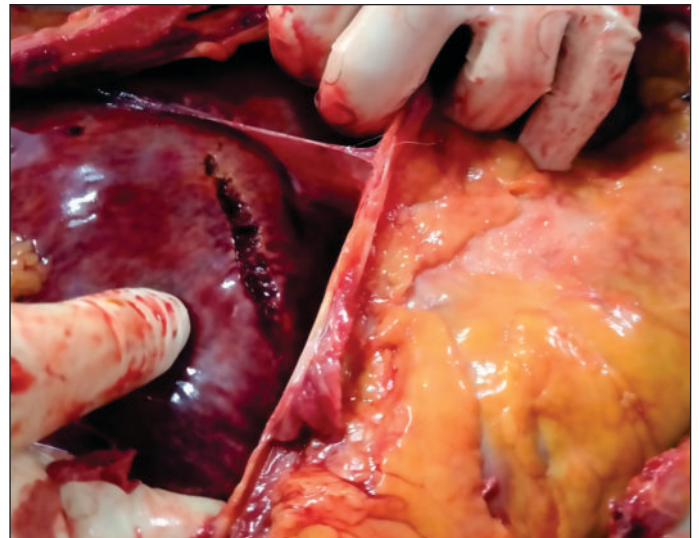


Figure 3.



Figure 4.

Therapeutic puncture marks noted over left cubital fossa of left forearm and right forearm.

Internal examination – Brain: 1. Multiple petechial haemorrhages noted in the white matter suggestive of hypoxic damage due to seizures associated with oedema of the flattening of gyri and loss of sulci.

Abdomen – Intact, 1000 cc of blood with blood clot noted. No any haemorrhagic infiltration into the abdominal muscles.

Liver – Haematoma present over right lobe of liver of size 8cm x 4cm (As depicted in image 2). Liver rupture of size 7cm x 4 cm with haemorrhagic parenchyma of right lobe of liver (As depicted in image 3). Rest of the liver parenchyma appeared fragile Rest of the organs were pale .

Histopathological findings of liver showed similar picture as in case I sub-capsular haemorrhage with interstitial haemorrhage. There was no evidence of benign or malignant neoplastic process, haemorrhage, intrinsic hepatic disease or vasculitis. The possibility of any sub-clinical trauma or antecedent trauma or any deceleration injuries was excluded.

Case Scenario III : A young male of 25 years complained of severe cramping abdominal pain with multiple episodes of vomiting. No sooner than he was brought to the casualty, he collapsed and was pulseless.

Resuscitative measures were initiated but he could not be revived. The physician was inquisitive and suspected acute pancreatitis clinically, however, the patient succumbed before any investigations or intervention could be done.

External examination – Moderately built and moderately nourished, cold body. Skin is dry and pale. Oral mucosa and conjunctiva is pale. Rigor mortis was generalised all over the body. Post-mortem lividity present over back, buttocks and thighs except at pressure points and bony prominences, purplish in colour. No any external injuries noted.

Internal examination – Abdomen: Intact, 2000 cc of blood with blood clot noted. No any haemorrhagic infiltration into walls of the abdomen.

Liver – Haematoma present over right lobe of liver of size 5cm x 4cm (As depicted in image 4). Liver rupture of size 6 cm x 3 cm with haemorrhagic parenchyma of right lobe of liver rupture with irregular, haemorrhagic margins with friable parenchyma. Rest of the organs were pale.

Histopathological findings showed multiple foci of haemorrhagic parenchyma of right lobe of liver without any other pathological findings. No any inflammatory infiltration noted at the ruptured site suggestive of a recent rupture.

Discussion:

Spontaneous hepatic bleeding is a rare condition that is mainly due to rupture of an underlying hypervascular tumor, hepatic adenoma, long term oral contraceptives, bleeding hepatocellular carcinoma.¹ HELLP syndrome is a group of symptoms which include haemolytic anaemia, hepatic enzyme increase and thrombocytopenia.³ In 10% of patients with severe pre-eclampsia showed liver involvement.⁴ In HELLP syndrome, vasospasm occurred from increased sensitivity to circulating vasopressors during pregnancy and vascular injury from endothelial damage leads to formation of micro-vascular thrombi that result in rupture.⁴ Amyloidosis is one of the contributory cause for spontaneous hepatic rupture. In amyloidosis, thromboses is due to liver enlargement, rigidity of hepatic parenchyma and vascular fragility.⁴

In HCC and other malignant liver lesions, the pathogenesis of spontaneous liver rupture may be due to overlying normal liver parenchyma splitting from the expanding tumor growth.⁴

In all the three cases, histo-pathological findings did not show any intrinsic hepatic disease. No evidence of a benign or malignant neoplastic process. No source for haemorrhage was identified. Also no evidence of vasculitis or other connective tissue noted.

Also in all the three cases, no any underlying liver pathology or inflammatory process was noted. Also other potentially

identifiable causes of hepatic rupture including trauma, unrecognised coagulopathy, collagen vascular disease were excluded.

All the case scenarios were not subjected to any subclinical trauma, any antecedent trauma or deceleration injuries. History of consumption of banned substances or body enhancing substances (anabolic androgenic substances) was ruled out. CPR usually causes primarily in left lobe and falciform ligament, hence, the parenchyma of left lobe is commonly lacerated causing haemoperitoneum.³

Due to rarity of the condition, and low index of suspicion, diagnosis of atraumatic liver rupture is rare.⁴ Kristen Klein concluded that spontaneous liver rupture does not necessarily infer definable underlying liver pathology.² After confirmation of diagnosis in stable patients with intact liver capsule and contained haematoma, conservative treatment with serial haemoglobin monitoring, ultra sonogram or CT is required. In unstable patients, emergency laparotomy, peri-hepatic packing or liver resection can be done.⁴ Stable patients who are diagnosed with aneurysms, interventional radiological procedures like angiographic embolization and hepatic artery ligation.⁴ In pregnant women with spontaneous rupture of liver an elective caesarean section is advised to prevent the precipitation of hepatic rupture.⁴ Bleeding is stopped by peri-hepatic packing. In conditions where packing is not useful, liver resection can be done. In severe cases with uncontrolled bleeding liver transplantation may be the only option.⁵ Due to the limitations of treatment options, early diagnosis of spontaneous liver rupture is essential. This article highlights three unfortunate case scenarios with missed and unsuspected diagnosis of liver rupture preventing further interventions. Hence, the phenomenon of spontaneous liver rupture is a diagnosis of exclusion without any obvious cause. Any clinical signs should raise a warrant suspicion and necessary imaging investigations should be advised with exploration of further treatment options.

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CASE REPORT

A Case of Failure of Implementation of MOHFW Guidelines for Medicolegal Examination of Sexual Violence Complicated by Contradictory Autopsy Findings

Roy DD,¹ Ongmu K.²

Assistant Professor,¹ P.G. First year.²

1-2. Department of Forensic Medicine, Institute of Medical Sciences, Banaras Hindu University, Varanasi.

Abstract:

A 13 year old female was brought to BHU, Trauma Centre in an unconscious, intubated state with a ligature mark around the neck, a crudely sutured wound on right wrist and an alleged history of sexual assault. We witnessed multitude of hurdles pertaining to this case which led to delay in evidence collection, dispatch, and analysis. This occurred at various steps beginning from preliminary reporting and treatment, up to the demise and even thereafter. The case was further convoluted with a completely contrasting autopsy report. It clearly indicates that major improvements need to be made at almost all steps and that we must bring to light the ground reality in dealing with such cases. There is a dire need for addressal of the deviations from beau ideal due to numerous shortcomings. The motive of presenting this case can be perceived through this quote: "If it were not for injustice, man would not know justice." Here, we aim to reduce barriers associated with preliminary reporting, evidence collection and autopsy documentation so as to support timely investigation and prosecution.

Keywords: Sexual violence; Medicolegal examination; Evidence; Delay.

Introduction:

The NCRB report of 2020 recorded a total of 19631 rape cases registered in that year alone.¹ Nevertheless, the ignorance in dealing with sexual violence cases at various levels remains astoundingly prevalent. In the State of Karnataka vs. Manjanna, medicolegal examination of a minor rape survivor was delayed because of absence of police request and unavailability of a female registered medical practitioner.² This notwithstanding the fact that doctors should not insist for police requisition or magistrate order before conducting medical examination (Section 27 and Rule 5 of POCSO Act).³ The Section 357 C of CrPC directs the hospital to conduct prompt medical examination. Section 164A, CrPC directs that the survivor shall be sent for medical examination within 24 hours of receiving the complaint. Section 164 A CrPC elaborates on survivor examination by a registered medical practitioner (RMP). The ministry of health and family welfare (MOHFW) issued guidelines and protocols for medico-legal care for survivor/victim of sexual violence in 2014. It asserts that in the absence of a female doctor, examination can be performed by a male doctor if the survivor/victim consents.⁴ Sec 166 A IPC & 166 B IPC defines punishment for public servant and doctor respectively for refusal to record information, provide medicolegal examination and treatment of sexual assault cases. The supreme court in the year 2000 recognized rape as a

medicolegal emergency.² All the aforementioned sections are dedicated to fulfilling the sole purpose of avoiding delay and loss of crucial time bound evidence. However as elaborated in the case below, the practical applicability remains largely inefficient.

Case report:

A 13 year old female presented to the trauma centre of SSH, IMS, BHU on 15/10/2022 at 1:50 pm with alleged history of physical and sexual assault. She was referred from district hospital, Ballia. The child had been missing since 6:00 pm the previous day (14/10/2022) when she left home with her friends. After 12 hours, she was found in an unconscious state at a field, few kilometres away from her village. The patient was examined by a panel of doctors in BHU, constituted for addressal of sexual violence cases. On general physical examination patient was supine, intubated, unconscious with a total GCS score of 3 (E₁V_{NT}M₁) that indicated severe brain injury (Table 1, Figure 1). On external examination conjunctival haemorrhage was noted in right eye at limbus on the medial side. Reddish scabbed grazed abrasion was present on left side of face of size 5cm x 4cm, 4cm away from angle of mouth. Multiple curvilinear abrasions were also noted on the left side of face of length ranging from 0.5cm-0.7cm, 1.5cm medial to the angle of mandible suggestive of nail marks. Ligature mark in the form of horizontal reddish scabbed pressure abrasion was present over front and both sides of neck, of total length of 18cm, maximum 2.8cm width, minimum of 1.8cm, lying at the level of thyroid cartilage, 6.2cm below chin and 6.5cm above sternal notch. On the right side, the ligature mark extended to lie 4cm below right angle of mandible and on the left side, the ligature mark extended to lie 4.7cm below left angle of mandible beyond which it was not visible (Figure 2). The right forearm showed a sutured wound with continuous stitches (unknown material) of length 10.3cm at flexor aspect, 5cm from the right wrist joint, 21cm from elbow joint (Figure 3). Reddish

Corresponding Author

Dr. Deepa Durga Roy

Email : deepadurgaroy@bhu.ac.in

Mobile No.: +91 6393770522

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Table 1. Glasgow coma scale was used to evaluate the brain injury in the patient.⁷

Glasgow Coma Scale		
Response	Scale	Score
Eye Opening Response	Eyes open spontaneously	4 Points
	Eyes open to verbal command, speech, or shout	3 Points
	Eyes open to pain (not applied to face)	2 Points
	No eye opening	1 Point
Verbal Response	Oriented	5 Points
	Confused conversation, but able to answer questions	4 Points
	Inappropriate responses, words discernible	3 Points
	Incomprehensible sounds or speech	2 Points
Motor Response	No verbal response	1 Point
	Obeys commands for movement	6 Points
	Purposeful movement to painful stimulus	5 Points
	Withdraws from pain	4 Points
	Abnormal (spastic) flexion, decorticate posture	3 Points
	Extensor (rigid) response, decerebrate posture	2 Points
	No motor response	1 Point

Minor Brain Injury = 13-15 points; Moderate Brain Injury = 9-12 points; Severe Brain Injury = 3-8 points



Figure 1. Decorticate posture of the victim at the crime scene which progressed to decerebrate posture at the time of presentation in SSH, BHU, Varanasi, indicating deterioration in the patient's condition with passage of time.

contusion of size 3cm × 2cm was present on right anterior superior iliac spine. No other external injuries were noted on general examination and local examination of genitals. The medicolegal examination for sexual violence was done following the guidelines and protocols provided by ministry of health and family welfare, government of India and all the evidence collected and preserved in accordance. Patient was admitted for treatment. She succumbed to her injuries on 21/10/2022 at 06:55 pm, following which autopsy was conducted by a panel of three doctors at district hospital on 22/10/2022, 04:00 AM. The IO came to our department, BHU with the PM report for expert opinion and statement recording. The autopsy report described 14 antemortem injuries-Ten contusions ranging from size 10 cm x



Figure 2. Ligature mark on the patient's neck suggestive of strangulation.



Figure 3. Crudely sutured wound on the wrist using an unknown suture material.

1.5 cm to 20cm x 3 cm were mentioned. (Back of abdomen, back of chest, inner aspect of right and left thigh, genital area.) Lacerated wound 5cm x 0.5 cm, muscle deep on the right side of neck, 5 cms from right pinna, 7cms from midline, below angle of mandible. Chop wound 7cm x 4cm, bone deep on inner part of forearm 5 cm from the right wrist joint. "Genital organs around the outer surface of labia majora with contused swelling. Hymen ruptured. Contusions found all around the labium minus and vulva. Contusion found all around anus area (inner wall of anus was contused). Cause of death was given as- "Asphyxia as a result of strangulation and injuries noted. Viscera preserved for chemical analysis." The IO also brought a DNA testing form sent from FSL Lucknow on 11/11/2022.

Discussion:

This case highlights the potholed road from medical attention to medicolegal assistance which the victim has to traverse for justice.

District Hospital, Ballia: The referral from district hospital Ballia to BHU (154 km) leading to delay in critical care, medicolegal examination and collection of evidence. The preliminary suturing of the wound was done crudely using a non surgical suture material, thus raising the question on capability of the treating medical officer (Figure 3).

Trauma centre, SSH, IMS, BHU: The bringing together of the

panel members from various specialities- OBGY, Forensic Medicine, Psychiatry, Paediatric Medicine, Paediatric Surgery, General Surgery who were also hesitant in a sensitive medicolegal case, which led to a delay of 2 hours in examination after admission.

The total delay in examination/collection of evidences was 25 hours since the child went missing, and 13 hours since her unconscious body was found.

Forensic Science Laboratory: The samples were sent back, unanalysed, on 9/11/2022 from FSL Ramnagar for redistribution (into 23 different envelopes) as DNA analysis could not be performed and had to be sent to FSL Lucknow. The IO again came with a fresh DNA testing form sent from FSL Lucknow on 11/11/2022. After about 21 days since death and 28 days since evidence collection the evidence sample packets were still unopened.

Postmortem Examination: The report was downright contradictory to the antemortem medicolegal examination. This case brings to light the poor response, failure to provide access to adequate health and medicolegal services, and the lack of coordinated services for efficient evidence analysis. The POCSO and the CLAA had hoped that by putting a time frame, the time taken from reporting to conviction will be brought to reasonable levels.⁵ Though the law instructs speedy justice, it is not in practice yet because of the loopholes in practice.

Suggestions:

- Educating all registered medical practitioners and auxiliary staff about the SOP in a case of sexual violence. Their duties, relevant legal sections, chain of custody and the need to treat it as medical emergency.
- NMC should also focus on educating and sensitising MBBS students throughout their M.B.B.S curriculum, every year, on sexual violence. It should not be limited to only one chapter in one subject.⁶
- Awareness workshops for police personnel.
- Collaborating with different FSL to arrive at a common protocol for documentation and forwarding the samples smoothly and speedily.
- Feedback should be collected periodically from all the stakeholders to assess the compliance and address the existent hurdles.

Conclusion:

Though MOHFW has given exhaustive instructions on medicolegal examination in a case of sexual violence, its implementation remains weak. And as the famous legal maxim goes- Justice delayed is justice denied.

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

Conflict of interest: None to declare.

Source of funding: None to declare.

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CASE REPORT

A Rare Case of Pulmonary Bone Fragment Embolism - A Case Report

Bakkannavar SM,¹ Jayakala A,² Nayak D,³ Shetty S,⁴ Bhat AK.⁵

1,2. Department of Forensic Medicine and Toxicology, Kasturba Medical College, Manipal, MAHE, Manipal.

3. Department of Pathology, Kasturba Medical College, Manipal, MAHE, Manipal.

4,5. Department of Orthopaedics, Kasturba Medical College, Manipal, MAHE, Manipal.

Abstract:

Bone fragment embolism (BFE) is a type of osseous related non-thrombotic pulmonary embolism (NTPE). Most commonly an incidental finding & usually does not cause death. We report a case of an 85-year-old woman who came with history of road traffic accident, with open right radius segmental shaft fracture for which debridement and K wire fixation was done but succumbed to complications. On post-mortem and histo-pathological examination pulmonary bone fragment embolism was seen. Bone fragment embolism is most commonly an incidental finding and it is usually overlooked when there is no major trauma involved. It is seen in cases with trauma to bones, bone marrow transplantation, orthopaedic procedures and trauma to diseased bones. BFE is a tell-tale sign of past traumatic injury. In the absence of other causes and even in the absence of a massive traumatic event, BFE should be kept in mind before issuing a cause of death.

Keywords: Bone fragment; Embolism; Pneumonia; Autopsy; Case report.

Introduction:

Non-thrombotic pulmonary embolism (NTPE) is rare when compared to thrombotic pulmonary embolism (PE) and contrary to thrombotic PE where the effects are solely mechanical, the morbidity and fatality of NTPE depends on the nature of embolus too.¹ Most commonly embolism of fat, bone marrow, air, tumour, amniotic fluid, foreign body like buck-shot are encountered in cases of NTPE in autopsy set up.^{1,2} Bone fragment embolism (BFE) is a form of osseous related NTPE and is found to account for fewer than 40 cases in literature and usually goes unnoticed.³ For BFE to occur a sudden rise in intra-osseous pressure is considered to be a pre-requisite, either due to a traumatic event or surgical interventions. BFE is most commonly an incidental finding and usually does not cause death, though cases have been reported in literature.

Case Report:

We report a case of an eighty-five-year-old woman, with a history of road traffic accident. She sustained a degloving injury to right forearm, with associated open right radius segmental shaft fracture (Fig. 1a) and head injury with plain CT study of brain showing intraxial hyperdensity noted in the left frontal lobe, likely to be haemorrhagic contusion. On the 8th day of admission wound debridement of right forearm was done, which was again repeated on the 12th day, along with K wire fixation of the radius segmental shaft fracture. However, on the 5th postoperative day, patient succumbed to the complication (sepsis). Since it was a medico-legal case, body was subjected to post-mortem

examination. On external examination, a partially healed wound with surrounding granulation tissue and yellowish slough, measuring 25 cm x 10 cm x exposed muscles and tendon, was present entirely involving the right forearm, right wrist and right hand, starting at a point 4 cm below the right elbow, was covered with a mesh and K-wire was present in situ. (Therapeutic artefact) (Fig.1b). Another partially healed wound with surrounding granulation tissue and yellowish slough, measuring 10 cm x 4 cm, was present over the left side of the face extending into left eye brow and forehead, situated at a point 7 cm away from the left ala of nose. Multiple abrasions with black scabs were present at several places involving the head, upper and lower limbs at places.

On internal examination, both the lungs were firm, congested and oedematous, and blood stained fluid oozed out on cut section. All other organs were intact and unremarkable on cut section. On cranial examination, diffuse sub arachnoid haemorrhage present involving bilateral cerebral and cerebellar hemispheres. Skin from the partially healed wound of forearm and a piece of lung were sent for histopathological examination, which revealed necrotising dermatitis of skin and in the lungs a bone fragment embolus within the alveolar air spaces with histiocytic reaction was seen (Fig. 2 and 3). Opinion as to cause of death was given as deceased died due to complications of polytrauma sustained to head & upper limb as a result of blunt force impact.

Discussion:

Bone fragment embolism and bone marrow embolism (BME) are types of non-thrombotic pulmonary embolism (NTPE) and unlike BME, BFE is rarely encountered. BME can arise due to osseous and non-osseous related injury, while BFE occur exclusively due to osseous related injuries.^{1,3} It occurs due to fracture of bone, as observed in the present case, and the fragment is forced into the veins by the sudden increase in pressure and also due to the pressure attributed by local haemorrhage and oedema that follows fracture. BFE has been observed in cases with bone marrow transplantation, vertebral body marrow infusion, trauma

Corresponding Author

Dr. Aparna Jayakala (Senior Resident)

Email : aparna.jayakala@gmail.com; aparna.jayakala@manipal.edu

Mobile No.: +91 8893805359

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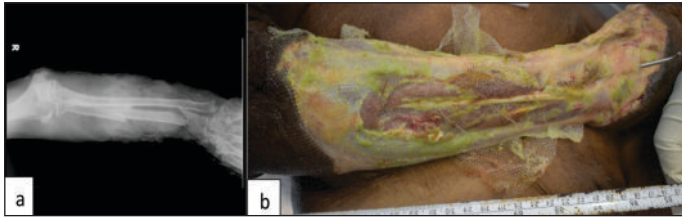


Figure 1. (a) X-ray of right elbow, forearm and wrist showing radius segmental shaft fracture; 1(b) Partially healed wound of right forearm, wrist and hand with K wire insitu.

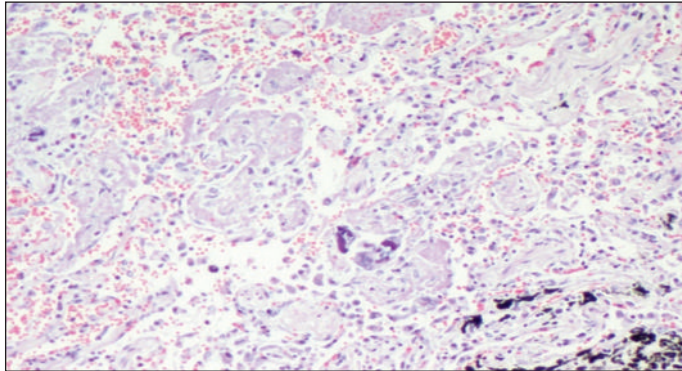


Figure 2. Lung lobules showing a focus of bone fragment within the alveolar air spaces (H & E x50).

to osteomyelitis affected bone and orthopaedic procedures like femoral nailing, spinal surgeries and total hip replacement.⁴⁻⁸

According to the observations made by Dettmer et al. in 2014, the incidence of BFE was observed to be 0.5%.³ They also found an increased incidence in cases of fracture in an infected bone and in pathological fractures of bone and attributed the embolization to increased blood flow due to inflammation. The cases reported in literature had undergone trauma varying from a period of 1 day to upto 2 years before their death, thus showing that infection is not a pre-requisite for BFE to occur.² Though BFE usually does not cause death, however cases have been reported in the literature where it has been attributed as the cause of death, due to obstruction of pulmonary vessels by the bone fragments and subsequent acute cor pulmonale.^{3,6}

In the present case, BFE was an incidental finding and did not contribute to the cause of death. Also the deceased never showed any signs or symptoms for the same. In view of trauma, the source of the bone fragment was identified from the radius bone, but it could not be established if it occurred due to the intitial trauma in the form of segmental fracture of radius or due to K-wire fixation thereof. Since both may have induced sudden intra-osseous strain, either of the processes may have contributed to BFE. Long term effects of pulmonary BFE has not been discussed though Zichner et al. hypothesised that it can lead to secondary pulmonary hypertension, as the bone fragment is eventually absorbed and gets replaced by fibrous tissue.⁹

Conclusion:

BFE is a “tell-tale sign of past traumatic injury” and definitely an ante-mortem sign.^{3,10,11} In the absence of any other cause and even in the absence of a massive traumatic event, as is in this case, the treating doctor or Forensic Pathologist should keep the entity of

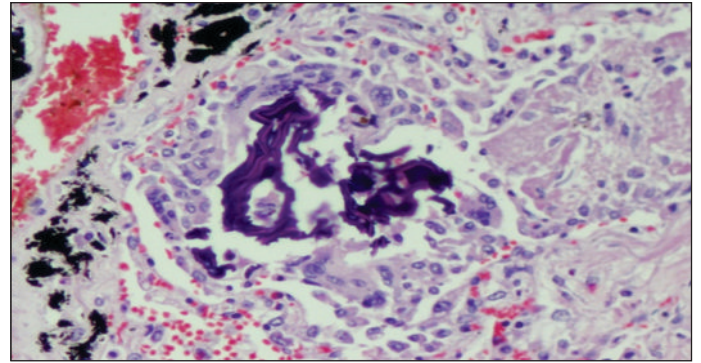


Figure 3. Bone fragment embolus within the alveolar air spaces with a histiocytic reaction (H & E x200).

BFE in mind before issuing a cause of death. The paper also highlights the importance of autopsy and ancillary investigations like histopathological examination.

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CASE REPORT

A Suicidal Death which was Treated and Masqueraded as an Accidental Death

Chouksey V,¹ Baveja VS,² Sabu N,³ Nigam M.⁴

Assistant Professor,¹ Senior Resident,² PG First Year,³ Professor and Head.⁴

1-4. Department of Forensic Medicine and Toxicology, Atal Bihari Vajpayee Government Medical College, Vidisha.

Abstract:

The work of an autopsy surgeon revolves not only around performing autopsy of the body but it also requires ruling out every single possibility, relevant or remote, even if the possibility of it, actually happening is as thin as a whisker before coming to formulation of opinion. It is not uncommon for an autopsy surgeon to come across cases wherein there is a stark contrast between what is being claimed and that which is evident. History is manipulated for a plethora of reasons, one prominent reason being eschewing the societal stigma associated with suicide as a consequence of probable sexual assault in a rural place. This is one such case wherein a 15 years old female was brought to the hospital with a history of being bitten by a snake which was witnessed by the deceased's father. Thereafter, treatment was provided at the hospital after taking the history into account. After almost 48 hours of survival, she was certified dead and owing to the unnatural death, an autopsy was deemed necessary. The lack of evidence supporting snake bite, certain incidental findings during the autopsy along with the reconstruction of events based on the circumstantial evidence led to the conclusion that this was a case of suicidal death caused by ingestion of a poisonous substance and not that of an accidental death as a consequence of snake bite.

Keywords: Misleading history; Organophosphate poisoning; Snake bite; Suicidal death autopsy.

Introduction:

The significance of the powers of observation and interpretation of autopsy findings, awareness of different possibilities, and a flexible and open mind of the autopsy surgeon are always stressed. The failure to maintain a high standard of care of post-mortem examination due to a low level of competency in Forensic Pathology can lead to mistakes in opinions concluded by the autopsy surgeon causing errors and, ultimately, injustice.¹

Literature pertaining to Forensic Medicine defines the type of incisions that can be made on the body but the very first incision that a good autopsy surgeon passes through the information that is being passed on to him by means of the deceased's relatives, police and even his own colleagues.

There may or may not be spurious malintent behind conveying wrong information, but an erroneous opinion formulated by an autopsy surgeon on account of misinformation or lack of information is never pardoned and is equivalent to preventing the justice from being served to the deceased. Hence, from practicality to morality, there is no excuse for basing the findings of an autopsy on the history that is being provided and/or the treatment that has been administered.

Case report: A 15-years old teenager who had allegedly been bitten by a snake in the presence of her father was brought to the casualty in a semi-conscious state where her treatment was started. The attending doctor in the emergency, saw merit and

conviction in the history that the father had provided, based on which treatment was administered. The girl was later shifted to the medicine ICU where also the line of treatment continued to be the same. Treatment that was prescribed to the girl included 10 vials of anti-snake venom, 1 vial of Injection atropine at an interval of 30 minutes and injection neostigmine 0.5mg every 30 minutes. The girl's condition continued to deteriorate and she was certified as dead after treatment duration of nearly 2 days.

Autopsy findings: A detailed account of the incident was taken from the father of the deceased in which he provided details which were in line with what he had provided earlier at the time of admission. The first striking finding that came to light upon external examination was the sheer absence of a bite mark at the alleged site of bite which was the right shoulder region. Careful inspection of the surrounding area also yielded no positive finding. It is common knowledge that there are often situation wherein the snake bite mark may not be evident on the body owing to various reasons mentioned in the literature. The autopsy surgeons still could not fathom the absence of a bite mark and decided to probe again. The father was still adamant about the occurrence of a snake bite and held on strong to his statement of the snake bite site being the right shoulder.

To further avoid any confusion or misunderstanding, the father was taken inside the autopsy room and was made to point at the bite site. The said site was then carefully dissected, examined and as expected there was nothing to suggest a snake bite (Fig. 1). Similar examination was conducted on the shoulder region of left side and other body parts were also keenly observed, only to find no positive finding. Further, as the stomach was opened, there was 100cc of yellowish-brown fluid present in it and the mucosa was found to be diffusely haemorrhagic, congested and sloughing of mucosa was evident all over the stomach mucosa at places (Fig. 2). The stomach content was emitting a peculiar kerosene

Corresponding Author

Dr. Manish Nigam

Email : jurimanish@gmail.com

Mobile No. +91-98262 13412

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Figure 1. Examination of alleged bite site.



Figure 2. Congestion and hemorrhage along with sloughing of stomach mucosa.

like odour. Upon careful dissection of the kidneys, the cortico-medullary junctions were found to be not well-differentiated (Fig. 3). All other visceral organs were noticeably congested. Upon examination of the external genital tract, an area of contusion at the 5 O'clock position of the introitus was found as an incidental finding (Fig. 4).

Death as a result of poisoning was indicated by the findings of the autopsy especially that of the stomach and the viscera were preserved and handed over to the police personnel for chemical and toxicological analysis.

Discussion:

The importance of examination of a patient has been known since almost as long as the evolution of Medicine, yet it is still very underrated and often not even practiced owing to various reasons, none strong enough to let a clinician completely waive it off. Not thinking of possibilities is a common enough reason for not finding out all there is to discover.² In cases of snake bites, during the initial evaluation, the bite site should be examined for signs of local envenomation (edema, petechiae, bullae, oozing from the wound, etc) and for the extent of swelling.³ While the local symptoms in a neurotoxic snake bite are not as pronounced as they are in a vasculotoxic snake bite, yet the presence of ecchymosis at the site of snake bite is almost always present which often lead to a dicey situation for the clinicians. In this particular case, upon a careful study of the treatment records, at no point were the findings or the lack of them were mentioned,

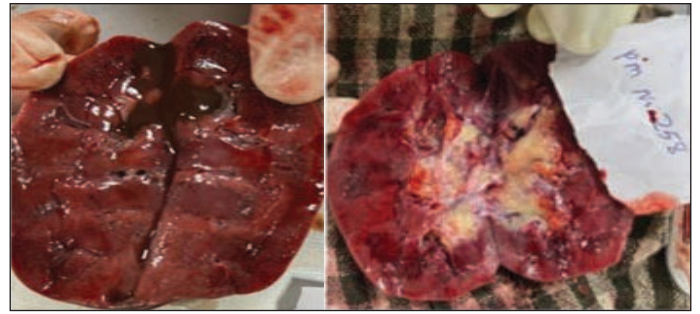


Figure 3. Congestion seen in kidney, cortico-medullary junction not well differentiated.



Figure 4. Contusion seen at 5 O'clock position in the introitus.

Investigations Advised :	Treatment Advised (Medical/Surgical)				
	Medication	Dose	Route	Frequency	Timing
Complete Blood count					
Renal function count					
Liver Function test					
Lipid Profile					
Serum Electrolytes (Na/K/CL/HCO3)					
Blood grouping					
Blood glucose (R/F/PP)					
HbA1C / GTT					
Uric Acid					
Bleeding / Clotting Time (PT/APTT/INR)					
Thyroid function Test					
HBsAG					
HBV / VDRL					
S. Lipase / Amylase					
Trop T/ILCP-K					
DJ Dimer					
Urine / Stool Test					
X-rays (Chest/)					
ECG					
Echocardiography					
Ultrasound ()					
	IVF NS II O				
	INT. CT 1gm (wholy)				
	INT. PANTOP 40mg qd				
	INT. AZIL 1amp				
	INT. DEXA 4mg				
	INT. TT 0.5mg				
	INT. ASV 10 vial in 20ml NS over 1hr				
	INT. ATROPINE 1amp stat P/B every 4hr				
	INT. NEOSTIGMINE 0.5mg every 30min x 4hr				
	INT. MIDAZ 2 vial in 50ml NS				
	VITALS MONITORING				
	SUCTONING @ 4hrly				

Figure 4. Treatment sheet – anti-snake venom, atropine and neostigmine given.

hence it is safe to assume that an external examination was completely omitted. It is noteworthy that the line of treatment was completely based on the history provided, so much so that even a mention of 'Ptosis being present' was made in the notes. The very mention of Ptosis in the case records made it evident that the treating doctors were suspecting a neurotoxic snake bite.

The autopsy surgeons gave due importance to the external examination and did a meticulous examination to rule out the snake bite. Furthermore, the peculiar smell of the gastric content along with the findings of the gastric mucosa were strong evidences sufficient to safely conclude this as a death caused by poisoning.

While viscera was preserved for chemical and toxicological analysis, the characteristic kerosene like smell strongly indicated the ingestion of Organophosphorous compound by the deceased. The possibility of poisoning was completely overlooked by the treating doctors and this omission reflected clearly in the medical records. Atropinisation is known to be the main stake in the treatment of Organophosphorous compound poisoning. A severe OP pesticide poisoning case has been known to deplete a hospital's supply of atropine.⁴ While atropine was being administered but the frequency at which atropinisation was being done i.e. at an interval of 30 minutes was clearly more in line with treatment of snake bite (Fig. 5). In cases of organophosphorous poisoning, a loading bolus dose of 0.6-3.0mg is given rapidly followed by doubling doses every 5 minutes until the patient is atropinized (HR >80bpm, SBP > 80mmHg, clear lungs).^{5,6} Usage of atropine in cases of snakebite involves observation over the next 10-20 minutes for signs of improved neuromuscular transmission.⁷ Additionally, neostigmine was being administered to the patient which is a drug nowhere advised to be used in cases of OP poisoning, it would rather worsen the symptoms of the patient.

Apart from this, the reckless usage of anti-snake venom without any finding suggestive of a snake bite could also be responsible for adverse effects. Approximately 20% patients treated with ASV develop either early or late reaction.⁸ The adverse reactions range from mild (rash, diarrhea, diaphoresis, and pain) to severe (anaphylactic shock, bronchospasm, angioedema, and hypotension).⁹ In Sri Lanka, where only Indian manufactured polyvalent antivenoms are available, reported severe reaction rates may be as high as 43%.¹⁰⁻¹³

Conclusion:

Medical practice in today's day and time has negligible scope for any error. A mistake on account of one doctor, if not evaluated properly by another one can ultimately lead to a catastrophe, which can have adverse consequences not only for the patient but also for the doctors on medicolegal grounds. The roaring number of patients coming to the casualty of tertiary health care centres paired with a very miniscule number of doctors is also a major cause of concern. The fate of the deceased in this case could have been different if the basic founding principles of medicine had been given due importance. The importance of a proper history and a complete examination of the patient, irrespective of this examination being conducted during life or after life can't be emphasised enough. Cases especially those where there is a provision for compensation by the government should be examined meticulously for any foul play. Furthermore, the practice of a thorough examination of a female's genitals during autopsy should be practiced so thoroughly that it becomes muscle memory and is practiced in all cases coming with relevant history or not.

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REVIEW ARTICLE

A Review of the Role of Microbial Forensics amidst Bioterrorism Threats and Strategic Measures needed to be taken in the 21st Century World and India

Barman DD.

Professor & Head.

Department of Forensic Medicine & Toxicology at Shri Sathya Sai Medical College & Research Institute, Ammapettai.

Abstract:

Bioterrorism is defined as the deliberate release or threaten to release deadly microbial organisms to cause damage to human lives, damage to live stocks and crops. Various countries and governments around the world have invested in setting up biolaboratories to conduct research on various pathogens. Microbial Forensics is the field of Forensic Science which apply the scientific principles of Microbiology and deal with the investigation and identification of suspected bioterror attacks, bio crime, and suspected accidental release of microbial agents or their toxins from a laboratory facility. The biological agents are commonly transmitted through oral, inhalational, and cutaneous routes. During the preparation of this review, scientific papers related to the topic of bioterrorism and Forensic Microbiology were searched using Scopus, PubMed, Google scholar and ProQuest. The search was focused on using key word, such as microbial agents, biological agents, bioterrorism, and microbial forensics. There is need for development of greater capacity in handling cases of natural as well as man developed biological agent attack. In this regard nations must work together by applying standard and structured Forensic Microbiology investigative procedures with use of state-of-the-art technology and tests. India too must build an effective mechanism and strategy to tackle any future event of biological agent led terror and this would need coordinated policy and approach of the major stakeholders.

Keywords: Bioterrorism; Microbial forensics; Biological agents; Global; India.

Introduction:

Bioterrorism is defined as the deliberate release or threaten to release deadly microbial organisms (bacteria, viruses, to cause disease, damage or even loss of lives to humans, damage to live stocks and crops.¹ Over the past several decades the possibility of accidental or intentional spillover of harmful microorganisms from laboratories or from their natural habitats i.e., from inside their natural hosts such as bats have always been a matter of concern. Various countries and governments around the world have invested in setting up state of the art biolaboratories to conduct research on various pathogens. The research, which was originally aimed at understanding the pathogens, their virulence, development of potential vaccines against the targeted organism. However, very soon the potential of using these pathogens against humans, animals, plants started to become a reality. During this period of uncertainty microbial forensics has evolved and emerged as a field which offers the ability to investigate and study cases of bioterrorism and bio crime.² Microbial forensics is defined as the field of forensic science which applies the principles and knowledge of microbiology to identify and investigate cases of bioterrorism, bio crime, accidental leakage of pathogen or toxin from a research laboratory.³ Microbial forensics is multidiscipline area which involves microbiology,

biochemistry genetics, forensic science, immunology, public health, law enforcement and intelligence services etc.² Though the importance of microbial forensics was realized after the anthrax attack, however its origin, could be traced to the practice adopted by epidemiologists and public health-experts who used to investigate outbreak by focusing on the characters of the pathogen, mode of spread, possible reservoirs of infection etc.⁴

Over the past few decades as terrorism grew and caused havoc around the world, the chances of using microorganism as a weapon have become a significant threat. The fact that biological agents are widely available and there are always loopholes in the regulations governing their safe handling and usage has made things worse. Coupled to these factors are the possible development of genetically engineered microorganism which could be more virulent and lethal. This article is an attempt to focus on the various challenges that the world faces about biological agents and their use as bioweapons. The article also tries to expound the possibilities in the field of microbial forensics investigate cases of biological agents outbreak and investigate the different ways microbial forensics can help to identify and solve cases of biological attacks.

Methods:

During the preparation of this review, scientific papers related to the topic of bioterrorism and Forensic Microbiology were searched using Scopus, PubMed, Google scholar and ProQuest. The search was focused on using key words such as microbial agents, biological agents, bioterrorism, and microbial forensics. Articles written in english, and on the topics of bioterrorism and Forensic Microbiology were chosen. At first the title of the article and the abstract was read carefully, and most relevant and

Corresponding Author

Dr. Dipayan Deb Barman

Email : dipayandebbarman@gmail.com

Mobile No.: +91 8015111461

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informative articles were chosen and the whole article was read carefully. A total of 36 articles published between 1964 to 2020 were chosen and analyzed to write this review present review article.

Evolution of the use of biological agents in warfare: Dating back as early as around 600 B.C, the harmful agents of infectious agents on humans and on animals have been witnessed when the Assyrians used the fungus *Claviceps Purpurea* to contaminate water⁵ and the use of animal carcasses, filths to contaminate food and drinking water sources to cause disease and death on the opposite armies have been done in many wars including the wars fought in Europe and even the American civil war and other wars of the 20th century.⁶ The British used blankets contaminated with smallpox virus to infect native Americans who were loyal to the French.⁷

With changing times along with natural outbreaks, the scope of induced outbreaks has also risen and for infectious disease experts and investigators differentiating between a natural and a deliberate outbreak remains a major challenge. The outbreaks of *B. anthracis*, Sh. Dysentery, Plague are some examples of spread of pathogenic organisms even outside their natural habitat or geographical region where they are endemic, and this can raise concern of biological attack. The emergence of Texan *B. Anthracis* in the east coast of USA in the year 2001 was such an example where concerns occurred about the possibility of bioterrorism.⁸

Evolution of bioterrorism in modern times: In modern times some nations have been indulged in developing means to utilize microbial organisms as weapons. For weaponization of microbial agents there is suspicion that extensive research on reverse engineering microbial agents is going on. This can appear as a conjecture at this point, but the possibility of it turning into a truth one day cannot be ruled out.

In the 1960s concerns grew over the risky and unpredictable nature of development of biological agents and their possible fallout. There were no epidemiologic and regulatory guidelines or measures available at that time to prevent their misutilization.⁹⁻¹¹ In the year 1972 at the world biological convention a treaty was inked which focused on the development, stockpiling and prevention of bacteriological and toxin weapons.⁹ This treaty has 183 signatory nations. It looks and calls for the development work on biological agents for research and vaccine development. The biological weapons convention came into effect on 1st March 1975.¹² It also prohibits work on genetically programming a microbial organism by altering its infectivity and virulence for the purpose of use against mankind. As per the BWC, the signatory parties must provide detailed information about the following such as information about where biological defense research are being conducted, the number of conferences which are held at different facilities, exchange of information about any disease outbreak.¹³ However there remains some very pertinent problems on the ground which questions the very existence of this treaty.

Why are biological weapons becoming a cause of worry for the world?

Microbial organisms have been always a matter of concern for mankind as they are harbinger of diseases and death. Despite of the presence of a treaty binding on the signatory nations the problem arises from the adequacy of regulations and how much it is working on the ground. Biological agents could be easily developed in any laboratory with very minimal facilities, and it is easy to transport without detection.

Biotechnology has evolved over the past few decades, and this was due to discovery in three key areas such as the deciphering of the DNA structure, development in polymerase chain reaction (PCR) technology and the work on human genome project.¹⁴ Gradually biotechnology saw advances such as the ability to copy, mutate, sequence, and even edit DNA. This led to work on microbial organism where in the year 2001 Australian scientists have been successful to work on Mousepox virus and thereby edit the virus resulting in controlling the population of wild mouse.¹⁵ This led to a very hazardous situation in which the modified strain of the virus became more lethal and began to kill mouse which were naturally immune to Mousepox and as well as those which were immunized against it. Now, given the similarity between Mousepox and Smallpox virus, if a rogue nation or any terrorist organization with the know how to work similarly were able to develop a lethal and more easily transmissible strain then the consequences could be catastrophic. The Smallpox virus is safe and the possibility of it becoming available to terrorist organization seems impossible, but what if an entirely new organism or a genetically modified different virus is made to unsettle the human system. In the US, scientists have been able to develop a new strain of polio virus from chemicals which are available in the market.¹⁶

Since bacteria, viruses, fungi etc. are highly susceptible to genetic reengineering and in one research a group of researchers while studying the reasons of tuberculosis remains latent in few individuals worked towards the development of a hypervirulent strain of the *Mycobacterium tuberculosis bacilli*, and this shows that how much risky these experiments could prove.¹⁷ In another experiment genetic modifications were done in *Leishmania major*.¹⁸ All these point to the fact that if such weird applications of biotechnology are not regulated then it could lead to development of pathogens which would be more easily transmissible, more virulent and would be able to invade human immune system with ease.

Potential agents which could be used as agents of bioterrorism: Potential agents which could be used for biological attack or bioterrorism have been divided into classes. The CDC have divided these agents into three categories such as A, B and C agents.¹⁹

Category A agents: These are high priority agents which when used could affect national security. These agents can be transmitted from human to human. They can cause serious morbidity and mortality and can affect workforce and have significant negative on the nation's economy and security. In the category A agents group the examples of biological agents include *Anthrax bacillus*, *Clostridium botulinum*, *Yersinia pestis* etc.

Category B agents: The second category agents have moderate

morbidity and comparatively low mortality. They are easier to spread. These agents require specific CDC diagnostic methods for their detection and very high yield surveillance techniques. Examples of category B agents includes Brucellosis (*Brucella* species), Typhus (*Rickettsia prowazekii*), Psittacosis (*Chlamydia psittaci*) etc.

Category C agents: This third category of agents include those which could be engineered to have the potential for spread due to their easy availability, ease of production and very high risk of major morbidity and mortality. These group of agents also have the potential to create a major public health impact. Examples of category C agents are Nipah virus, Hanta virus.

Characteristics of an ideal biological weapon:

1. Easy to produce.
2. Easy to acquire.
3. Have high infectivity.
4. Have high virulence.
5. Easily transmissible.
6. Storage potential for use later without losing the infectious potential.
7. Ability to withstand environmental factors during transportation.
8. Can be easily disseminated over a large area without detection.
9. Should have the potential to be reengineered for development of a more lethal and infectious strain.

The biological agents are commonly transmitted through oral, inhalational, and cutaneous routes. These agents could be delivered to the area of interest through bombs dropped from airplanes. Pathogens causing disease such as anthrax, plague, viral hemorrhagic fever, brucellosis, smallpox, viral encephalitis could be delivered via aerosols targeting a large area.²⁰

Role of microbial Forensics in events of biological attack: Forensic microbiology is an essential component for identification and investigation of a biological outbreak. Whenever there is an infectious disease outbreak the important question which arises are: 1) When did the outbreak started? 2) What was the possible causative organism? 3) What is the vector of the pathogen? 4) Who are the population at risk? 5) How is the mode of spread of the infection?

Following report of an unusual illness occurring at a particular area of a region, epidemiologist, and forensic microbiologist travel to that area to begin the investigation. Epidemiology and forensic microbiology should be treated as inseparable arms of biological attack and infectious disease outbreak investigation.²¹ In cases of epidemiological investigation of a bioterrorism or bio crime there is application of various molecular method which helps to identify the putative pathogen responsible for the outbreak and this is called molecular epidemiology.²² Advances in biotechnology and microbiology have made possible identification of the causative agent to the outbreak. In cases of an infectious disease outbreak forensic investigators visit the place of outbreak and collect samples from humans and livestock. The samples may range from human body fluids, throat swabs, wound swabs etc. or samples of water, food etc. Following collection of

samples forensic microbiology can employ various methods for detection and isolation of the pathogen. These methods can range from traditional culture to use of molecular techniques such as nucleic acid or antibody-based methods.

Biothreat pathogens possess greater challenge compared to infectious disease pathogens when attempt is done for their genotyping.²³ A wide variety of pathogens such as bacteria, virus, fungi, protozoa may pose threat to humans, and environmental flora and fauna. There are an estimated 1400 pathogens which have the known potential to infect human beings.²⁴ However, genetic markers such Single Nucleotide Polymorphisms (SNPs), insertions and deletions (INDELS), repetitive sequences, antimicrobial resistance genes.^{23,25,26} MLVA (Multi Locus variable number Tandem Repeats) based analysis have been found very effective in identifying minisatellite regions within the bacterial genome and this is useful in differentiating the strains of monomorphic species such as *B. Anthracis* and *Yersinia pestis*.^{27,28} MLVA was first applied in the investigation of the Aum Shinrikyo Anthrax release to identify Sterne strain²⁹ and then in the year 2011 in the Amerithrax investigation to identify the Ames strain.³⁰

There remains a problem with these techniques as they cannot provide attribution at the isolate level and this mandates use of SNP microarray technique. SNP microarray have been highly effective in screening and delineation tool for bacteria and virus and achieve successful species and strain identification.^{31,32}

Whole genome sequencing technique (WGST) has emerged as a very useful technique for isolation and attributing an outbreak to a particular pathogen. In this technique the variations in genome of microorganism have been effectively identified.³³ In the year 2009 when there was a laboratory spillover of *Yersenia pestes* in a laboratory of Chicago, USA then whole genome sequence testing was applied very effectively.³⁴

Opportunity and challenges before the world and India to develop a state-of-the-art Forensic Microbiology investigation mechanism: Capacity building in Forensic microbiology investigative techniques and strategy is the need of the hour in present times where chances of natural and as well as manmade biological agent disaster is considered a threat for causing disease and death. Looking at capacity building measures in forensic microbiology it is necessary to develop a standard operating procedure for investigation methodology such as visit to the ground zero from where the outbreak started, interviewing patients and relatives, identification of clinical manifestations, identifying and collecting samples, transportation to the laboratory and subsequently examining the sample for isolation and identification of the pathogenic strain responsible for the outbreak. In the USA, the Federal Bureau of Investigation (FBI) has developed a Scientific Working Group on Microbial Genetics and Forensics (SWGMEG) to build a platform for microbial forensic investigative arm aimed at investigating biological agent related outbreaks and acts of bioterror.³⁵ There is need for other nations to build effective measures to respond and track incidents of sudden bioterror.³⁶

Major steps required to be taken towards mitigating such crisis:

1. Mechanism for detecting the works going in the field of biological agents' research.

2. Develop better coordination among nations to monitor over nations suspected of carrying out bio-organism research.
3. Developing a comprehensive protocol for addressing the issue of bioterrorism.
4. Focus on development of vaccines, test kits and extending the healthcare outreach activities across the spectrum of developed, developing and poorly developed nations.
5. Allocation of funds for development of research for detection of outbreak, surveillance of infection, identification of the organism, detecting their mode of transmission.
6. Develop control and preventive strategies.

India is a developing nation and is already posed to become a superpower. The demographic advantage has put India in an advantageous position. However, with the wide magnitude of disease and healthcare resource allocation for a big and populous nation, India has major concerns amidst the risk of bioterrorism threat.

Concerns for India:

- India's geography and climatic conditions which is subtropical could be more favorable for growth and dissemination of pathogens in the event of a biological attack.
- India does not have a very robust healthcare system with facilities to handle any major infectious disease outbreak.
- Funds allocation in the field of defensive biological research must be increased.
- More surveillance capacity should be added to the process of monitoring any potential outbreak.
- India has a large population with high population density, and this could facilitate rapid dissemination of infection.
- The SARS CoV-2 COVID-19 pandemic has shown the unprecedented event that could follow during a pandemic of such large scale where healthcare resources of many nations including India was put to test.

Strategies which India need to adopt to handle face any major bioterrorism threat/attack?

India must invest heavily on development of laboratories with cutting edge technology across the country to develop diagnostic techniques for detection of pathogens in the event of an outbreak. The Indian healthcare system need to be revamped with building a well-developed infrastructure and expertise human resource pool which can handle outbreak effectively. There is need for bolstering the surveillance mechanism across the country involving healthcare professionals and as well veterinarians. Doctors and paramedics must be trained to identify the clinical features associated with the various agents which could be used as biological weapon. Major steps need to be taken in the field of research and development of vaccines and India should increase the production and stockpiling of vaccines. As every possible biological agent have their characteristic clinical features the policy for tackling each pathogen should be tailored according to the need of the country.

The health department should introduce awareness programs to

raise awareness among the population to be aware of any suspected outbreak and educate them on the duties of a citizen during such an outbreak and how to immediately notify the nearest health care centers. Electronic and print media must be sensitized as to how to raise the level of awareness and disseminating information about the must do and must not do activities during an infectious disease outbreak. Care should also be taken so that in any condition misinformation must not spread and never a situation of public panic occurs. As biological attacks or acts of bioterrorism needs multipronged approach hence there is a need for India to coordinate and seek expertise from agencies such as DRDO (Défense Research and Development Organization) and ISRO (Indian Space Research Organization) and thus leading to a collaboration between health research organizations such as ICMR (Indian Council of Medical Research). With time various commercial laboratories and government laboratories have come up and there is utilization of biochemical, immunological, nucleic acid procedure to identify infectious disease pathogens. There is need to build advanced biocontainment facilities in various nations including India.

India needs to work with other nations having experience of working in the field of anti-biological warfare, and effectively increase collaboration with regional strategic partnerships such as the QSD (Quadrilateral Security Dialogue) to facilitate data sharing, sharing of expertise that can help to develop capacity building for research in the field of biological agents and finding effective ways to tackle bioweapons threat.

Conclusion:

The world today is witnessing rising cases of disease outbreaks and the risk of bioterror in such situations cannot be ruled out. In the inadvertent event of a man-made biological agent caused outbreak, the role of Forensic Microbiology becomes very important. In the world there have been utilization of microbial forensics in investigation of suspected bioterror attacks. There is need for development of greater capacity in handling cases of natural as well as man developed biological agent attack. In this regard nations must work together by applying standard and structured forensic microbiology investigative procedures with use of state-of-the-art technology and tests. India too must build an effective mechanism and strategy to tackle any future event of biological agent led terror and this would need coordinated policy and approach of all the major stakeholders.

Abbreviations:

BWC – Biological Weapons Convention.

CDC – Center for Disease Control.

PCR- Polymerase Chain Reaction.

USA – United States of America.

Dan- Deoxy Ribonucleic Acid.

SNPs = Single Nucleotide Polymorphisms.

INDELS- Insertions and Deletions.

MLVA - Multi Locus Variable number Tandem Repeats Analysis.

WGST - Whole Genome Sequencing Technique.

SWGMPF- Scientific Working Group on Microbial Genetics and Forensics.

DRDO- Defense Research & Development Organization.

ISRO- Indian Space Research Organization.

QSD - Quadrilateral Security Dialogue.

Conflict of interest- There is no conflict-of-interest.

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Ethical clearance- This is a review article, and, in this article, no personal data was divulged. Hence, there is no requirement of ethical clearance.

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REVIEW ARTICLE

Ear Biometrics and Morphological Variation in Diverse Population of World

Chhikara K,¹ Saini V.²

1,2. Department of Forensic Science, Faculty of Science, SGT University, Gurgaon.

Abstract:

Different human ethnic races have different morphological characteristics and measurements of the external ear, which can be used in forensics to identify live or deceased people. Biometrics plays an important part in individualization. The most common types are fingerprints, palm prints, retina, and iris. The face is more easily used in surveillance scenarios where fingerprint and iris capture are not feasible. However, due to variations in emotion, lighting, and make-up, the face is not yet as precise and adaptable as expected. However, ear images can be acquired similarly to facial images and used in biometry. Different human ethnic races have different morphological characteristics and measurements of the external ear, which can be used in forensics to identify live or deceased people. Biometrics plays an important part in individualization. The main contribution of this work lies in the comparative examination of the uniqueness of morphological, ethnical, and biometric variations of both ears for individualization among the different sub-population of India and other ethnic groups of the world. The study shall help anthropological and forensic science agencies with the inclusion and exclusion of persons for identification based on ear variations.

Keywords: Ear biometry; Personal identification; Ethnic variation; Forensic science; Anthropometry.

Introduction:

Biometrics is a technique for identifying or validating an individual's identity, and it is capable of accurately distinguishing between individuals. In a world where social connection is increasingly digital and financial transactions are routinely handled over the internet, it is critical to establish an individual's identity reliably.¹ Additionally, law enforcement and military applications require a reliable technique for identifying individuals for a variety of reasons. The shortcomings of standard authentication methods based on identification cards and passwords facilitated the development of sophisticated biometric systems.^{1,2} Passwords and other conventional methods of automated recognition or identification cards are susceptible to theft, forgery, and forgetfulness. On the other hand, biometric identifiers are universal, one-of-a-kind, irreversible, and quantifiable, and it provides a better level of authenticity than conventional approaches.

Classification of biometric recognition techniques: Biometric recognition is a technique for identifying or validating a person's or subject's identity based on physiological and behavioral features.

Physiological biometrics is based on measurements taken directly from a part of the human body.

Behavioral biometrics is based on data obtained from an individual's actions or behavioral traits.

Selection of a specific biometric trait: The selection of a

Corresponding Author

Dr. Vineeta Saini (Assistant Professor)

Email : vineetasaini2012@gmail.com, vineeta_fpssc@sgtuniversity.org

Mobile No: +91 9971790222; 9971793868

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particular human characteristic as a biometric trait is determined by the following criteria:

- Uniqueness refers to how well the biometric distinguishes itself from other biometrics.
- Permanence evaluates biometrics' resistance to aging.
- Collectability is the ease with which data can be collected for measurement.
- Performance accuracy, speed, and robustness of the technology utilized.
- Acceptability is a measure of a technology's level of acceptance.
- Universality is the property of being universal, existing in all places.
- Circumvention is how simple it is to deceive the system through fraudulent techniques.

One such method is ear biometry, which has all the above specifications needed for a perfect biometric system. Biometric ear recognition has several advantages over other types of recognition since its structure does not alter with age and is unaffected by facial expression, in contrast to other biometrics.¹ The human ear is larger than the iris, retinal scan, or fingerprint, and imaging capturing of the human ear is relatively easy and can be done from a distance, giving it certain benefits over other biometric systems.

The external ear flap, also known as the pinna, has several morphological components and varies (Figure 1). Although its structure is relatively simple, it varies significantly from person to person. In addition to the ear's size, color, and texture, these variations can serve as distinguishing characteristics.

Changes in facial expression and age have little effect on the appearance of the ear, but gravity and ear accessories can affect the length of the ear lobe.

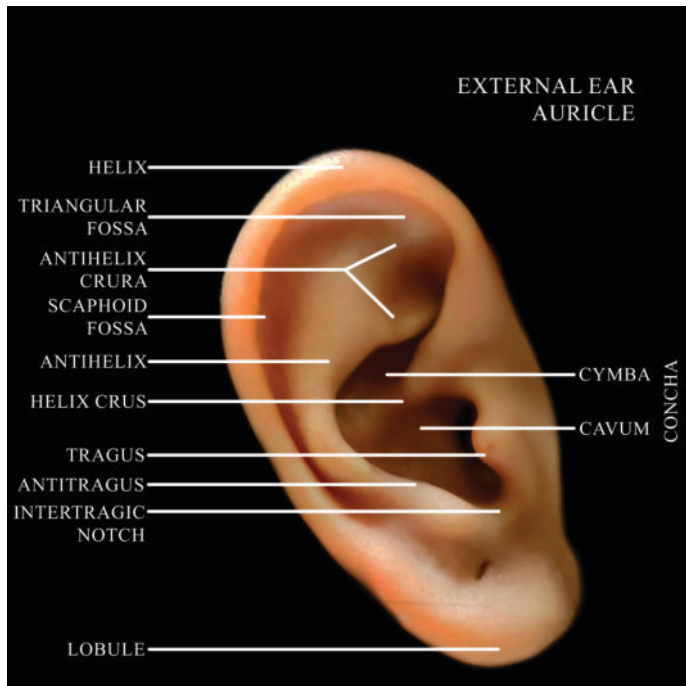


Figure 1

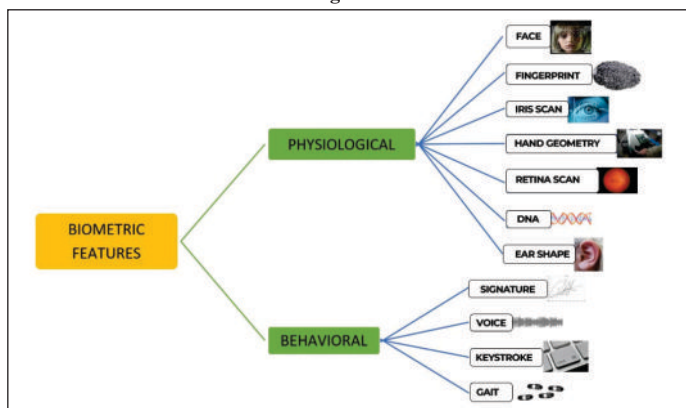


Figure 2

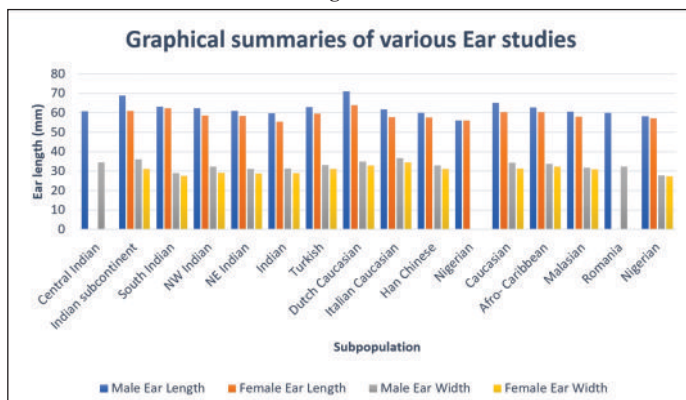


Figure 3

Importance of ear biometrics: Ear prints or impressions are occasionally discovered when a person attempts to overhear what is being said behind a closed door by placing their ear against the door's or glass window's surface. Sometimes, these prints may

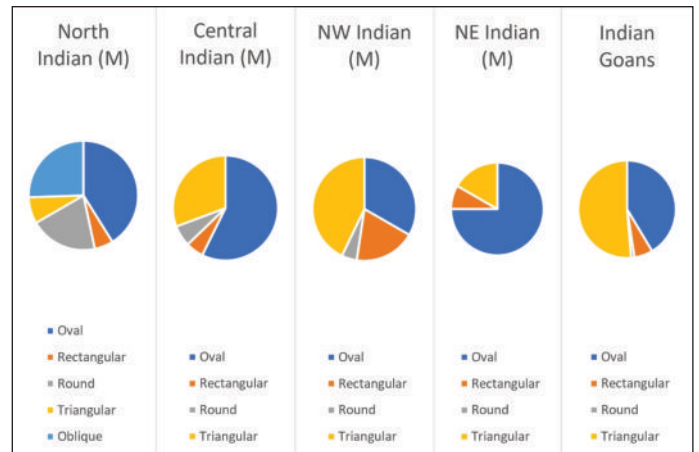


Figure 4

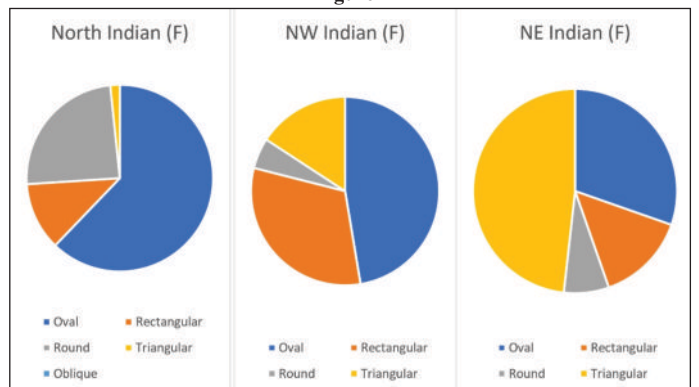


Figure 5

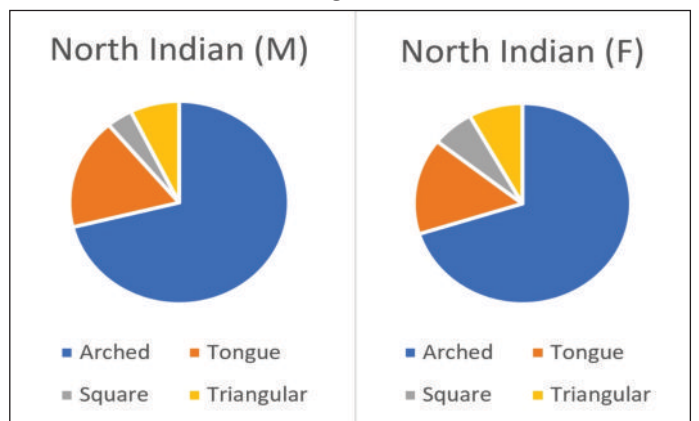


Figure 6

be found on the window glass of any room, vehicle, etc. It may be of the victim, culprit, or witness. Such occurrence of ear prints may link the suspect, victim, or another witness to the specific crime scene. These prints can be photographed or developed and examined for identification purposes. Additionally, there are instances where the face has been severely mutilated beyond recognition - in these instances; ear examination may be beneficial, if only for elimination.³ It is believed that the external ear characteristics of humans are unique to each individual and, except for size growth, do not change throughout an individual's lifetime. According to some scientists, external ear characteristics can be used to positively identify individuals with

Table 1. Summary of various ear studies for ear length and width in males and females.

S. No.	Source	Population studied	Sample collection method	Population size		Male Ear length (mm)	Male Ear width (mm)	Female Ear length (mm)	Female Ear width (mm)
1.	Purkait and Singh (2007)	Central Indian	Direct measurement	415	L	60.54	34.04		
					R	61.06	34.88		
2.	Alexander et al. (2010)	Indian subcontinent	Direct measurement	56		68.9	36.0	60.9	31.2
3.	Shireen &Kharadkhelkar (2015)	South Indian	Direct measurement	147	L	61.9	28.7	61.4	27.4
					R	64.2	29.4	63.4	27.9
4.	Verma et al. (2016)	NW Indian	Direct measurement	40	L	61.11	32.19	58.16	29.13
					R	63.74	32.3	58.9	29.48
5.	Verma et al. (2016)	NE Indian	Direct measurement	40	L	60.03	30.72	57.51	27.97
					R	61.58	31.46	59.38	29.48
6.	Kumar and Selvi (2016)	Indian	Direct measurement	100	L	58.5	31.6	53.5	28.3
					R	61.1	31.2	58.5	29.6
7.	Bozkır et al. (2006)	Turkish	Direct measurement	341	L	63.1	33.3	59.7	31.3
					R	62.9	33.1	59.5	31.2
8.	Meijerman et al. (2007)	Dutch Caucasian	Photogrammetry method	1353		71	35	64	33
9.	Sforza et al. (2008)	Italian Caucasian	3-D measurement	843	L	61.7	36.68	57.92	34.48
					R	61.7	36.68	57.61	34.52
10.	Wang et al. (2009)	Han Chinese	3-D CT Reconstruction technique	485	L	60.1	33.1	57.75	31.05
					R	59.65	32.9	57.5	31.45
11.	Ekanem et al. (2010)	Nigerian	Direct measurement	217	L	56.2		55.8	
					R	56		56.1	
12.	Alexander et al. (2010)	Caucasian	Direct measurement	288		65.2	34.4	60.4	31.3
13.	Alexander et al. (2010)	Afro-Caribbean	Direct measurement	62		62.7	33.8	60.4	32.3
14.	Kumar and Selvi (2016)	Malaysian	Direct measurement	100	L	60.8	31.9	59.9	31.5
					R	60.2	31.6	56.2	30.6
15.	Petrescu et al. (2018)	Romania	Photogrammetry method	14	L	60.69	32.71		
					R	59.27	32.16		
16.	Edibamode et al. (2019)	Nigerian	Direct measurement	112	L	58.14	27.41	57.9	27.45
					R	58.4	28.21	56.66	27.51

the same degree of certainty as fingerprints.⁴

The ear is the most distinctive facial feature and is unaffected by emotional expressions. Several studies have sought to identify individuals using ear morphology. The external ear's lobule height, lobule width, and ear length have all been studied with remarkable accuracy. Several studies explain the anatomy of the external ear.^{4,5} but there is a lack of information about morphological variation between population groups, which is important for identification and medicolegal purposes. There are 12 basic parameters of the external ear that have been investigated as mentioned previously, but the ethnicity variation among the population of India and abroad still needs to be explored.

Early development of ear biometrics: In the beginning, "Earology" was described by Lavater. Later on, this term was utilized by other people, such as Haken Jorgensen, who developed a system for recording the morphology of the ear by using ear measurements and ear molds from convicts in Denmark at the turn of the twentieth century. Several attempts, most notably by Alphonse Bertillon in 1862 and Alfred Iannarelli in the 1940s, have been made with different degrees of success to build a categorization system for the ear and found it the most distinguishing element of the body at the time. In 1906, Imhofer discovered that in a set of 500 ears, only four traits were required to identify each pair as distinct.⁶ Iannarelli published long-term research on ear recognition in 1989. Iannarelli's foundational

study comprised more than 10,000 ears and investigated the similarity of siblings, twins, and triplets, parent-child ear appearance relationships, and ethnic differences in ear morphology.⁷ More study is being done on the measurement and frequency of occurrence of specific ear traits in human populations, such as the American and Dutch studies.^{8,9}

Emeršič et al.⁹ provided a wonderful review on ear biometry and its development. Meijer and colleagues studied the external ear and measured adult ear enlargement. 919 male and 434 female Dutch subjects were evaluated for ear print anatomical changes. According to the study, males' auricles grew 0.18 mm every year and females' 0.16 mm. Between 18-29 and 30-39, the length increased significantly. Imhofer also emphasized the use of ear morphology to assess familial relationships.⁶

Various case studies demonstrate innovative approaches and practical experiences in this field. Pinna features were utilized to successfully identify catastrophe victims in a few such cases.⁹ In 2004, a Special Task Force in India used ear morphology to identify Veerappan, a sandalwood smuggler. Veerappan, an Indian timber smuggler, was also identified by the physical traits of his ear, including a flat tragus confluent with the curved region of the helix and an expanded and squarish lobule. The piercing of the lobe is also beneficial for forensic identification.⁸

Recent work focuses on developing, quantifying, and validating genetic ear variation for use in a legal setting now that it has been

Table 2. Shape of ear in diverse populations of india.

S. No.	Source	Population	Shape of Ear (in percentage)					
				Oval	Oblique	Rectangular	Round	Triangular
1.	Purkait & Singh (2007)	Central Indian	M (L)	57.3		5.6	6.5	30.6
			M (R)	57.3		5.4	6.5	30.8
2.	Dinkar & Sambyal (2011)	Indian Goans	41			6.1	1.1	50.8
3.	Verma et al. (2016)	Northwest Indian	M (L)	33.3		19.05	4.76	42.86
			M (R)	33.3		19.05	4.76	42.86
			F (L)	47.37		31.58	5.26	15.79
			F (R)	47.37		31.58	5.26	15.79
4.	Verma et al. (2016)	Northeast Indian	M (L)	75		8.33	0	16.67
			M (R)	75		8.33	0	16.67
			F (L)	29.63		14.81	7.41	51.85
			F (R)	33.33		14.81	7.41	48.15
5.	Krishan et al. (2018)	North Indian	M (L)	40	22.2	8.9	20	8.9
			M (R)	42.2	28.9	2.2	20	6.7
			F (L)	44.8	16.1	9.2	17.2	12.7
			F (R)	46	16.1	8	18.4	11.5

Table 3. Shape of left and right ear lobe in North Indian males and females.

S. No.	Source	Population	Shape of Ear lobe				
			Arched	Tongue	Square	Triangular	
1.	Krishan et al. (2018)	North Indian	M(L)	67.8	20	3.3	8.9
			M(R)	74.4	15.6	4.4	5.6
			F(L)	67.8	16.1	5.7	10.4
			F(R)	72.4	15	6.9	5.7

demonstrated as a feasible tool for identification. New Advances: Automatic ear photo identification is a contentious issue in biometrics. The ability to remotely and discreetly capture ear images makes the technology intriguing for surveillance and security purposes. The first significant endeavor in the area of ear identification, known as the Forensic Ear Identification Initiative (FEARID) project, was started in 2001.¹⁰ In this study, the usefulness of ear prints at crime scenes is investigated. From three different nations, three left and three right ear prints were obtained. When comparing prints to marks, the equivalent error rate climbed to 9 percent from its initial value of 4 percent for lab-grade photos.¹⁰

Multimodal approach: Currently, researchers apply numerous image enhancement techniques to improve picture contents based on the quality of the input image, and the initial phase focuses on these approaches. The second step consists of many researchers experimenting with feature extraction approaches to extract the image's unique properties with the appropriate degree of precision. The third phase addresses multiple distance metrics and algorithms to use and compare the ear feature vectors and make decisions for final authenticity.

Recent biometric research suggests combining multiple biometrics for better performance. In a multi-modal biometric system, data is collected from multiple biometric sources or sensors (e.g., infrared or reflected light), or multiple samples of data are combined. So, depending on availability and confidence, different subsets of biometrics can be used to make decisions. Multi-modal systems also resist spoofing better because it is difficult to spoof multiple biometrics at once. The ear has been tried to integrate with other biometric traits such as the face, gait,

palm print, fingerprint, iris images, etc. Using both the ear and the face, Chang and associates found that multi-modal recognition outperforms individual biometric recognition by 90.9%.¹¹ Victor et al. preferred the face-and-ear model. They applied the PCA method to photos of the face and ear using the same set of subjects. Their result indicated that the face and ear provide more reliable results in comparison to the ear alone.¹²

Morphometric analysis: Geometric morphometrics (GM) includes methods based on 3D coordinates of homologous landmarks that describe the studied object. It is a set of numbers that indicate a GM that allows for the differentiation of size and form variations in biological objects. This set of numbers is also referred to as a coordinate system. The quantification of shape and size using statistical GM procedures provides more precise results than other methods, increasing their reliability. The same method works for ear biometrics.¹³

One of the more recent methods is thermography. It is a method that records the emission of long-wavelength infrared radiation from surfaces to produce a visual representation of the surface's temperature. This heat radiation is sensed electronically, and the results are shown with a variety of colors, each of which corresponds to a specific temperature. Additionally, using ear thermograms may help alleviate the occlusion problem caused by hair and accessories.

Recent times have seen tremendous breakthroughs in technology, however, cost and unsolved research difficulties preclude commercial implementation of ear biometrics on large scale.

Interpretation and Analysis: The anatomy of various parts of the ear is described in Figure 1. When examining or comparing ears morphologically, we must rely on individual ear variances or features for comparison, if observable. We should consider the shape, curves, and lines of each person's ears; these ear-forming structures are unique to everyone. Ears can be oval, round, triangular, or rectangular in shape or a combination of these. The intertragal notch varies in width and height between individuals. Ear length and width vary in different populations. Additionally, we can also inspect the lobes to determine whether they are joined or unattached. Lobes can be narrow, broad, pointed, squared, flat, or wrinkled, among other characteristics. Researchers from universities, forensic labs, and national police training centers are adapting existing technologies and finding new methods for identification using the ear as supportive evidence. Identical investigations were conducted in this research. A summary and graphical comparison of several ear investigations conducted by various scientists are included in tables 1 to 3 and figure 3 to 6.

Out of 16 sub-populations studied for the review, the ethnic groups were: Indian (6), Caucasian (3), Afro Caribbean (1), Romania (1), Nigerian (2), Han Chinese (1), Malaysian (1), Turkish (1). The variables studied in different populations, demonstrated a high percentage of differences between females than in males. Males' ear lengths ranged between 56 and 71 millimeters, as shown in Table 1. The same difference was higher in females which ranged from 53.5 to 64 millimeters. Table 2 shows different types of ear shapes in the Indian sub population. As shown in Table 3, the shape of ear lobes varied significantly in North Indians. The maximum percentage of distribution is of

arched type and the least is of square type, indicating significant statistical variation between individuals. All data of the population is also represented in graphical form. Figure 3 represents graphical summaries of various ear studies included in this paper. According to the data, Dutch Caucasians have the largest ear length as compared to other population groups and Nigerian the least. Figure 4 and 5 represents a graphical comparison of different types of Shapes of Ear in males and females respectively, which depict that in most of the population group oval type is most common. Figure 6 shows a graphical representation of types of shapes of ear lobes in males in North India concluding that arched types are most common and square the least.¹⁴⁻²⁴

The analysis of collected data from various sources indicates morphological and metrical population variation in each part of the human ear. It requires the population database for ear biometrics like other body parts.

Conclusion:

Ear comparisons based on morphological and morphometric variations in specific landmarks can be used as supporting evidence for personal identification in forensic cases. Further, these differences in populations also create scope in population-based anthropological studies. There are no commercially available ear recognition systems now. However, even as researchers continue to refine the technology, the future holds tremendous potential for incorporating ear images alongside face images in a multi-biometric configuration. Assigning an ear image to one of several predefined categories, for example, may facilitate the rapid retrieval of candidate identities from an extensive database. As the technology matures, this biometric will benefit both the forensic and biometric domains.

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REVIEW ARTICLE

DNA Sampling Methods and Extraction Techniques in Forensic Odontogenetics - A Review

Dineja R.¹

Lecturer, Department of oral pathology, SRM dental college, Ramapuram.

Abstract:

Like In large-scale disasters like bombings, terrorism, hurricanes, earthquakes, air crashes, Victim identification include physical identification of documents, their jewellery, and belongings. But this identification cannot be helpful in many cases in such scenarios data related to dental, hairs, and fingerprint. In recent times DNA application in forensic dentistry have been increased. Forensic odontogenetics have expanded its reach in forensic investigation. Generally large amount of DNA is present in teeth. Since teeth can withstand extreme climate changes and high temperature which makes it to be as available evidence in mass disaster conditions. In this review methods to collect DNA from saliva, teeth, mucosal surfaces and others. Also, about the techniques of DNA extraction for identification were discussed. This is a Narrative type of review. Pubmed and Scopus indexed journal were reviewed and keywords used for searching are DNA extraction, DNA isolation, Forensic genetics, Forensic dentistry.

Keywords: DNA sampling; DNA extraction; Forensic odontogenetics; Forensic investigation.

Introduction:

Forensic odontology is a branch of Forensic sciences that uses the dentistry in identification of human being during any mass calamities, sexual assault or child abuse. Forensic odontology comes in critical time, when dental remains are the only available evidence. Now a days this branch is also growing in tenfold potential.¹ Dr. Oscar Amoedo was called as father of the Forensic odontologist. He was also awarded as doctorate for the thesis entitled 'L' Art Dentaire en Medicine Leagale' to the faculty of medicine.² In the world of medical and Forensic sciences development of genetics introduced a new dimension. Discovery of DNA (Deoxyribonucleic acid) called as human genome, helps to identify an individual information that helps the Forensic investigation which made genetics research dealing with DNA in Forensic science. There are most important three methods are involved in human identification by using genetic material that includes extraction of DNA, DNA amplification by using PCR technique (Polymerase Chain Reaction) and third method was molecule profile analysis.³ This is a narrative type of review. Pubmed and Scopus indexed journal were reviewed and keywords used for searching are DNA extraction, DNA isolation, Forensic genetics, Forensic dentistry.

Guidelines to obtain dental DNA: DNA can be extracted from saliva and tooth for Forensic odontology investigations. In 2010, Stravinos et al. have proposed certain guidelines to obtain dental DNA for Forensic investigations that includes. i) Blood or any soft tissue adherent to the tooth should be sampled. ii) Debride the

Tooth with hydrogen peroxide. iii) A conventional endodontic access can be conducted in case of intact tooth. iv) For a greater access to the pulp chamber vertical sectioning the tooth can be done. v) Pulp chamber walls can be curetted if the tooth is open. wide mouth sterile container can be used to collect Pulp tissue and powder. vi) Crushing the tooth may be performed.⁴ For Forensic odontology investigations DNA sample collection and analysis can be done by following methods that is from dental pulp, from mucosal cells – saliva, from mucosal cells – swabs, from saliva-bite-marks and other sources, from biopsy and samples were also obtained by using cigarette butts. Sampling for DNA analysis can be done by following techniques like crushing entire tooth, conventional endodontic access, Vertical split of entire tooth, Horizontal sectioning, cryogenic grinding, orthograde entrance technique.

Sampling Methods:

Crushing- In this method DNA is obtained by grinding complete teeth. But in this procedure, morphological/anatomical information of tooth is lost, that may provide information related to developmental pathology/abnormalities of the teeth.⁴ Damgaard et al., found that crushed cementum of the roots contains up to 14 times more endogenous DNA than the dentin on 14 ancient teeth.⁵

Conventional endodontic access opening procedure- In this method to restore the tooth, dental DNA is also obtained from access opening procedure. But it is difficult to obtain a sufficient amount of DNA.⁴ Recently removed intact teeth can be used for this method.⁶

Splitting- Teeth are cut down into two equal halves either vertically or horizontally. By this method A larger quantity of pulpal tissue may be obtained. The vertical splitting method may have some problems while accessing whereas horizontal splitting gives more access for pulp excavation.⁴

Corresponding Author

Dr. Dineja Raman

Email : drdineja@gmail.com, dinejar@srmist.edu.in

Mobile No.: 9688595606

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Vertical splitting- The vertical splitting method facilitates more amount of pulp tissue although the restoration and tooth are also damaged, but this technique is practically impossible. carborundum discs are used for splitting and procedure is done with extreme care. The tooth is held securely and split is done from the incisal edge along with frequent hydration. Near the pulp cavity, split was made by a chisel. Excavated pulp is transferred to vials.⁶

Horizontal section- Split is done at the enamel-dentine border. In this technique has better accessibility and also the crown remains intact. Chisel or rotary disk maybe used for this method. But rotary instrument may produce heat that damage DNA.⁶ Sectioning horizontally through the cervical root is preferred and it is used by Preseeki et al. in their studies to collect DNA.⁵

Cryogenic grinding- Liquid nitrogen is used to for grinding the tooth.⁴ Sweet and Hildebrand (1998) was the first to use this method where pulverization of a cleaned tooth is done in a freezer mill then it is cooled by liquid nitrogen. This method reduces the contamination risk and also time saving. Then the proteinase K buffer solution is used to solubilize the powder and incubated for overnight. DNA was quantified by using Slot blot hybridization. The yield of DNA was found to be around 18.4 µg per gram of powder. Main advantage of this technique is, Liquid Nitrogen is used to cool the sample which prevents the heat degradation of DNA and at the same time since the tooth is pulverised to a powder it increases surface area and also helps to expose trapped cells to biochemical agents which in turn helps to release DNA into solution. Even root filled teeth supply sufficient biological material for PCR analysis.⁶

Sampling and preparation of mucosal cells – saliva: Since saliva is very rich in DNA, it can be collected normally either as resting or stimulated saliva. If needed, diluted saliva can also be collected by rinsing the mouth with a mouthwash and spitting into a test tube. Now-a-days the Oragene test kit is being simple and safe method for sample collection.⁷ The kit consists of customized test tube along with a lid. And it has a compartment containing the Oragene solution, this solution will help for stabilizing DNA at room temperature. Collected Saliva is filled up to the level marked on it and closed, by piercing the compartment of the lid, will result in mixing of saliva and the liquid. The test tube is transported to the lab under normal or refrigerated conditions. The procedure was done in the same day, or after a week at 4°C, or a month at -70°C the purity of DNA samples and PCR results were unaffected but the quantification will be different under various condition. The collected saliva then dabbed onto specialized card - FTA cards. These cards are chemically treated filter papers specially designed for the collection and storage of any biologic samples for molecular analyses; and prevent DNA against oxidation, ultraviolet damage, bacterial and fungal degradation. Now – a day's real-time polymerase chain reaction (RT-PCR) is being widely used for sampling saliva and found to yield the highest content of DNA therefore PCR is the most recommended method. There might be some problems found in some studies even with PCR, when the specialized cards have not been used may be due to PCR inhibitors present in the saliva. These FTA cards were used and repeated washing helps to minimize the inhibition.⁷

Sampling and preparation of mucosal cells – swabs: For DNA sampling, swabbing the mucosal surface of the oral cavity with a cotton tip can be done. Dacron-coated tips, foam-coated tips, or tongue depressors are used to collect the exfoliated mucosal cells. For collecting living cells cytobrushes can be used. These cytobrush are gently and firmly pressed and rotated and removed at the site of needed. This technique extracts the basal and supra basal cells with a high nuclear content. In 2005, Burger et al. tried a new technique of buccal cell sampling which is called as the buccal DNA collector, in this method he used plastic handle with a filter paper attached to it. Greater number of swipes increased the DNA yield, sufficient DNA was obtained just from swiping twice.⁷

Salivary sampling from bite-marks and other sources: Bites marks with salivary deposits can also be a best source of DNA of a suspect. After bite mark replication additional swabbing is done. In the crime scene, saliva can also be isolated from various source for example, postage stamps and envelopes, cigarettes, straws, food and chewing gum, toothbrushes and dental floss, and dental impressions. For bite registration impression wafers are used. The quantity of DNA from impression wafers was less when compared to that of buccal swabs, mouthwash rinses.⁷

Sampling and preparation from biopsy: For examination and diagnosis purpose surgical removal of tissue from a living organism was performed that is called as biopsy. Frozen samples can be used for genetic analysis. This method is rarely used because formalin fixed tissue will limit the usefulness of the source of genetic material.⁷

DNA samples were obtained by using cigarette butts-researchers have developed specific kits for DNA analysis from cigarette butt samples. because cigarette butts contain many PCR inhibitors like phenolic/tar compounds and color and flavour additives which gave negative results in the past. In 1998, Hochmeister and his co-workers done a study where they used sterile scissors and forceps to remove 1 cm of the circumference of the cigarette butt paper and then it was cut down into quarters. Each quarter cigarette butt paper was again cut into four sections and then the paper was added to a well of a 96-well tray for PCR amplification then agarose gel for visualization electrophoresis was performed.⁷

Decontamination of DNA: samples from teeth- prior to DNA extraction from tooth, decontamination methods should be performed, most common methods for the decontamination of teeth or bones are sodium hypochlorite treatment.⁸

DNA extraction techniques: DNA extraction-From tooth material DNA can be extracted by dissolving the material in a guanidine EDTA buffer solution followed by centrifugation. The white precipitate which is obtained is again dissolved in proteinase K buffer and incubated for overnight. for inactivation of proteinase K, centrifugation is repeated.⁴

General principles of DNA extraction-DNA extraction can be classified as 3 stages cell membrane is disturbed so that lysis of the cell takes places this is the first stage in second stage protein denaturation occurs and finally in the third stage separation of a DNA is done from denatured protein.⁹

CHELEX 100 Resin: For extracting DNA from Forensic-type samples, along with PCR-Chelex 100 chelating resin extraction procedure have been developed. By using this method from dental pulp the extraction of DNA was found to be more efficient when compared to proteinase K and phenol-chloroform extraction methods. In incinerated teeth Chelex 100-based DNA extraction can be performed.¹⁰ In this method first cellular material is added to 1 ml of TE that is 1mm EDTA and 10mm Tris: pH 8.0 and then it is incubated for 10–15 minutes at room temperature. Then the tube is allowed to centrifuged at high speed to mix the cellular material and then the supernatant is removed. The cellular material pellet is again resuspended in 5% Chelex x, and it is incubated at 56°C for 15 to 30 minutes and for 8 minutes it is placed in a boiling water bath. Then the tube is again centrifuged for 2–3 minutes at high speed to precipitate protein. Finally, the supernatant contains the DNA and used in PCR.¹¹ Advantages of this method includes time saving, simple, prevent accidental mixing of the sample also avoids chemicals. Even though DNA extract by this method is crude but it is sufficiently clean to generate DNA profile.¹¹

Phenol–chloroform-based DNA extraction: This an oldest and sensitive method for the extraction of DNA This method yields high quality DNA, but it has many disadvantages like it is technique sensitive, time consuming, using harmful chemicals and mainly this method is applicable only when there is more amount of sample is available.⁸ For DNA extraction from buccal swab cells is performed by this method, first the cellular material is added to lysis buffer and proteinase K and for 15 minutes it is incubated for 56°C, then the swab is removed and phenol is added, the solution now is allowed to centrifuges and vortexed. At the interface the protein and carbohydrate precipitate forms pellicle. Again, this step is repeated till no precipitate is visible, phenols or other chemicals like chloroform is used to prevent it separating. Chloroform is added to remove the residual phenol which might interfere the PCR process, then to the sample butanol is added, lower aqueous is transferred to microcon and centrifuged at low speed, the sampled are washed with water. Finally elute the samples and store at 20 °C.¹¹

FTA paper: Buccal swabs and fresh blood samples are collected and stored by using FTA paper. Small region of the card, is taken of about 2mm in diameter of circle and placed it into a 1.5 ml tube, then the non-DNA components are washed off, which leaves only DNA on the card, added directly to a PCR. Main Advantages of this method is simple to perform and mainly this method does not require multiple tube changes, there for it will also reduce the possibility of sample mixing. This is also most inexpensive method for long-term storage of DNA.¹¹

Silica-based DNA extraction: This method is the most suitable method of DNA extraction from ancient teeth and bone. From degraded bone samples this method provided good results in nuclear STR typing. For DNA isolation bone powders are digested with proteinase K, and then finally extracting purified DNA using silica-based spin columns is an efficient method. This method also minimizes co-extraction of substances that inhibit PCR. For poorly preserved PCR resistant and ancient samples Silica-based a DNA extraction method is used which provides increased PCR amplification for those samples.⁸ First

lysis buffer and proteinase K are added to the cellular material and incubated for 15 minutes at 56-degree celcius before transferring to the spin basket ethanol is added and then lysis solution is then transferred to the spin basket with membrane that will bind with the DNA. Now the spin basket is allowed for centrifugation and DNA is captured by the help of membrane as the solution passes through it, then wash buffer is added and centrifuged. Finally, 100 µl of elution buffer is added to the membrane, and DNA is released in the absence of chaotropic salt and it's recovered by centrifugation.¹¹

Studies related to DNA extraction: In 2002, Tsuchimochi et al. conducted a study to extract DNA from dental pulp for PCR analysis. All samples heated up to 300°C could be amplified, but those subjected to temperatures above 400°C did not produce any PCR product.¹² In 2014 Pai et al., determined the PCR-based blood group on primary teeth pulp obtained from teeth stored under various environmental conditions. At pH 4 and 7 it showed 100 percentage of result.¹³ For Bite mark investigation, bacterial DNA apart from the host DNA, is another marker of important value within saliva which will be deposited during a bite mark.¹⁴ The perpetrator of a homicide can be identified through the analysis of DNA which was isolated from bite marks found on the victim.¹⁵ For DNA analyses resin prosthesis used by the patients can be used those resin pieces treated with protinase K and SDS from the basal surface.¹⁶

Conclusion: Field of Forensic dentistry should always try to incorporate these new technologies, Forensic odontogenetic provide several methods for DNA extraction from biological materials and accurate identification.¹⁷ There are many technologies like mRNA analysis, microarray techniques, oligonucleotide microarrays, next generation genome sequencing, microfluidic systems, nanotechnology; Fluorescence in situ hybridization (FISH) probes. Also plays an important role in Forensic investigation.¹⁸

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LETTER TO EDITOR

India's Latest NHRC Advisory on the Problem of Floating Corpses in the River Ganges: Forensic Dental Recommendations**Kumar A,¹ Singh R.²**Additional Professor,¹ Assistant Professor.²

1,2. Department of Forensic Medicine & Toxicology, All India Institute of Medical Sciences, Bathinda.

The review paper titled “India's latest NHRC advisory¹ on the problem of floating corpses in the river ganges: Forensic dental recommendations” was published in J Indian Acad Forensic Med. 2023 April-June 45 (2). The title of the review Article was “India's latest NHRC advisory on the problem of floating corpses in the river Ganges: Forensic dental recommendations”, but on going through the article nothing about “Latest NHRC Advisory” was discussed except for one or two points as mentioned in the advisory. Moreover, the recommendations as advised in the NHRC advisory were not discussed at all. The recommendations mentioned by the authors in their review paper were their own interpretations and viewpoints, on the dignified management of the dead. Those recommendations were not of the National Human Rights Commission.

Recommendations of NHRC are as follows:

1. Enact specific legislation to protect the rights of dead: There is a need for specific legislation to be enacted for the purpose of upholding the dignity and protecting the rights of the dead.
2. Set-up temporary crematoriums: In view of the large number of COVID deaths and long queue of dead bodies seen at crematoriums, temporary arrangements should be made urgently in order to avoid undue delay in cremation.
3. Sensitization of the staff working in crematoriums/burial grounds/cemeteries: In order to ensure that dignity is upheld during handling of dead bodies, the cremation/burial ground staff must be sensitized about proper handling of the dead body. Further, they need to be provided necessary safety equipment and facilities so that they may perform their duty efficiently without any fear or risk.
4. Performing last rites: Religious rituals that do not require touching of the dead body may be allowed such as reading from religious scripts, sprinkling holy water, etc.
5. In cases where the family members are not in a position to perform last rites: In cases where family members or relatives are not there to perform last rites as they themselves may be infected or are not willing being afraid of getting infected, etc., or where the repatriation of the body to the family may not be possible, the state/local administration may perform the last rites of the body, taking into account the religious /cultural factors.
6. Encourage use of electric crematoriums: Use of electric crematoriums may be encouraged in order to avoid the health hazards emerging from the emission of smoke from burning pyres in large number.
7. Piling of dead bodies: Piling up of dead bodies during the transportation or at any other place must not be allowed to happen.
8. Mass burial/ cremation: Mass burial/cremation should not be allowed to take place as it is in violation of the right to dignity of the dead.
9. Proper identification and information: Accurate identification of the dead body must be aimed by using different criteria for identification and the state authorities must ensure proper handling of the information about the dead and missing persons in disasters.
10. Curbing arbitrary hike of ambulance charges: To curb arbitrary hike/overcharging for transportation of dead bodies the prices of the hearse/ambulance services should be regulated so that people are not exploited and do not face difficulties in transportation of dead bodies.
11. Staff handling dead bodies to be protected and fairly paid: Since the staff at crematoriums, burial grounds, mortuaries, etc., are working round the clock during this wave of pandemic, they may be paid fair wages to compensate their hard work. Further, they should be vaccinated on priority basis keeping in view the risk they are exposed to.

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Corresponding Author**Dr. Ajay Kumar**

Email : iamdrjay@gmail.com

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