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CONTENTS

ORIGINAL ARTICLES

A Study about Knowledge and Perception of Medical Students Towards Autopsy and Attitude Towards Forensic Medicine as a Career Option07
Kunal Mishra, Bikash Chandra Nayak, Mohan Kumar Hansda, Ashim Mishra
Case Series of Pediatric Special Cases on Autopsy 13 Radhika Rai, Astha Dawani, Chakshu Sukheja, Ashok Panchonia, Meena Mittal, Mrudula Yerawar
Histopathological Spectrum of Kidney Lesions in an Autopsy 2 Years Study at Tertiary Care Hospital
Importance of Leukocyte Count, Neutrophil to Lymphocyte Ratio and Platelet to Lymphocyte Ratio in Prognosis of Pesticide Poisoning Shubham Chourishi, Vijayalaxmi S. Patil
Sexual Assault: Types and Associated Factors 31 Jayanth S.H., Basappa Hugar, Girish Chandra Y.P., Praveen S.
Estimating Sexual Dimorphism using Anthropometric Measurements of Permanent Dentition
Detection of Gunshot Residue on Glass Fired using Airguns and Insas LMG 5.56mm
Epidemiologocial Profile of Medico-Legal Cases at Tertiary Care Centre in Eastern India
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An Approach to Obscure Death: A Case Series

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A study about Knowledge and Perception of Medical Students Towards Autopsy and Attitude Towards Forensic Medicine as a Career option

Kunal Mishra¹, Bikash Chandra Nayak², Mohan Kumar Hansda³, Ashim Mishra⁴

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ABSTRACT

INTRODUCTION: The questionnaire based study was carried out with the objective to know the present knowledge of students regarding autopsy, attitude towards autopsy and probability of choosing forensic medicine as a career which can enable to find out ways to make autopsy an enriching academic exercise and further increase the acceptability of our subject.

METHODOLOGY: A questionnaire based cross-sectional study, was carried out among the 2nd year medical students at IMS and Sum Hospital, Bhubaneswar. The first part of questionnaire comprised of items in form of simple statements for which response recorded dichotomously as true or false. The first nine statements were on knowledge component and second nine items were on attitude of the students. The second part of questionnaire comprised of eight items which contained the eight reasons for forensic medicine of not choosing forensic medicine as career.

RESULTS: A majority of students were found to have reasonable knowledge of the basic autopsy procedure. 88% of the students were of the opinion that autopsy has utility in medical education. 68% of the students were confident of independently performing an autopsy. 88% of students proactively searched for information on autopsy. However only 11.54% students reported that they plan to pursue a career in Forensic Medicine.

KEYWORDS: Autopsy; Forensic medicine; Knowledge; Attitude; Career.

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INTRODUCTION

The essence of learning Forensic Medicine lies in experiential learning experience by observing autopsy which is essential for effective understanding of associated pathology This traumatology. learning and instils а sense of confidence among the students while discharging medico legal duties and also enhances inquisitiveness in clinical practice. Even stalwarts

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of medical science, Virchow and Osler, had also stressed on investigative dissection of dead body to establish pathology of fatal diseases.¹ The autopsy data play significant role in clinical auditing, clinical quality control and medical education.² Demonstration of autopsy is of prime importance in medical education, as it provides a holistic learning to students about gross anatomy of disease, pattern of injury, toxicology, protocols, the importance of death certification and thereby aid in better interpretation of death statistics.³

At present, most of the autopsy is Medico-legal autopsy carried out by specialists of Forensic Medicine permitted in Government set up and limited private medical colleges recognized by respective state governments. Few institutions also have the facility for pathological autopsy where documentation and consent process are streamlined. The new CBME curriculum has mandatory forensic posting of the interns reaffirms the significance of this discipline. Thus, it becomes essential for medical graduates to be capable of conducting an autopsy in a peripheral set up mandating the goal of an Indian Medical graduate making it locally relevant. Even Forensic Medicine was included in 3rd Professional year a vertical shift to put forth the importance of this subject. Although a post graduate degree in Forensic Medicine establish role as an expert conforming to Section 45 and 46 of Indian Evidence Act, the vacant PG seats of the discipline has questioned the existence of this subject. The vacuum in faculty positions is tangible and substantive which could have devastating effect on the Medico-legal work in coming years.

Despite the seemingly overwhelming importance of autopsy study in medical education, literature search indicates that the forensic autopsy rates have stayed stagnant, throughout the world. Authors had already pointed decline of autopsy as an educational tool as an alarming sign and the fact that many freshly graduating Medical undergraduates and junior doctors have never attended an autopsy, during their training.⁴ Thus, it was imperative on the part of authors to carry out this study to know the present knowledge of students regarding autopsy, attitude towards autopsy and probability of choosing forensic medicine as a career which can enable to find out reasons of this stagnancy.

MATERIALS AND METHODS

A questionnaire based cross-sectional study, was carried out among the 2nd year medical students at IMS and Sum Hospital, Bhubaneswar, a tertiary care teaching hospital in Odisha, India. After necessary approval, a total of 104 students consented to participate in the study and the anonymity and confidentiality of the collected data was maintained.

The questionnaire was framed with the objective of analyzing the knowledge, and attitude of students and pre-validated after deliberation with the Forensic Medicine faculty of three Government Medical Colleges and two private Medical Colleges of the state of Odisha. The first part of questionnaire comprised of items in form of simple statements for which response recorded dichotomously as true or false. The first nine statements were on knowledge component and second nine items were on attitude of the students. The second part of questionnaire comprised of eight items which contained the eight reasons for forensic medicine losing its significance as a career option which students had to number with 1 as the primary reason to 3 as third common reason. It was pretested on 10 students and subsequently modified with reframing of some items. Data wereanalyzed using SPSS version 22.0 and expressed in percentage and means.

RESULTS

A total of 104 students who took part in the study, all the students had basic knowledge of the procedure of conduct and primary objective of autopsy evident from 100% true response to the first four items (Table 1) 95.2% knew about types of skin incisions in autopsy while 72.1% of the students had knowledge regarding procedure to preserve viscera. 90.4% had knowledge about negative and obscure autopsy while 31.7% gave a true response to knowledge regarding the time since death. (Table 1)

It was found that 72.11% of students were comfortable in their first exposure to autopsy room and all students felt the essentiality of autopsy training during MBBS. 74% of students were not comfortable with observing autopsy on a close relative while only 8.65% students would prefer to skip observing an autopsy if they had options. Majority of students viewed autopsy as scientific study and not disrespectful to the dead body. However only 65.4% of students were confident of performing a medico legal autopsy independently. 84.6% of the students searched internet and other learning modules for better experiential learning and almost hundred percent enjoyed this experience. But when it came to choose forensic medicine as a career only 11.54% were interested to

study further. (Table 2)

Stigma associated with dealing with dead body rather than a patient was the primary reason by 48 (46.2%) students followed by limited scope of super specialization by 30 (28.84%) students.

Table 1: Response of students regarding knowledge about autopsy.

SL. No.	Statements	True response	False response
1.	Medico-legal Autopsy done in all deaths.	0	104 (100%)
2.	Autopsy is done primarily to find the cause of death.	104 (100%)	0
3.	Police requisition, Inquest Report and Dead body challan are three essential items before conduct of medico legal autopsy.	104 (100%)	0
4.	Autopsy involve both external and internal examination.	104 (100%)	0
5.	There are basic three types of skin incision given in a Medico-legal autopsy.	99 (95.2%)	5 (4.8%)
6.	Preservation of viscera is done in all cases of autopsy.	7 (6.73%)	97 (93.3%)
7.	Supersaturated solution of common salt is used for preserving viscera in poisoning cases.	75 (72.1%)	29 (27.9%)
8.	An autopsy can reveal the cause of death in all cases.	10 (9.6%)	94 (90.4%)
9.	Inference about a range bound time since death is possible from external and internal post mortem changes	33 (31.7%)	71 (68.3%)

Table 2: Response of students regarding attitude towards autopsy

SL. NO.	Statements	True response	False response
1.	l am comfortable on my first exposure to autopsy.	75 (72.11%)	29 (27.88%)
2.	I feel autopsy is essential for medical education.	104 (99%)	0
3.	I am comfortable with autopsy conducted on my close relative.	27 (25.96%)	77 (74.03%)
4.	I choose to skip an autopsy demonstration if I had a chance.	9 (8.65%)	95 (91.35%)
5.	The autopsy is a disrespect to the dead body.	13 (12.5%)	91 (87.5%)
б.	I am confident enough to perform an autopsy independently with out assistance after graduation.	68 (65.4%)	36 (34.61%)
7.	I proactively search for information and knowledge about autopsy in journals and internet.	88 (84.6%)	16 (15.4%)
8.	I enjoy the experiential learning during the autopsy.	104 (99%)	0
9.	I am interested to pursue a post graduate degree (MD) in Forensic Medicine as a career option.	12 (11.54%)	82 (78.8%)

Table 3: Reasons for not opting Forensic Medicine as a career

Reasons	Primary reason	Second reason	Third reason
Stigma in dealing with dead body	48	18	4
Limited scope	30	17	22
Dealing with police and court	12	31	29
Erratic timing of work	3	10	12
No holidays in govt set up	2	2	10
Only academics in private set up	3	4	1
Limited job prospects	5	12	6
Work pressure	1	10	20

Indian journal of Forensic medicine and pathology. volume 17, number 1, january - March 2024

Dealing with police and court was the second common reason by 31(29.8%) students. Work

pressure was the last reason since it was present in

all streams of medical profession. (Table 3)

DISCUSSION

The autopsy used to be considered vital for acquiring of medical knowledge and has been considered central in the training of medical students.⁵ Our observations were line with authors who had shown that a majority of students were conscious of practical utility of autopsy in medical education and consensus on making autopsy mandatory for all medical students.⁶

However, our result was not in agreement with the study in India which found that almost one third of the students, were ignorant about importance of autopsy examination in the country.⁷

An autopsy procedure involves extensive which dissection could make the students emotionally unstable if performed on a known person. Our finding similar to a study conducted at United Kingdom where majority of the students, rejected the idea of an autopsy being conducted on a close relative.8 However a study in Sweden showed 90% of students agreed to autopsy being performed on themselves proving adoption of the procedure as basic necessity.9 Although we have advanced in different fields, with regard to autopsy we have a static mind set and still considered a taboo in many parts of our country. Our findings were similar in view with a study done at Gujrat where autopsy was regarded as an important learning tool which was essential in medical education and opined of more exposure during the training period.¹⁰

Earlier study revealed that the scientific interest was the primary motivation for choosing forensic as a career. While the fear of death was more intense in students rejecting forensics. The study also observed stereotypical mentality about forensic doctors significantly modified the decision of students.¹¹ Another earlier study by researchers identified independent risk factors five for negative psychological reactions towards forensic dissections which were female gender, stereotypic beliefs, a less cognitive and more emotional frame of mind relative to forensic dissection, more passive coping strategies, and greater fear of death.¹² There were 31,185 PG seats in 2014, which increased to 64,059 in 2022. The government is having a target of 80,000 PG medical seats by 2024.13 The students had been more inclined towards clinical subjects. The time has come for introspection and inculcate good practices of fair practices of medical colleges of national and international repute. The grey

areas of our curriculum like Toxicology, Forensic Psychiatry and Clinical Forensic Medicine needs focus. The faculty need to update his knowledge and skills and keep abreast of recent developments.

Limitations of our Study

The cross-sectional nature of the study and less number of participants were the major limitations. A qualitative study could provide a better insight. Multidisciplinary studies involving other subject experts could be carried out to assess the student's choice for career.

CONCLUSION

The findings of the present study, indicate that students do possess a fair knowledge of medico legal autopsy. The autopsy being a crucial component of medical education, medical students must acquire reasonable skill to perform autopsy by themselves. A finding of concern in the general apathy of medical students to pursue a career in Forensic Medicine.

The reasons provided for not choosing Forensic Medicine is APT as increased MD/MS seats had increased the probability of a student to pursue a different career path. It has also left us with introspection as to enrich the student learning experience. The introduction of DM, Toxicology in AIIMS, Raipur and DM, Forensic Pathology in AIIMS, Jodhpur has proved to be pivotal.

The Fellowship courses undertaken by Indian Society of Toxicology and Indian Academy of Forensic Medicine also act as catalyst in regenerating interest. A earnest effort is required to change the fixed mindset of our fraternity. The Bioethics part in AETCOM curriculum also can be explored under this discipline. Innovations in teaching is imperative to rekindle the interest of students in our discipline.

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Case Series of Pediatric Special Cases on Autopsy

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ABSTRACT

CONTEXT: Medico-legal autopsy is performed to find out the cause, time of death and identify diseases which could have contributed to the death. Gross and microscopic examination, toxicological analysis and laboratory investigations will aid in establishing the cause of death. Histopathological analysis is considered as the gold standard in finding out a cause of death in cases of sudden death or when there is no history of any previous illness.

METHODS AND MATERIAL: Four infant autopsies were conducted and their respective organs which included lungs, liver and brain and were received in our department.

STATISTICAL ANALYSIS USED: Results were tabulated, analyzed, and subjected to statistical analysis using SPSS (Statistical Package for Social Sciences) Software (Trial version).

RESULTS: First case showed fat emboli which was an incidental finding. Second was a case of hyaline membrane disease in a newborn. Third one was a case of steatohepatitis in a 9 month old child and the last one was an incidental finding of gemistocytic astrocytoma which was undiagnosed antemortem.

CONCLUSION: The precise cause of death must be determined with reference to clinical, autopsy, and forensic findings before reporting histopathological finding. Histopathology in autopsy plays a vital role in the study of some of the rare lesions contributing to the knowledge of pathology. This study highlights the various incidental and rare cases in autopsies, which are of critical value in academic and research purposes.

KEYWORDS: Fat emboli; Gemistocytic astrocytoma; Hyaline membrane disease; Autopsy; Incidental finding.

Key Messages: Histopathological evaluation of various incidental and rare cases in autopsies.

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INTRODUCTION

Medico-legal autopsy is performed to find out the cause, time of death and identify diseases which could have contributed to the death. Gross and microscopic examination, toxicological analysis and laboratory investigations will aid in establishing the cause of death. Histopathological

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analysis is considered as the gold standard in finding out a cause of death in cases of sudden death or when there is no history of any previous illness. Histopathological analysis may reveal co existing diseases or incidental findings which may not have been diagnosed ante mortem. Sometimes such diseases must have caused sudden death and was diagnosed only at autopsy. These incidental findings may serve as a learning tool for pathologists and also to assess the mortality statistics which play an important role in health and treatment planning. Various studies have proved that autopsy helps to establish the cause of death as well as to study disease in situ thus enriching medical knowledge and making various rare diagnoses.

Autopsy of newborns and infants can provide vital information to clinicians and families about the causes of death and the accuracy of antemortem clinical diagnosis. Since clinical manifestations of conditions in newborn infants are often nonspecific, unintentionally delayed, wrong, or missed diagnoses are still inevitable. The present study was undertaken to evaluate the various accidental findings that were undiagnosed during the person's life.

CASE SERIES

We present a case series of four pediatric patients where interesting incidental findings were obtained on autopsy without any specific antemortem clinical diagnosis.

Case 1

The first interesting case was that of a two days old male baby brought dead to hospital. The lung appeared normal on gross examination.



Fig. 1: H & E showing deposition of fat cells in the alveolar parenchyma.

Microscopy from lung tissue showed dilation and disruption of alveoli. At places alveoli were filled with fluid. Interalveolar septa showed inflammatory cell infiltrate. Blood vessels showed congestion, fat globules and nuclear debris which lead to the diagnosis of fat embolism.

Case 2

Patient 2, was a 2 days old male baby who was admitted to the nicu with chief complaints of respiratory distress but died within 2 days of admission. Autopsy was done and histopathological examination of lungs were characterized by typical hyaline membrane lining the respiratory



Fig. 2 A 6 B: H & E micrograph showing deposition of hyaline membrane in the alveoli. A: 10x view, B: 40x view.

bronchioles and alveolar ducts. Other prominent findings were atelectasis, interstitial edema and congestion and lymphatic dilatation. This disease, associated with surfactant deficiency in premature infants, is characterized by eosinophilic hyaline membranes lining the airspaces, bronchioles, and alveolar ducts. There is little inflammatory reaction.



Fig. 2 C: Gross image of hyaline membrane disease. *Case 3*

Patient 3, a 9-month old male was admitted in the NICU with the complaints of fever and abdominal distention who died within a day of admission. Autopsy was done. Grossly the liver appeared shrunken with presence of multiple small yello wish nodules. Microscopy showed extensive fatty changes, periportal inflammatory cell infiltrate along with presence of focal fibrotic changes and congestion. The diagnosis of steatohepatitis was made corresponding with the gross and microscopic features.



Fig. 3A: Gross image of shrunken liver showing yellowish nodular deposits.



Fig. 3B: H & E micrograph showing extensive mixed (microvesicular and mancrovesicular) fatty changes.

Case 4

A 9-year-old male child was brought dead to the hospital. The attenders gave history of seizures. The histopathological examination of brain after autopsy revealed presence of fair number of gemistocytes that are large tumor cells with abundant dense eosinophilic, and eccentrically displaced nucleuswith small nucleoli. Perivascular lymphocytic cuffing was noted.



Fig. 4A: Gross image of a single well defined nodule in the brain tissue.



Fig. 4B: H & E micrograph showing large tumor cells (gemistocytes) having abundant eosinophilic cytoplasm and eccentric nuclei.

MATERIALS AND METHODS

A prospective study of four infant autopsies was conducted and their respective organs which included lungs, liver and brain and were examined which were received in MGM Medical college Indore for pathology department for evaluation.

RESULTS

The histopathological examination of autopsies showed following results:

- 1. Fat emboli which was an incidental finding.
- 2. Second was a case of hyaline membrane disease in a newborn.
- 3. Third one was a case of steatohepatitis in a 9 month old child.
- 4. And the last one was an incidental finding of gemistocytic astrocytoma which was undiagnosed antemortem.

DISCUSSION

Case 1

Fat embolism is characterized by the presence of fat globules in the circulatory system. This is very common condition especially after long bone fractures and in several other conditions, such as surgery, septicemia, sickle-cell anemia, pancreatitis, acute respiratory distress, osteomyelitis, and cardiopulmonary resuscitation (CPR). The lungs, central nervous system, skin, and kidneys are the most frequently affected organs in FE, and mortality due to this complication is about 5–15%.

Isolated pulmonary FE (IPFE) is a particular manifestation of FE characterized by the presence of fat globules in pulmonary vessels, without any evidence of FE in other organs. The presumable diagnosis of IPFE is difficult due to obscured clinical symptoms, and laboratory and radiological findings are not always indicative. Therefore, definitive diagnosis of this is established by histopathological examinations of postmortem lung tissue samples.

Etiological factors contributing to the development of IPFE have not been clearly documented, especially in atraumatic patients without known risk factors. Though studies have reported that a number of patients with pulmonary FE also had CPR history, more data are still required about the contributions of CPR to the development of IPFE.

Case 2

Pulmonary pathology is one of the commonest causes of death in preterm babies in most of the autopsy studies. The thyroid transcription factor-1 (TTF-1) plays a vital role in morphogenesis of lung and differentiation of pulmonary epithelial cells as well as in the transcription of surfactant proteins and Clara cell secretory protein. Hyaline membrane disease is a type of acute lung injury seen in neonates. Hyaline membrane disease occurs as a result of surfactant deficiency owing to prematurity. Though surfactant granules can be seen in lungs as early as 20 weeks of gestation, surfactant is produced in sufficient quantities only around 34 weeks. Surfactant deficiency leads to increased alveolar surface tension, along with subsequent resistance to inflation which results in collapse of the alveoli at the end of expiration. In this process, the alveoli become injured, as a result of shear stresses on the alveolar walls. Increase in either mechanical ventilation pressures or the respiratory effort can lead to severe form of lung injury ultimately leading to diffuse alveolar damage.

Case 3

Various conditions, more commonly chronic liver diseases, can lead to cirrhosis in children and adolescents. In infants, cirrhosis is most often caused by biliary atresia and genetic metabolic diseases, while in older children, it tends to result from autoimmune hepatitis, Wilson's disease, alpha-1-antitrypsin deficiency and primary sclerosing

16

cholangitis. Histologic features of pediatric liver diseases are mild steatosis which may mimic nonalcoholic fatty liver disease or nonalcoholic steatihepatitis. With progressive parenchymal damage, fibrosis and cirrhosis develop.

Case 4

In the 5th edition (2021) of the WHO classification of CNS tumors, the term gemistocytic astrocytoma is no longer recognized as a specific diagnosis. Rather, gemistocytic differentiation is a feature that may be observed in both IDH mutant and wild-type astrocytic tumors.

Gemistocytic astrocytomas, an isolated as variant, account for no more than 10% of WHO grade II astrocytomas. Histologic preparations of gemistocytic astrocytomas readily reveal the distinctive cells with large eosinophilic, plump to slightly angulated cytoplasm, and eccentric nuclei. The tumor cells may project short, delicate glial processes that confer a mildly fibrillated pattern to the tumor matrix. Multinucleate cells are not uncommon, but a highly variable small glial cell component appears to be mitotically active, in contrast to the gemistocytic tumor cells. Strong GFAP immunoreactivity in the gemistocytes is consistent with the ultrastructural finding of numerous bundles of intracytoplasmic filaments. Perivascular lymphocytic infiltrates appear to be more common in this variant than in other astrocytomas. Gemistocytic astrocytomas may

behave more aggressively 201 than other WHO II diffuse astrocytomas, and around 80% of these tumors progress to glioblastoma. Molecular genetic analyses of gemistocytic astrocytomas indicate that TP53 mutations are a genetic hallmark of this variant, whereas PTEN mutations are absent in low grade and rare in anaplastic gemistocytic astrocytomas.

CONCLUSION

The precise cause of death must be determined with reference to clinical, autopsy, and forensic findings before reporting histopathological finding. Histopathology in autopsy plays a vital role in the study of some of the rare lesions contributing to the knowledge of pathology. This study highlights the various incidental and rare cases in autopsies. which are of critical value in academic and research purposes. Certain findings in our study lead to conclusive diagnosis and helped in reaching the diagnosis, some of which were indeterminate at the time of death. These incidental findings in autopsy has revealed the histopathological changes that help in the understanding of disease processes which are otherwise rare for a pathologist to encounter in the day to day specimens.

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Histopathological Spectrum of Kidney Lesions in an Autopsy 2 Years Study at Tertiary Care Hospital

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ABSTRACT

Autopsy survey of 110 cases of kidney specimen over a period of 2 years done in Vyedhi institute of medical science and Research centre, Department of Pathology, Bangalore. Kidney diseases are due to sequelae of primary or secondary accumulation of risk factors such as diabetes, hypertension, dyslipidaemia and obesity. Autopsy helps in the establishment of diagnosis and determines the cause of sudden death of known and unknown aetiology. Histopathological examination of renal tissue in autopsy gives valuable information for identifying the risk factor for various renal diseases and to monitor the disease trends.

KEYWORDS: Autopsy; Kidneys; Histomorphology; Glomerular disease; Risk factor.

INTRODUCTION

Autopsy is still an important diagnostic procedure despite improvements in ante mortem diagnosis and modern diagnostic facilities available, missed diagnosis discovered during autopsies is still as high as 44.9%.¹ Henriksen postulated that the examination of kidney and the interpretation by the pathologist is a factor of

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training in renal pathology and experience. The findings at post-mortem examination of the kidney might be crucial for the family members of the deceased especially those with genetic components as the kidney is rarely biopsied in many medical renal diseases in critically ill patients.²

Some of disease are only diagnosed at autopsy as they don't cause any functional derangement. Medical renal diseases are frequent during autopsies, most of them are unnoticed cases brought for examinations although they are mostly under recognized and significant diagnosis can be missed as well. Thus the autopsy provides a unique opportunity to confirm the clinical suspicion of medical renal disease, establish the effect of systemic disease on the Kidney and also diagnose the occult renal pathology.²

This study emphasizes on various disease that are seen in the kidney at autopsy includes glomerular diseases, tubulointerstitial diseases and vascular diseases. Histopathological features of acute tubular necrosis and arterionephrosclerosis also studied in the autopsy kidneys. Hence this study was conducted to assess the histopathological spectrum of renal lesions and the frequency of various renal lesions.

AIMS AND OBJECTIVES

The main aim of this study was to analyze the histopathological spectrum of renal lesions and to find the frequency of various renal lesions and to categorize the renal lesions according to the histomorphological findings in relation to sex and age.

MATERIAL AND METHODS

Retrospective study was conducted on renal specimens of 110 routine autopsies received in Vyedhi institute of medical science and Research centre, Department of Pathology, Bangalore were examined grossly as well as microscopically. Postmortem examinations were being done in our institution for common cases are road accidents, drowning, hanging, poisoning and with death due to chronic medical disease. Kidney specimens were mostly received as part of examination of multiple viscera. The medical history and clinical history was recorded. The received specimens of kidneys were fixed in 10% formalin, weighed and dimensions measured were recorded. A minimum of two sections per kidney were studied. All the histological sections were stained in H & E stain & mounted. All the histological sections were examined microscopically & findings were recorded and tabulated.

RESULTS

A total of 110 cases which was sent for kidney autopsies a maximum of male cases were seen. Males constituted 81 percent (89 cases) and Females, 19 percent (21 cases), the male to female ratio was 4.23:1. The series had 66 cases (60%) without any remarkable pathology in the kidney tissue. Congestive changes, a non-specific common feature in autopsies in various organs, were found in the renal tissue in 18 cases (16.3%). The remaining 26 cases with definitive Kidney lesions were examined. Out of 26 cases, 4 cases of Glomerulosclerosis (3.6%), 2 cases of Glomerulonephritis (1.8%). The common pathologies were the predominant involvement of tubular and interstitial components in 20 (18.1%) cases. In these 1 case of Tubular Hemorrhage (0.9%), 11 cases of Tubular Necrosis (10%), 2 cases of Pyelonephritis, 1 case of Interstitial Nephritis (0.9%), 1 case of Renal Arteriosclerosis (0.9%), 2 cases of Simple cyst (1.8%). There were 2 cases that had involovement of all components of renal tissue (ESRD) and only one case of (0.95%) cases with only vascular lesions.

DISCUSSION

The term autopsy is derived from the Greek word "autopsies" meaning auto (oneself) and opsis (eye) which is "to see for self." Medico-legal autopsies are a mandatory specialized surgical procedure conducted on the corpse to determine the cause of death. Autopsy remains an important tool for the quality assessment of clinical diagnosis. Various findings, unrelated to the cause of death may be noticed during histopathological examination of various organs and tissues retrieved during autopsies. It is important that pathologists pay attention to kidney examination as most medical renal lesions are likely to be missed. The frequency of Renal lesions in autopsy kidneys tabulated in Table 1

Table 1: Frequency of Renal lesions in autopsy kidneys

	Histomorphological Findings	Males	Females	% of Cases
I.	GLOMERULAR LESIONS			5.4%
•	Glomerulosclerosis	4	0	
•	Glomerulonephritis	2	0	
II.	TUBULAR LESIONS			13.6%
•	Tubular Hemorrhage	1	0	
•	Tubular Necrosis	9	2	
•	Pyelonephritis	1	1	
•	Interstial Nephritis	0	1	
III	VASCULAR LESIONS			0.9%
•	Renal Arteriosclerosis	1	0	
IV	. RENAL CELL CARCINOMA	0	0	0%
V.	OTHERS			3.6%
•	Simple Cyst	1	1	
•	End Stage Renal Disease	2	0	
•	Nephrolithiasis	0	0	
VI	. NORMAL HISTOLOGY	53	13	60%
VI	I. CONGESTION	15	3	16.3%
TC	ITAL: 110 CASES	89	21	

In the present study the maximum number of cases were seen in the age group 21-40 years (42.7%) which were similar tostudies conducted by Amandeep et al^3 and Sapna et al^4 . And Study done by Jesu et al⁵ showed the age ranged from 17 to 70 years with male predominance. Maximum deaths occurred in the age group between 31 and 35 years and males were affected more than females. They attributed the higher age group involvement to the demographic pattern of the population with higher elderly population. (Table 2) In the present study, Kidney lesions are predominate in males (89%) and females (19%). Several authors have reported male preponderance (shown in Peichart) All histopathological findings of renal autopsy of present study is compared with the study Amandeep et al (2018)

In current analysis in 66 (60%) cases the microscopic findings were close to normal histology. The studies conducted by Amandeep *et al* (2018),³ Vaneet *et al.*¹¹ Utsa *et al*⁸ (2014). Show lesser in number, this could be due to the fact that their study was a specially designed clinical autopsy series to find out renal diseases that go unrecognized. (Table 2).

Table 2: Comparable study- Maximum affected age group

SI. No.	Study	Age Group
1	Jesu et al (2014)	31-35
2	Sapna et al(2016)	21-40
3	Amandeep et al (2018)	21-40
4	Present Study (2021)	21-40



SEX DISTRIBUTION OF CASES

 Table 2: Comparison of percentage of normal histology in various studies.

SI. No	Study	Cases
1	Vaneet et al (2017)	27 out of 120 cases (22.5%)
2	Utsa et al (2014)	23 out of 55 cases (41%)
3	Amandeep et al(2018)	25 out of 100 cases (25%)
4	Present Study 2021	66 Out of 110 cases (60%



The Chronic kidney disease is now recognised as a major global public health problem and is an independent risk factor for cardiovascular disease and affecting 10-15% of adult population worldwide. In the present study, nephropathological changes were seen in 40% of renal autopsies. The Glomerular changes (Fig. 1) were present in 6 cases (5.5%). The studies by Monga *et al.*⁶ (20%) and Hailmariam S *et al*⁷ (28%) showed slightly higher percentage of renal lesions. (Table 3) In our study it is less, the reason we analysed only histomorphological changes in all renal lesion autopsy kidneys.

 Table 3: Comparison of percentage of Glomerular lesions in various studies

SI. No	Study	Cases
1	Monga el al (1997)	25 cases out of 120 (20%)
2	Hailemariam S et al (2001)	67 cases out of 237 (28%)
3	Amandeep et al (2018)	17 cases out of 100 (17%)
4	Present Study (2021)	6 cases out of 110 (5.5.%)



Fig. 1: H&E, 10X The microscopic picture show Glomerulosclerosis

In our series among kidney lesions the predominant diagnosis was tubular necrosis 11 cases and etiology was trauma, sepsis, endogenous toxins and shock. Acute tubular necrosis is seen on histology as disruption of the lining epithelium of the tubules (Fig. 2) This is the most common cause of clinical Acute Kidney Injury (AKI) in hospitalized patients and it could be ischaemic or toxic. It results commonly from hypotension, sepsis, endogenous toxins and nephrotoxic drugs such as antibiotics and chemotherapeutic drugs. It is not easy distinguishing autolysis from AKI from autopsy samples. Autolysis commonly is more widespread, show complete detachment of the tubular cells in the lumina with preservation of the brush borders that are easily demonstrated on PAS stain.



Fig. 2: H & E, 10X, The microscopic picture showtubular necrosis

In present study, the involvement of tubular and interstitial components was found in approximately 20 (18.1%) cases. Among 20 cases the 2 cases (1.8%), with end stage renal disease involving all the components of renal tissue. Chronic pyelonephritis is a descriptive term that refers to the presence of chronic inflammation within the tubules and interstitium and scarring due to bacterial infection (Fig. 3) It could be obstructive or non-obstructive.¹⁰



Fig. 3: H&E, 10X The microscopic picture show pyelonephritis

There were two (3.6%) cases of cyst presented with incidental findings (Fig. 4) with and one case (0.62%) of arteriosclerosis. Most studies confirm that atherosclerotic involvement of the intrarenal vasculature is common in the elderly population.⁹



Fig. 4: H6E, 10X The microscopic picture show renal cyst lined by flat epithelium

In the present study was observed 18 (16.3%) cases congestion of kidney in the interstitial space and glomeruli (Fig. 5) was observed due to electrocution, road traffic accidents and trauma.



Fig. 5: H&E, 10X The microscopic picture show congestion

In summary the most common findings are of near normal histology and congestion fallowed by non glomerular lesions and glomerular lesions. The autopsy provides a valuable renal pathology educational tool, as a wide range of medical renal lesions can be seen from kidneys examined at post mortem. It is known that complication of CKD and AKI includes cardiovascular diseases, death and ESRD.

CONCLUSION

The study highlights the various lesions of kidney found in renal tissue obtained on autopsy. Histopathological examination of autopsy kidney lesions helps in identifying cause of death of known and unknown etiologies. Common causes can be identified, and preventions can be taken at earlier stages to either reduce the occurrence of the disease by reducing risk factors or by reducing the advancements of the disease.

KEY POINTS

1. Kidney is vulnerable to a wide variety of

autoimmune, metabolic, toxic, microbial and circulatory insults.

- 2. Henriksen postulated that the examination of kidney and the interpretation by the pathologist is a factor of training in renal pathology and experience.
- 3. Prevalnce of Chronic kidney disease (CKD) from hospital studies is high and ranges from 11.4 to 26% cardiovascular diseae and mortality risks are significantly increased in patient with end stage renal disease (ESRD) and CKD worldwide.
- 4. The Use of autopsy findings in conjunction with other scientific methods and investigate techniques remains as valuable today as it was centuries ago, both in daily practise and for scientific endeavour.

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Importance of Leukocyte count, Neutrophil to Lymphocyte Ratio and Platelet to Lymphocyte Ratio in Prognosis of Pesticide Poisoning

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ABSTRACT

CONTEXT: Pesticides are chemical compounds used for crop protection and poisoning with them is a very common occurrence in farmers. In an emergency setting, the identification of quick and powerful prognostic markers can be of high significance in the management of these patients.

AIMS: To assess the severity of Pesticide Poisoning by assessing the leukocyte count, neutrophil count, neutrophil-lymphocyte ratio (NLR) and platelet lymphocyte ratio (PLR) and its comparison with levels of Plasma Cholinesterase (PChE) as an aid to clinical diagnosis, for early treatment of the patients.

SETTINGS AND DESIGN: Hospital based Cross-sectional study. Study period 1st November 2018 - 30th May 2020

METHODS AND MATERIAL: Study was done on 148 confirmed cases of pesticide poisoning over a period of 1.5 years. Blood samples were collected in EDTA and plain vacutainers within 24 hours of admission and the values of total leukocyte Count (TLC), neutrophil count, NLR, PLR and PChE were measured and compared. The severity of poisoning was assessed according to Peradeniya Organophosphorus (POP) scale.

STATISTICAL ANALYSIS USED: Mean ± SD, Chi square test for association, Comparison of mean using ANOVA test for comparison between and among groups, Sensitivity and specificity

analysis.

RESULTS: 89.86% and 10.14% of cases were due to poisoning by Organophosphorus compounds and carbamate respectively. The severely poisoned patients according to POP scale had more leukocyte count, neutrophil count, NLR and PLR; and less plasma cholinesterase level as compared to the patients with mild and moderate poisoning.

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CONCLUSIONS: Total Leukocyte count,

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neutrophil count, NLR and PLR are simple and easy to use parameters for estimating the severity of pesticide poisoning and assessing its prognosis. In resource limited setups, along with the clinical history, these basic CBC parameters can be useful and patient's immediate treatment can be started as early as possible.

KEYWORDS: Pesticide Poisoning; Organophosphorus poisoning; Neutrophil to lymphocyte ratio; Platelet to lymphocyte ratio; Plasma cholinesterase.

INTRODUCTION

Pesticide poisoning is common among farmers and it contributes to 2,50,000-3,00,000¹ deaths and 76,000² deaths worldwide and in India respectively. In India, highest incidence of suicides due to poisoning has been estimated as 8 to 43 per population.³ Continued 1,00,000 investigation of these chemicals over the past seventy years has produced greater variants of organophosphorus pesticides and nerve agents.4,5 Pesticide poisoning causes increased free radicals in the body which leads to noticeable changes on the direct (Leukocyte count) and calculated (NLR and PLR) parameters of CBC. At a primary setup, where cholinesterase levels cannot be performed, these parameters can help in assessing the prognosis of patients if combined with clinical history.

SUBJECTS AND METHODS

The study included 148 patients clinically diagnosed with pesticide poisoning at the time of admission to the Casualty of Shri B.M. Patil Medical College, Hospital and Research Centre Vijayapura, between 1/11/2018 to 30/05/2020. The effects of poisoning on various muscarinic and nicotinic receptors^{6,7,8,9} were evaluated largely based on the Peradeniya Organophosphorus poisoning (POP) scale¹⁰ and the patients were graded as mild, moderate, and severe cases of poisoning. The values of total leukocyte Count (TLC), neutrophil count, neutrophil-lymphocyte ratio, platelet lymphocyte ratio and plasma cholinesterase (PChE) were measured and compared to know the severity of the disease. The values of total leukocyte Count (TLC), neutrophil count and platelet count were measured on Sysmex XN-1000 fully automated hematology analyser. Neutrophil-lymphocyte ratio and plateletlymphocyte ratio were calculated manually. The value of plasma cholinesterase was measured on Ortho Clinical Vitros 250 Chemistry System.

Cases of poisoning by unknown compounds and compounds of other chemicals such as benzene, mercury and cadmium were excluded.

All characteristics were summarized descriptively. For continuous variables, the summary statistics of mean \pm standard deviation (SD) were used. For categorical data, the number and percentage were used in the data summaries and diagrammatic presentation. Chi-square (x^2) test was used for association between two categorical variables. The difference of the mean of analysis variables between more than two independent groups was tested by ANOVA test and F test was used for testing of equality of Variance.

If the p-value was < 0.05, then the results were considered to be statistically significant otherwise it was considered as not statistically significant. Data were analyzed using SPSS software v.23 (IBM Statistics, Chicago, USA) and Microsoft office.

RESULTS

In the present study, out of 148 cases studied, 43.9% cases were of 21-30 years of age group constituting majority of the cases. Females constituted 54.7% (81) of the total patients while males constituted 45.3% (67) of the total cases. Out of 148 cases, 79.72% (118 cases) of poisoning cases were suicidal, followed by 13.52% (20 cases) and 6.76% (10 cases) of homicidal poisoning and accidental poisoning respectively. 133 cases (89.86%) of poisoning were due to consumption of Organophosphorus compounds and 15 cases (10.14%) of poisoning were due to carbamate consumption.

Majority of the patients (including those with ventilatory support) survived (90.5%), whereas 9.5% patients succumbed to death.

The values of TLC, Neutrophil count, NLR and PLR showed an increase from mild to severe grade of poisoning as described in Table 1.

		POP		
Parameters —	Mild	Moderate	Severe	p value
TLC	11801.27±	12409.78±	19296.41±	<0.001
(cells/uL)	4814.7	4004.01	5952.62	*
Neutrophils (%)	75.67±12.25	82.17±6.92	87.55±5.66	<0.001*
Plasma Cholinesterase	6547.62±2121	3902.61±1646	561.54±423.	<0.00
(Units/L)	.58	.54	24	1*
NLR	5.68±4.75	8.93±8.72	14.51±10.71	<0.001*
Absolute Lymphocyte Count	2223.12±146	1622.63±90	1579.87±92	0.008
(cells/uL)	3.67	7.02	8.21	*
Platelet lymphocyte ratio	168.14±104.	202.52±170.	281.13±257.	0.000*
(PLR)	18	43	63	U.UU8 ^
				0.00/ C 1 '

Table 1: Values of CBC and Biochemical parameters in different grades of poisoning

DISCUSSION

Pesticides are extremely toxic to human beings, and pesticide poisonings are associated with high morbidity and mortality.1 Deaths due to pesticide poisoning per year has been estimated to be 2,50,000-3,00,000 approximately worldwide¹ and India contributes to a significant proportion of these deaths (76000 per year).² Acute pesticide poisoning can be accidental, suicidal or homicidal. Oxidative stress is the major mechanism in the pathophysiology of most toxins and diseases.¹¹ Experimental and clinical studies have reported that the production of free radicals is increased in pesticide poisoning. More severe pesticide poisonings will lead to an increased production of free radicals. When the production of free radicals exceeds the antioxidant capacity of the patient, there will be noticeable changes on the CBC due to the oxidative stress. Increased oxidative stress in the acute period will lead to Leukocytosis, neutrophilia, lymphocytopenia and monocytosis that can be detected on CBC.1 "Leukocytosis in acute poisoning is due to neutrophilia caused by neutrophil margination, and not due to increased production".12 Neutrophils marrow comprise approximately 65% of the peripheral blood and are important to generate an immune response. Therefore, patients with increased stress due to poisoning have a higher WBC count as compared to patients with minor or nostress.¹²

This study found out that approximately 80% of the poisoning cases in Vijayapura district were

due to suicidal poisoning and 90% of the poisoned patients consumed Organophosphorus pesticides followed by Carbamates. In areas like Vijayapura, financial constraints in addition to low rainfall leads to an increased burden of suicidal attempts in the farmer community. The general supportive therapy given to poisoned patients, particularly respiratory and cardiovascular support, are crucial and it is important to decide on admission to the Emergency Department which patient should be followed in the intensive care unit (ICU) and also to estimate which patient can be expected to have a better prognosis during the follow-up period.¹

In general, a pesticide poisoning causes acute oxidative stress which leads to neutrophilic margination, as neutrophils act as the primary reactors in bodily stressful conditions.¹ According to Tang et al^{13} the most important indices in predicting mortality in OP poisoning were Neutrophil percentage, followed by Total WBC count, MCHC, and hemoglobin while the most important indices in Paraquat (PQ) poisoning were Platelets, followed by Neutrophil count, Total WBC count and hemoglobin. In the present study, cases showed an increase in the Neutrophil count with the increasing grades of poisoning which was in correlation with the study done by Tang et al. (Table 2)

Table 2: Neutrophil count (%) in present study and other studies

Study	Mild cases	Moderate cases	Severe cases	p-value
Tang et al	56±9	82±10	83±13	<0.001
Present study	75.67±12.25	82.17±6.92	87.55±5.66	<0.001

As a primary laboratory abnormality, leukocytosis occurs along with neutrophilia to combat oxidative stress in cases of acute poisoning. In a retrospective study of 209 patients done by Dundar *et al*¹ it was suggested that more severely poisoned patients had leukocytosis, neutrophilia, monocytosis, and lymphocytopenia within the first 24 h after admission to the ED. Significant leukocytosis in the death group was also noted in studies performed by Kumar S *et al*¹² and Elhosary NM & Abd-ElBar ES.¹⁴ The present study showed similar results as compared to the above mentioned studies. (Table 3)

Table 3: Total Leukocyte count (cells/uL) in the present study and other studies

Study	Mild Cases	Moderate Cases	Severe cases	p-value
Tang et al	5890±1300	14220±6160	18460±8240	<0.001
Kumar et al	7041.35±2405±42	10245.48±4392.69	13440±5130	0.0001
Elhosary NM & Abd-ElBar ES	8210±1050	9550±1420	13320±1050	<0.001
Present study	11801.27±4814.7	12409.78±4004.01	19296.41±5952.62	<0.001

Study done by Elhosary NM and Abd-ElBar ES¹⁴ revealed leukocytosis, lymphopenia, and thrombocytosis in death group. In contradiction, the Absolute Lymphocyte Count (ALC) was increased in the death group of patients with Paraquat

poisoning in a study done by Kang C *et al.*¹⁵ This study showed decrease in absolute lymphocyte count similar to the pattern mentioned in the study done by Elhosary NM and Abd-ElBar ES. (Table 4)

Table 4: Absolute lymphocyte count (cells/uL) in the present study and other studies

Study	Mild Cases	Moderate Cases	Severe Cases	p-value
Elhosary NM & Abd-ElBar ES	1670±494.9	1000±70.7	830±56.6	<0.001
Present study	2223.12±1463.67	1622.63±907.02	1579.87±928.21	0.008

Neutrophil to lymphocyte ratio and platelet to lymphocyte ratio have been indicated as fast, feasible and easy to use parameters indicating severity of the oxidative stress in various conditions like sepsis¹³, heart failure¹⁴, snake bite¹⁵, Gastrointestinal cancers¹⁶ and poisoning. Several studies undertaken by Elhosary NM & Abd-ElBar ES¹⁴ and Dundar *et al*¹ showed that Neutrophil to Lymphocyte Ratio and Platelet to Lymphocyte Ratio were statistically elevated in severely poisoned patients. In the present study, the relation of neutrophil to lymphocyte ratio with the various levels of poisoning was in agreement with stud conducted by Elhosary NM & Abd-ElBar ES as mentioned in Table 5.

Table 5: Neutrophil to Lymphocyte ratio in the present study and other studies

Study	Mild cases	Moderate cases	Severe cases	p-value
Elhosary NM & Abd-ElBar ES	2.09±0.33	3.72±0.59	8.67±2.35	<0.001
Present study	5.68±4.75	8.93±8.72	14.51±10.71	<0.001

The Neutrophil to lymphocyte ratio in the present study showed an increase in the nonsurvivors as compared to the survivors, similar to the results of the study conducted by Dundar *et al*¹ (Table 6)

Table 6: Neutrophil to lymphocyte ratio in survivors and non-survivors

In the present study, the Platelet to lymphocyte ratio showed an increase in the values in non survivors as compared to survivors which was in conjunction to the study done by Dundar *et al*¹ (Table 7)

Table 7: Platelet to lymphocyte ratio in survivors and non-survivors

Study	Survivors	Non Survivors	Study	Survivors	Non Survivors
Dundar et al	7.3±7.1	11.8±3.6	Dundar et al	174.8±118.7	217.2±102.2
Present study	8.44±8.48	14.5±8.9	Present study	199.55±182.92	295.14±137.49

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The present study showed increase in platelet lymphocyte ratio from mild to severe cases of poisoning as described in the study sone by Elhosary NM & Abd-ElBar ES (Table 8).

 Table 8: Platelet to lymphocyte ratio in the present study and other studies

Study	Mild Cases	Moderate Cases	Severe Cases
Elhosary NM & Abd-ElBar ES	116.36±25.6	200.63±29	362.51±59.45
Present study	168.14±104.18	202.52±170.43	281.13±257.63

Studies undertaken by Dundar *et al*¹ and Kumar *et al*¹² revealed that mean plasma cholinesterase levels was reduced in non-survivors as compared to the survivors. The present study showed similar results as mentioned in Table 9.

Table 9: Plasma cholinesterase (Units/L) in survivors and non-survivors

Study	Survivors	Non survivors	p-value
Dundar et al	5449±3919	1667±3025	0.005
Kumar et al	3287.16±2719.30	1456.05±1159.42	0.0001
Present study	4520.89±2826.43	580±1098.64	< 0.001

CONCLUSION

With respect to an increasing death toll due to pesticide poisoning among farmers and lack of specialized instrumentation and technology at the primary care level, few simple and convenient parameters can be used to assess the severity of poisoning, if combined with a history of poison intake. In this study we found that there was increase in the various hematological parameters neutrophil lymphocyte like leukocyte count, ratio and platelet lymphocyte ratio with increase in the severity of the pesticide poisoning. The plasma cholinesterase level was noted to decrease with increase in the severity of the pesticide poisoning. Hence, leukocyte counts, neutrophil count, neutrophil lymphocyte ratio, and platelet lymphocyte ratio within 24 hours of pesticide exposure and prior to the administration of any medications are useful, valuable, inexpensive and easily accessible parameters in estimating prognosis and the follow-up of patients with acute pesticidepoisoning.

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Sexual Assault: Types and Associated Factors

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ABSTRACT

BACKGROUND: Sexual assault is a rising medico-legal issue and also an important social problem. Medico-legally sexual violence can be Penetrative sexual assault, Non penetrative Sexual assault and Sexual harassment. Thorough knowledge about manner and traits of sexual assault is vital for forensic examination. Keeping this in view, the study was taken up with the aim of analysing the circumstances and factors associated with sexual assault.

MATERIALS AND METHODS: The present prospective cross sectional study was conducted in the Department of Forensic Medicine, M.S. Ramaiah Medical College Bangalore from January 2018 and December 2020. All victims of alleged sexual assault brought for medical examination to the Department of Forensic Medicine were interviewed through a detailed questionnaire after taking consent.

RESULTS: 82 victims of alleged sexual assault were examined. 80 of them were females and 2 were boys who were less than 12 years. Children and adolescents in the age group of 12-18 years constituted 65.85% of the cases. Penetrative sexual assault (peno-vaginal type) was reported by 62 of the victims (75%). Anal intercourse was alleged in 2.5 % (n=2) of the victims.

CONCLUSION: Peno-vaginal type of sexual assault in the minors less than 18 years is the most common type of sexual assault reported. Health care professionals and others involved in providing care and support in all forms should be thoroughly trained and informed about the current laws. Preventive campaigns and sex education programmes in schools and colleges should be taken up the concerned authorities to create awareness amongst the teenagers.

KEYWORDS: Forensic Medicine; Crime; Sexual assault; Rape.

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INTRODUCTION

S exual assault is a rising medico-legal issue and also an important social problem affecting both males and females. Cases are rapidly increasing worldwide as well as in India. It is estimated that 13% of women and 3% of men worldwide may be raped at some time in their life.¹ Rape is the fourth most common crime against women in India.^{2,3} According to the 2021 annual report of the National

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Crime Records Bureau (NCRB), 31,677 rape cases were registered across the country, or an average of 86 cases daily, a rise from 2020 with 28,046 cases, while in 2019, 32,033 cases were registered.⁴

17.6% of all the women in the US were found to be exposed to sexual assault or attempts of sexual assaults. 54% of these women were found to be 17 years old or younger when exposed to sexual assault.⁵

Medico-legally sexual violence can be Penetrative sexual assault, Non penetrative Sexual assault and Sexual harassment. Thorough knowledge about manner and traits of sexual assault is vital for forensic examination and it would also help us in coming up with measures which can prevent such crimes in the society.

There are few studies which discusses the details and characteristics of sexual assault cases. These are useful to all health care professionals caring for such victims. Keeping this in view, the study was taken up with the aim of analysing the circumstances and factors associated with sexual assault. The different types of sexual assault as classified under the Indian Law including penetrative and non-penetrative were also studied.

MATERIALS AND METHODS

The present prospective cross sectional study was conducted in the Department of Forensic Medicine, M.S. Ramaiah Medical College Bangalore from January 2018 and December 2020. The approval was taken from the Institutional Ethics Committee. All victims of alleged sexual assault brought for medical examination to the Department of Forensic Medicine were interviewed through a detailed questionnaire after taking consent. Cases which were reported and brought as sexual harassment were excluded. Descriptive statistics for qualitative type of data were summarized using frequency and percentage.

RESULTS

Study was conducted from January 2018 and December 2020; 82 victims of alleged sexual assault were examined. 80 of them were females and 2 were boys who were less than 12 years. Children and adolescents in the age group of 12-18 years constituted 65.85% of the cases followed by the age group 18-25 years (14.63%). Majority (91.6%) of the victims were moderately built and only one was having a poor built.

Table 1: Marita	l status of	f the victims
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Marital Status	Frequency	Percent
Single	76	92.8
Married	3	3.6
Separated	2	2.4
Widow	1	1.2
Total	82	100.0

Legal minimum age limit for a woman to get married in India is 18 years. 22 of the females were more than 18 years of age and 16 of them were unmarried/ single, 3 were married, 2 were separated and 1 was a widow. Remaining 60 were minors who were less than 18 years.

Table 2: Distribution of cases based on Threatening, using force and deception

Assailant threatened Victim			
	Frequency	Percent	
Yes	18	21.7	
No	64	78.3	
Total	82	100.0	
	Assailant used physical force	2	
	Frequency	Percent	
Yes	14	18.1	
No	68	81.9	
Total	82	100.0	
	Assailant's use of deception		
-	Frequency	Percent	
Yes	11	14.5	
No	71	85.5	
Total	82	100.0	

In 18 cases the assailant had threatened the victims of dire consequences and in 14 cases the assailant had allegedly used physical force to overcome the resistance offered by the victim during the alleged sexual assault. A knife as a weapon was used by the assailant in only one case to threaten the victim. In 11 cases, victims' were deceived by the assailant under the pretext of promise of marriage. In none of the victims, there were demonstrable injuries at the time of examination.

Only one victim was found to be under the influence of alcohol, where in the assailant had offered the alcohol for the victim and then sexually assaulted her when she was intoxicated.

Table 3: Distribution of cases based on Time of Sexual Assault

Time	Frequency	Percent
0000 h to 0600 h	3	3.65
0600 h to 1200 h	11	13.41
1200 h to 1800 h	35	42.68
1800 h to 0000 h	33	40.26
Total	82	100.0

About 83% of the incidents took place between 12 noon to 12 midnight.

Table 4: Distribution of cases based on No. of times of sexual assault

No. of Times of sexual assault	Frequency	Percent
Once	11	13.4
Twice	2	2.4
More than twice	69	84.2
Total	82	100.0

Majority of the victims (n=69, 84.2%) alleged that they were sexually assaulted by the same assailant on multiple times (>2 times) and it was only once with 11 victims (13.4%).

Table 5: Distribution of the cases based on the Type of alleged Sexual Assault.

Type of alleged sexual assault	Frequency	Percent
Penetrative sexual assault- Vaginal	62	75.6
Penetrative sexual assault- Anal	2	2.5
Non penetrative sexual assault	18	21.9
Total	82	100.0

Penetrative sexual assault (peno-vaginal type) was reported by 62 of the victims (75%) followed by the non-penetrative sexual assault (21.9%, n=18). Anal intercourse was alleged in 2.5% (n=2) of the victims. Both of them were children (a girl and a boy).

60 cases were minors and are classified as children under Indian Law and cases were booked under POCSO Act. Out of which 44 of them reported alleged vaginal intercourse, 2 reported anal intercourse and it was non penetrative sexual assault in 14 cases. 22 cases were above 18 years and cases of sexual assault were booked under Indian Law Sec 375 IPC. 18 of the 22 adults reported vaginal sexual assault and the remaining 4 were of non-penetrative type. DISCUSSION

M.S. Ramaiah Medical College & Hospital received requisition for examination of 82 victims of alleged sexual assault between January 2018 and December 2020. All the cases were examined after obtaining an informed written consent from the victims and assent of parents in cases of minor victims.

In the present study, 97.5% were females except for 2 boys who were less than 12 years. 73% (60) of them were minors under Indian law. In a similar study done in Taiwan, a total of 114 sexual assault cases were analyzed, 93.9% of them were females and 6.1% were male victims. About 63.6% of the victims were younger than 19 years.⁶ Compared to our study, male victims were slightly higher whereas percentage of victims who are teenagers and children is almost same. In another study done in the United States, 54% of the victims were found to be 17 years old or younger when exposed to sexual assault.5 Out of 324 sexual assault victims included in a study in Turkey, 268 (82.7%) were females and 56 (17.3%) were males; male victims were quite large compared to our study.7 Possibility of under reporting of male victims in India could be one of the reasons. 91.6% of the victims were moderately built and only was poorly built for age. There was no correlation between built of the victims and sexually assault in our study.

All 60 minors of the 82 cases were college or school going students and out of 22 of the adult females only 3 were married, 16 of them were unmarried, 2 were separated and 1 was a widow. In a study by Karanfil R *et al* in Turkey, students and adolescents constituted 55% of the cases compared to 73% (60 minors) in our study.⁷ This category of people is more vulnerable to sexual assault followed by unmarried or single women (19.5%).

Victims were under threat of violence in 22% of the cases. Assailants had used physical force to subdue the victims in 17% of the cases. A weapon was used as a threat only in one incident by the assailant. Hwa Hsiao-Lin *et al* in their study reported that 12% of the patients were threatened with weapons, including a knife (seven cases), and rope (three cases). Seven patients (6.1%, 7 in 114) told physicians that they were drugged by the offenders.⁶ Whereas in our study only one victim was found to be under the influence of alcohol, where in the assailant had offered the alcohol for the victim and then sexually assaulted her when she was intoxicated.

In 13% of the cases, victims and assailants were romantically involved with each other and the assailants had promised marriage during their relationship. Under this false pretence victims were deceived into sexual intercourse. Though these were incidents of consensual sexual intercourse, consent here becomes invalid as it was taken under deceit; and as per Indian Law these incidents amount to sexual assault.

L.A. Fryszer *et al.* observed extra genital injuries in 61.4% (522/815) of patients.⁸ Karanfil R *et al* observed 22.5% had injuries located in parts of the body other than the genital region.⁷ Quite differing from our study where there were no physical injuries in any of the case examined. Victims were intimidated and subdued before sexually assaulting them; and in many instances (13%) victims and assailants were romantically involved. This could be the reason for no physical injuries in our study.

Majority (83%) of the sexual assaults occurred between 12 noon to 12 midnight almost equally distributed in the afternoon and evening. In contrast to a study done in Germany by L.A. Fryszer *et al.* where it was observed that 60% of the sexual assaults took place between 000h to 0759 h.⁸ In an Indian study nearly two-thirds (188, 60.3%) of the cases occurred during daytime (from 7 a.m. to 7 p.m.).⁹ It could be due to certain practises in Indian families restricting the movements of their children late in the nights especially minors who live with their parents.

In 69 cases (84%), victims were sexually assaulted by the same assailant on multiple occasions (>2). Karanfil R et al reports a similar observation where 82.7% of the victims were exposed to assaults by only one assailant.7 In an observation by Rossman et al, 43.2% of the victims had previous history of sexual assaults.¹⁰ Tolu LB, Gudu W. found that 85.3% of the victims were sexually assaulted once.11 In the present study, most of the assailants were known to the victims either closely or by acquaintance. Hence in 84% of the cases there was sexual assault on many occasions by the same perpetrator. Victims might have been willing to have a sexual relationship initially, but later complained about it directly or through their parents. Complaints to the police were made when the victims were minor as per law and when there was breach of promise of marriage by the assailant. All such cases were registered as sexual assault as consent to sexual intercourse becomes invalid when it was obtained under deception or when obtained from a minor who is less than 18 years of age.

The Protection of Children from Sexual Offences Act, 2012 (POCSO Act) applies to minor victims who are less than 18 years of age. As per this Indian act a person is said to committed "penetrative sexual assault" if (a) he penetrates his penis, to any extent, into the vagina, mouth, urethra or anus of a child or makes the child to do so with him or any other person; or (b) he inserts, to any extent, any object or a part of the body, not being the penis, into the vagina, the urethra or anus of the child or makes the child to do so with him or any other person; or (c) he manipulates any part of the body of the child so as to cause penetration into the vagina, urethra, anus or any part of body of the child or makes the child to do so with him or any other person; or (d) he applies his mouth to the penis, vagina, anus, urethra of the child or makes the child to do so to such person or any other person.¹²

Under the Indian Law, 73% of the victims were children and cases were booked under POCSO Act. It was penetrative type in 76.6% of them and it was non penetrative sexual assault in the remaining 23.4%. Adult victims constituted 27% and 82% of them reported vaginal sexual assault and in the remaining 18% it was of non-penetrative type.

Overall in 78.1% (n=64) of the cases, penetrative sexual assault was reported followed by the nonpenetrative sexual assault in 21.9% (n=18). In 62 of the 64 victims' peno-vaginal penetration was involved. It was anal intercourse in the remaining 2 victims. Both of them were minors aged less than 18 years (one male and one female). There was no oral or digital penetration observed in our study.

Similar to our study, LA Fryszer et al observed penile penetration vaginally, orally or anally in more than 75% of the cases (510/674).8 In contrast, in a two year study on 478 sexual assault victims by McCall-Hosenfeld et al in the US, 99% of the cases reported penetration.¹³ Grossin C et al observed that 87.7% of the victims reported penetrative type when examined within 72 hours of sexual assault. Vaginal, oral and anal penetration was involved in 55%, 23% and 13% of the cases examined within 72 hours of sexual assault respectively. There was no penetration involved in 8% of the cases. Anal penetration was seen in 50% of male victims.¹⁴ This finding is similar to our study where one of the only two male victims had reported penetrative anal intercourse. Ingemann-Hansen et al have observed penetrative sexual assault in 59% of the cases.¹⁵ Various studies have reported different frequency of penetration in sexual assault cases ranging from 59% to 99%. Age of the victim, validity of consent for sexual intercourse and relationship between

victim and accused are some of the influencing factors which determine penetration.

CONCLUSION

Peno-vaginal type of sexual assault in the minors less than 18 years is the most common type of sexual assault reported. 84.2% of the victims were sexually assaulted multiple times on multiple occasions, because most assailants are known to the victims. Though consensual, consent of the victim is invalid under Indian Law. In non-consensual cases and adults, victims were under threat and deception and also were physically forced to submit. Health care professionals and others involved in providing care and support in all forms should be thoroughly trained and informed about the current laws. One should be aware that there should not be any delay in examining, providing treatment. Failure to collect forensic evidence and to report to law enforcing authorities is an offence. Preventive campaigns and sex education programmes in schools and colleges should be taken up the concerned authorities to create awareness amongst the teenagers. It must be brought to cognizance that even consented sexual intercourse with a minor is a crime and involves prosecution.

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I, **Dinesh Kumar Kashyap**, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Sd/-(Dinesh Kumar Kashyap)

Estimating Sexual Dimorphism using Anthropometric measurements of Permanent Dentition

Kashmira Kusumkant Dhote¹, Jyotish Guria², Ashim Mishra³

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ABSTRACT

CONTEXT: The ability to determine the sex of an unknown person is extremely useful because it narrows the search to nearly half of the population. Teeth are excellent choice for identification since they are resistant to putrefaction and are well protected anatomically.

AIMS: The study is aimed at presence of sexual dimorphism in different tooth measurements in the lower jaw.

SETTINGS AND DESIGN: Cross sectional study

METHODS AND MATERIAL: The study was conducted on 51 male and 54 female participants. Exclusion criteria for the subjects were: Dental caries, Crowded or excessive spacing in the anterior teeth, Orthodontic treatment, Occlusal abnormalities, Any trauma to lower jaw. Measurements were taken clinically using geometric divider and digital callipers. Odontometric dimensions included in the study taken from the lower jaw only are: Mesiodistal width (MD) and Buccolingual width (BL) for canine, central incisor and first molar (both left and right) and inter canine width (ICW).

STATISTICAL ANALYSIS USED: Jamovi Software version 2.3.24 was used for statistical analysis. Independent sample t and Binomial logistic regression was applied to see the accuracy of predictive measures for different dimensions in identifying sex of an individual.

RESULTS: Mesiodistal and buccolingual dimensions of canines, central incisor and first molar in the lower jaw differ significantly in males and females. Mesiodistal dimensions are more accurate in identifying

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the sexes. Mandibular canines are more sexually dimorphic compared to mandibular central incisors and first molars.

CONCLUSIONS: The study findings indicate that the Mandibular dental measurements and canine indices can be used as supportive adjunct rather than the sole criteria for sex determination in forensic investigations.

Keywords: Sexual dimorphism; Canine; Mandibular canine Index; Intercanine width.

Key Messages: Mandibular dental measurements and canine indices can be used as supportive adjunct for sex determination in forensic investigations. Further studies are needed with larger sample size from the population for a higher accuracy in the use of these parameters for sex determination.

INTRODUCTION

Determining the sex where only body parts or remains are available, is always a challenging task. Teeth being well preserved anatomically, make excellent identification tools.^{1,2,3} Canines are most dimorphic teeth and also resist extreme conditions.^{4,5,6} Sexual dimorphism is found highest in mandibular teeth.^{7,8,9} In this study we focussed on mandibular canines together with central incisors and first molars. Few past studies have employed clinical measurements; the majority are based on dental casts. This study aims at presence of sexual dimorphism in lower jaw teeth.

OBJECTIVES

- i. To estimate sexual dimorphism for different tooth in lower jaw.
- ii. To evaluate the accuracy of sex determination from various dental measurements.

SUBJECTS AND METHODS

A cross sectional study was conducted on young adult Indian population aged between 18-25 years of age, as this group shows less attrition of teeth. The study was initiated after the approval from Institutional Ethics Committee and registering in Clinical Trial Registry of India (CTRI).

Inclusion Criteria: Subjects with normal dentition and good oral hygiene.

Exclusion Criteria: Subjects under the following criteria were excluded from the study:

- 1. Dental caries
- 2. Crowded or excessive spacing in the anterior teeth
- 3. Orthodontic treatment
- 4. Occlusal abnormalities
- 5. Any trauma to canine, central incisor, or 1st molar teeth in the lower jaw.

A total of 105 subjects participated in the study consisting of 51 male and 54 female students pursuing MBBS. Each participant was informed about the study in detail and prior consent were obtained.

Measurements were taken clinically using geometric divider and digital callipers with the provision to fix it in the desired position to avoid any errors.

Odontometric dimensions included in the study are taken from the lower jaw only:

- 1. Mesiodistal width (MD) for canine, central incisor and first molar (both left and right)
- 2. Buccolingual width (BL) for canine, central incisor and first molar (both left and right)
- 3. Inter canine width (ICW)

Mesiodistal width (MD) was measured as the greatest width of the crown between the contact points of the teeth on either side of the jaw. Buccolingual width (BL) was measured as the maximum width between the buccal and lingual surfaces of tooth perpendicular to the mesiodistal width. ICW was measured as the distance between the cusps tips of two canines in the same jaw.

Mandibular Canine Index was Calculated for each side using the Formula:

Mandibular canine index (MCI)=Mesiodistal crown width of mandibular canine / ICW

Standard canine index for male and female were calculated using the formula:

Standard canine index = [(Mean Male MCI-SD) +(Mean female MCI+SD)]/ 2

According to Rao *et al*, canine index more than the standard canine index suggests the unknown individual to be male and vice versa. Canine index less than the standard canine index suggests female.¹⁰ The percentage accuracy of reporting sex identity by this technique was then calculated by matching against the true sex of each participant.

Sexual dimorphism in different tooth dimensions was calculated using the formula given by Garn et al

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(1)01)	•

Sexual dimorphism = $[(Xm/Xf)-1] \ge 100$,

Xm = Mean value of ales,

Xf = Mean value for females.

Different dimensions observed in the study were subjected to analysis by statistical methods. Statistical analysis was done using Jamovi Software version 2.3.24. Mean and standard deviation of the observed measurements were calculated. Independent sample t-tests were used to compare the means in male and female participants. Binomial logistic regression was applied to see the accuracy of predictive measures for different dimensions in identifying sex of an individual.

RESULTS

A total of 105 subjects participated in the study. Out of which 54 were female (51.4%) and 51 were male (48.6%). The mean age of participants was 20.8 for both male and female.

Mean mesiodistal and buccolingual dimensions of male participants for each tooth in the study is found to be more than that of the female. Intercanine width (ICW) in male (27.68 ± 2.665) was also found to be higher than that in female (26.96 ± 2.120) .

The comparison of mean of the different measurements female in male and using independent sample t-test based on normality check of different parameters is depicted in Table no. 1. Student t-test was applied for most of the samples while for CMDR (right canine mesiodistal) and MMDL (left first molar mesiodistal) Mann Whitney test were applied after normality check. (Table No. 1.1) As shown the differences in mean measurements in the two groups (male and female) are statistically significant p< 0.05, except for the Intercanine width (p > 0.05).

 Table 1: Comparison of mean of the different measurements in male and female.

Independent Samples T-Test

-	-	Statistic	df	р
CBLR	Student's t	-3.15	103	0.002
CMDL	Student's t	-6.78	103	<.001
CBLL	Student's t	-3.32	103	0.001
MMDR	Student's t	-3.51	103	<.001
MBLR	Student's t	-4.38	103	<.001

ICW	Student's t	-1.54	103	0.127
IMDL	Student's t	-3.73	1.03	<.004
IBLR	Student's t	-2.73	103	0.007
IMDR	Student's t	-2.60	103	0.011
MBLL	Student's t	-3.81	103	<.001

Note: H $F_{\mu} # \mu_{m}$

Levene's test is significant (p < .05), suggesting a violation of the assumption of equal variances.

Table 1.1

Independent Samples T-Test

-	-	Statistic	Р
CMDR	Mann-whithey U	361	<.001
MMDL	Mann-Whitney U	940	0.005

Note: H $F_{\mu} # \mu_{m}$

Levene's test is significant (p < .05), suggesting a violation of the assumption of equal variances.

Mandibular canine index was calculated for each participant for both left and right side. Mean mandibular canine index for right mandibular canine is 0.247 ± 0.0315 for female and 0.0274 ± 0.0329 for male. Mean mandibular canine index for left mandibular canine is 0.259 ± 0.0224 for female and 0.276 ± 0.0311 for male.

Table No. 2 depicts the statistically significant difference between the mean mandibular canine indices, both left and right when compared in male and female. Similar findings were reported in other studies where had higher statistically significant value for MCI compared to female.^{4,12,13,14}

 Table 2: Comparison of means of right and left mandibular canine indices for two sexes

Independent Samples T-Test

-	-	Statistic	df	р
MCIR	Student's t	-4.32	103	<.001
MCIL	Student's t	-3.32	103	0.001

Note: H F₁₁ # μ _m

Levene's test is significant (p <.05), suggesting a violation of the assumption of equal variances.

Standard Mandibular canine index for right and left mandibular canines for the sample was calculated as Standard MCIR= 0.2598 and Standard MCIL = 0.2632 using the formula given by Rao *et al.* Percentage accuracy of reporting correct sex identity by this technique was calculated. Table no. 3 shows an accuracy of 66.7% and 57.1%, respectively for right and left standard mandibula canine index. This method was found to be more accurate in females in conformity with the findings of Rao *et al*, Muller *et al* and Kushal *et al*.^{4,10,15}

Table 3: Predictability using the standard canine index.

Standard MCIR	Cases	% Age accuracy
Female	37/54	68.5
Male	33/51	64.7
	70/105	66.7

Standard MCIL	Cases	% Age accuracy
Female	31/54	75.4
Male	29/51	56.9
	60/105	57.1

Sexual dimorphism was calculated for each tooth using the formula by Garn *et al* (1967) (Table No. 4). Mesiodistal dimensions in the right mandibular canine (CMDR) is found to be having the highest dimorphism (13.4%) followed by mesiodistal dimension in the left mandibular canine (CMDL) (9.22%) and Buccolingual dimension in the left mandibular canine (CBLL)(7.16%).

Table 4: Sexual dimorphism in various tooth measurements used in this study.

Sex	CMDR	CBLR	CMDL	CBLL	MMDR	MBLR	MMDL	MBLL	IMDR	IBLR	IMDL	IBLL
Female	6.64	6.93	6.94	6.98	10.9	11.1	10.9	11	5.86	5.81	5.85	5.57
Male	7.53	7.4	7.58	7.48	11.5	11.7	11.2	11.6	6.16	6.11	6.23	6.09
% sexual dimorphism	13.404	6.782	9.222	7.163	5.505	5.405	2.752	5.455	5.119	5.164	6.49	5.91

Binomial logistic regression model for different measurements suggested highest predictive measure accuracy for Mesiodistal dimension for right canine (CMDR)(79%) followed by mesiodistal dimension for left canine (CMDL)(73.3%) and right central incisor (IMDR)(73.3%). (Table No. 5)

Table 5: Predictive measure accuracy by logistic regression for different tooth measurements

-	sex	CMDR	CBLR	CMDL	CBLL	MMDR	MBLR	MMDL	MBLL	IMDR	IBLR	IMDL	IBLL
Mean	F	6.64	6.93	6.94	6.98	10.9	11.1	10.9	11	5.86	5.81	5.85	5.75
	М	7.53	7.4	7.58	7.48	11.5	11.7	11.2	11.6	6.16	6.11	6.23	6.09
Predictive measure accuracy		79	63.8	73.3	62.9	71.4	63.8	65.7	62.9	73.3	60	67.6	65.7

DISCUSSION	

Identification is the fixation of individuality of a person. Sex determination undertakes half of the task in that process and narrow downs the search to half of population. Many anthropometric parameters are available which are immensely helpful for the purpose. In cases where only body remains are available odontometric dimensions are also used. Dentition being the part of the body which resists degradation for a long time and thus is a valuable tool.

The mean mesiodistal and buccolingual measurements of tooth were found to be more in male than in female, which was statistically significant. Similar statistically significant difference in width of canines were obtained in the previous studies done by Kushal *et al.* and Rao *et al.*

This is explained as the Y chromosome controls the thickness of dentin, whereas the X chromosome is responsible for the thickness of enamel.¹²

This study also finds Intercanine width more in males compared to females, but the difference was not significant. Agnihotri *et al* in their study which focused on three Indian cities, also found similar in significant differences in ICW in one of the groups.¹⁶ However previous studies by Singh SK *et al* ad Kushal *et al* have shown significant differences in ICW in male and female.^{4,12}

The present study establishes a statistically significant sexual dimorphism in 3 set of mandibular teeth (canines, central incisor and first molars).

In this study mesiodistal dimension in the mandibular canines demonstrated the highest sexual dimorphism. Similar findings were reported on mandibular canines in previous studies.^{5,7,9,12}

The right and left canines had a score of 13.4% and 9.22% respectively. These values are higher in comparison to the corresponding values of 6.2% and 7.7% reported for south Indian population and 7.954% and 8.891% for North Indian population.⁴

Buccolingual dimension showed highest sexual dimorphism in the left mandibular canine 7.16%, followed by right mandibular canine and mandibular left first molar. There are very few studies in Indian population using the buccolingual dimensions for reporting sexual dimorphism. Prabhu S *et al* and Zorba E *et al* reported BL dimension to be the highest sexually dimorphic in their respective studies on Indian and Greek population.^{5,14}

Present study also shows the percentage accuracy of identifying sex correctly by comparing the calculated MCI with the standard MCI. For right and left sides, it was found out to be 66.7% and 57.1% respectively, with overall accuracy of 61.9%. Nearly similar percentage accuracy has been reported by studies conducted by Muller *et al.* (2001) on the French population (59.57%) and also by Mohsenpour K *et al.*^{15,17} Higher overall accuracy of 75-85.9% has been reported by other Indian studies in different population groups.^{4,10,12}

The logistic regression method demonstrated higher chances to predict the sex correctly in

Canines. The higher accuracy was found in Mesiodistal dimension in Mandibular canine. Similarly high predictive accuracy was reported by Martins *et al.*¹⁸

CONCLUSION

The study findings indicate that the mesiodistal and buccolingual dimensions of canines, central incisor and first molar in the lower jaw differ significantly in males and females. Mesiodistal dimensions are more accurate in identifying the sexes. Mandibular canines are more sexually dimorphic compared to mandibular central incisors and first molars. Mandibular dental measurements and canine indices can be used as supportive adjunct rather than the sole criteria for sex determination in forensic investigations. Further studies are needed with larger sample size from the population for a higher accuracy in the use of these parameters for sex determination.

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Detection of Gunshot Residue on Glass Fired using Airguns and Insas LMG 5.56mm

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ABSTRACT

Locating and retrieving gunshot residue from the scene of the crimeis important for the investigation of shooting-related crime incidents. The presence of gunshot residue on the glass that can be hit as an intermediate target is occasional but not collected commonly because of its nature and the amount found on the glass. They may be found in crimes such as shooting where the target involves windowpanes or windshields among many other shooting related incidents. It is indicative that gunshot residues provide an exemplary source of partially burnt, completely burnt, and unburnt residues of primers and propellants that can help establish the manufacturer's details. Gunshot residues are deposited on the hands, face, and clothing of the shooter and are commonly found on the entry hole of the targets. These residues can be recovered from the surface of intermediate targets through which the bullet travels. Detection of gunshot residue from these intermediate targets can be useful for forensic investigation. They can be promising in absence of other pieces of evidence such as cartridge cases, bullets, or firearms. The current study was performed to explore the detection of gunshot residue on glasses fired at 25 metres range. Lead, barium, and antimony were successfully detected on all samples fired at 25 metres range. The analysis provided consistent evidence that gunshot residue detected can be helpful to obtain reliable data for forensic investigation. The statistical analysis of the data revealed a significant difference in the diameter of entry, number of radial fractures, diameter and thickness of mist zone with types of glass.

Keywords: Scene of crime; Intermediate target; Glass; Gunshot residue; Glass fracture.

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INTRODUCTION

The position, recognition, and retrieval of glass containing gunshot residue help in the reconstruction of shooting-related crimes involving firearms. Trace evidence can be collected from the crime scenes even if found in minimum amount. Trace evidence of forensic interest commonly includes glass, soil, paint, fibres, and hair. Analysis of glass fractures can aid in forensic investigation to establish a link and determine the sequence of events at the scene of crime.1 However, the use of country made firearms in the commission of crimes has become a matter of concern for law enforcement agencies. The analysis of glass fractures is useful in forensic science in determining the direction of impact and the position or location of the shooter. The fracture analysis can provide a useful tool for differentiating the range of firing. The energy of absorption and distribution depends on various factors that result in variations of impact patterns.² Projectile impacts can be classified into low velocity, medium velocity, high velocity, and hypervelocity based on the velocities of the projectile.3 Glass fracture analysis hence becomes an important tool in investigation depending upon the type of crime. Glass fracture analysis also becomes important in arson investigation to investigate whether the thermal stresses result in the formation of fractures on the glass surface.4

The impact of air rifles on windowpanes of different thicknesses to study multiple fractures has exhibited a difference in hole diameter. It is found that the diameter made by the first impact is larger as compared to the second in the transparent glass with the thickness of glass panes 4mm and 5mm. In the case of tinted pane glass having 4mm thickness, the hole diameter of the second impact is found to be more than that of the first impact. It is also found that the increase in distance for a few meters does not change the impact pattern to a greater extent.5 Recent studies have shown the impact of projectiles on window glasses. The impact made by air guns has a hole diameter almost double the calibre of the gun. There exists a huge variation in fracture patterns and hole diameter formed due to the impact of improvised weapons. However, they exhibit a key-hole appearance on glass.^{2,6}

While analyzing the fracture patterns, it is observed that there are various regions around the bullet hole. The smooth region is known as the mirror zone. Surrounding the mirror zone is the mist zone which is rough and does not have well defined boundaries. After the mist zone, the hackle region exists which has radiating lines away from the fracture origin.⁷

Analysis of bullet holes and features such as the number of radial and concentric fractures, and analysis of mist zone can provide crucial information to the investigators.⁸ The impact of a projectile on the surface of the glass may result in radial, concentric, and cone fractures. Cone fractures are formed from the impact of highvelocity projectiles.^{9,10} The fracture always initiates from pre-existing flaws which are termed commonly Griffith's flaws.¹¹

Gunshot residue (GSR) recovered from intermediate targets such as glass is not routinely considered in a crime scene concerning firearmrelated crime.¹² Gunshot residue which is termed nowadays as firearm discharge residue may not be present in weapons that utilise compressed air.¹³

When a firearm is discharged a series of events occur in the firearm from the time when the trigger of the firearm is pulled, the firing pin of the weapon strikes the primer cup which holds the primary explosives.¹⁴ These explosives are susceptible to pressure or friction. The oxidants present in the primer provide oxygen for the flame creating a sudden rise in the temperature. The temperature leads to the ignition of the fuel in the presence of oxygen which later ignites the propellants.¹⁵ The burning of the propellant produces a large volume of gases which in turn provides an adequate amount of kinetic energy to the projectile.16 The heat developed inside the barrel causes the vaporisation of components and the pressure generated pushes the vapours and particles out of the muzzle end of the firearm.¹⁷ The particles released from the firearm are referred to as gunshot residue and can be found on the target, shooter, and the surrounding exhibits as far as 10m from the position of discharge.¹⁸ The gunshot residue contains burned or unburned particles of primer, propellant, and any other component present inside the firearm.¹⁹ The GSR can be classified as organic gunshot residue (OGSR) and inorganic gunshot residue (IGSR). Inorganic components such as Lead (Pb), Barium (Ba), and Antimony (Sb) are considered major components of GSR and are used to establish the presence of GSR.20 Along with the inorganic components, the GSR also contains organic components such as Nitrocellulose, Nitro-glycerine, Diphenyl Amine (DPA), and Nitroguanidine which are present in the propellants as well as stabilizers used. Over the decades, different chemical and instrumental techniques were employed for the detection and identification of GSR.4 With the latest advancement in technologies, various instrumental techniques such as Neutron Activation Analysis (NAA), Flameless Atomic Absorption Spectroscopy (FAAS), Scanning Electron Microscope (SEM) with Energy Dispersive X-rays (EDX), Inductive Coupled Plasma Mass Spectroscopy (ICP-MS), Laser Ablation Inductive Coupled Plasma Mass Spectroscopy (LA-ICP-MS), Laser Induced Breakdown Spectroscopy (LIBS).21-23

While the quantity of gunshot residue may vary at the crime scene, it is possible to encounter gunshot residues on intermediate targets through which the bullet has travelled.²⁴ They are always present when fired through standard firearms containing primers and propellants.²⁵ The composition of gunshot residue might differ when improvised or country made firearms are used.²⁶ The improvised or country made firearms utilise readily available materials and hence do not follow any specific standard for manufacturing.^{27,28}

The factors that can contribute to variation in the deposition of gunshot residue include the angle of firing, the distance of firing, the type of ammunition used, the condition of the barrel, and the condition of the firearm.²⁹ The manufacturing process and materials used in making country made weapons make it difficult to standardize the amount of gunshot residue which can be obtained at a specific range to determine the range of firing.³⁰ The gunshot residues deposited on glass are retained longer as compared to the skin making it more probable for detection and study.^{31,32}

MATERIAL AND METHODS

Sample Collection

The current study focused on the analysis of glass fracture pattern to analyse the trends in feature of radial and concentric fractures, mist zone and entry hole. Windowpanes of 4mm thickness of 1ft x 1ft dimension were obtained from a local glass manufacturer. The test firing was carried out at an enclosed shooting range in Bengaluru, Karnataka, India by random sampling using 30 samples. Inclusion criteria were the glass of 4mm thickness and exclusion criteria were glasses with pre-existing fractures. Soda lime glass, patterned glass, and tinted panes are more commonly used in doors and windows. Soda lime glass is relatively economical and chemically stable and extremely feasible. It is composed of about 70 percent silica (silicon dioxide), 15 percent soda (sodium oxide), and 9 percent lime (calcium oxide), with much smaller amounts of various other compounds. Tinted windows have a film applied to the glass. This film blocks out some of the light, making it more difficult to see through the window. Patterned glasses have a pattern that gets embossed on to the glass which provides privacy that many homeowners desire. In addition to privacy, there is no loss of artificial or natural light, as light can still easily pass through the glass.

Glass sample firing

A designed wooden frame was used to affix the glasses of fixed dimension. The firing was carried out in the firing range of the Corps of Military Police, Bengaluru under the supervision of experts. An INSAS LMG 5.56mm rifle having a capacity of 30 rounds was used in the study. It has a rimless cartridge case made of brass with bottle neck shape. Bullet used was made of gilding metal envelope FMJ, steel insert and lead core. A ball powder of with mass 1.64gm is utilised as propellant. The frame was fixed at a suitable height of 3 feet from the ground to ensure consistency in height for firing. Each glass sample was kept perpendicular to the muzzle end of the barrel. The glass sample was then fired at a 25-metre range. Each test firing was repeated five times for 25 metres distance. Each glass type was utilised and replaced after every round of test firing. The fired samples were packed in zip lock bags and labelled. To avoid possible contamination while the sample collection, gloves were utilised. The glass samples were further transported to the laboratory for examination. The fragments from the area near the bullet hole was collected using rubber tipped forceps and packaged with a label separately. To replicate the probability of discovering glass fragments at the crime scene, a random selection of the glass piece near the bullet hole was made.

Sample Measurements

The bullet holes were identified due to characteristic entry and exit hole specifications of the margins of the hole. The diameter of the impact hole was measured using a Mitutoyo Vernier Caliper of 0.01 to 150mm dimension with a measuring range of 6 inch. The measurements were calculated thrice, and an average of the readings was noted. Similarly, the diameter and thickness of the mist zone were measured. The number of radial and concentric fractures were also counted.

Detection of Gunshot Residue

The fragments of glass near the bullet holecollected using rubber tipped forceps were subjected to SEM-EDX analysis. The analysis was carried out using the CARL ZEISS Field Emission Scanning Electron Microscope (FESEM) instrument. The microscope is equipped with a Schottky thermal field emission gun with an accelerating voltage variation between 0.2 to 30kV with a resolution of image 2.8nm at 1kV and 1.5nm at 15kV. The instrument operates on high vacuum mode with a variable pressure range of 2 to 133pa.

RESULTS

Gunshot residue was successfully detected on the glass samples fired at a 25-metre range. The gunshot residue on the glass indicates the deposition and presence with a sufficient detectable limit enough to identify the bullet hole on the glass samples. The glass samples utilised were soda-lime glass, patterned glass, and tinted pane fired at 25 metres in firing range. All the glass samples exhibited bullet hole, radial, and concentric fractures along with the formation of a mist zone (Fig. 1). The glasses were deposited with gunshot residue particles and successfully detected (Fig. 2). The presence of lead, barium, and antimony suggests that gunshot residue was deposited on the glass samples. A sufficient amount of gunshot residue was detected on all three types of glass samples for analysis at a 25-metre range (Fig. 3). The overall validity of the method adopted, and results obtained were checked by analyzing gunshot residue found on the same glass at the same distance for comparison.



Radial fracture

Concentric fracture

Thickness of mist zone

Diameter of mist zone Bullet hole

Fig. 1: Tinted pane 4mm thick depicting bullet hole, radial fractures, concentric fractures, and mist zone

Table 1: Descriptive Statistics



Fig. 2: EDX spectrum of residues detected on glass



Fig. 3: Glass fragment with traces of gunshot residue

The glass fractures were analysed for the number of radial and concentric fractures, the diameter of the mist zone, and the thickness of the mist zone. Descriptive statistics were used to summarise the data. Table 1 shows the results of descriptive statistics utilising measures of central tendency (mean) and dispersion measure (standard deviation).

	Variables	Ν	Mean	Std. Deviation
Diameter of entry (mm)	4mm Tinted Glass	5	11.940	0.2510
	4mm Textured Glass	5	9.740	0.2302
	4mm Soda-lime Glass	5	16.080	0.4550
	Total	15	12.587	2.7375
Diameter of mist zone (mm)	4mm Tinted Glass	5	24.480	0.9284
	4mm Textured Glass	5	23.960	1.8876
	4mm Soda-lime Glass	5	26.380	1.2235
	Total	15	24.940	1.6885

Table Contt...

INDIAN JOURNAL OF FORENSIC MEDICINE AND PATHOLOGY. VOLUME 17, NUMBER 1, JANUARY - MARCH 2024

Number of concentric fractures	4mm Tinted Glass	5	4.600	0.5477
	4mm Textured Glass	5	4.800	0.8367
	4mm Soda-lime Glass	5	5.800	0.8367
	Total	15	5.067	0.8837
Number of radial fractures	4mm Tinted Glass	5	37.200	1.9235
	4mm Textured Glass	5	35.400	1.1402
	4mm Soda-lime Glass	5	50.400	3.0496
	Total	15	41.000	7.2111
Thickness of mist zone (mm)	4mm Tinted Glass	5	7.180	0.5450
	4mm Textured Glass	5	6.660	0.3362
	4mm Soda-lime Glass	5	8.720	0.6017
	Total	15	7.520	1.0199

Source: SPSS output

A parametric independent sample Analysis of Variance (ANOVA) was used to measure the statistically significant difference among the population mean. Table 2 depicts the homogeneity assumption using the Levene test which signifies the equal variance assumed. All the dependent variables have a significance value higher than 0.05 which states the homogeneity assumption has been met to execute ANOVA. (Refer to Table 2)

Table 2: Test of Homogeneity of Variances

Dependent Variables	Levene Statistic	Sig.
Diameter of entry (mm)	0.620	0.554
Diameter of mist zone (mm)	0.533	0.600
Number of concentric fractures	0.330	0.725
Number of radial fractures	3.240	0.075
The thickness of the mist zone (mm)	1.683	0.227

Source: SPSS output

The normality assumption using the Kolmogorov-Smirnoff test signifies the cumulative distribution among the datasets (Refer to Table 3).

Table 3: Kolmogorov Smirn off Test of Normality

-	Kolmogorov-Smirnov		
	Statistic	df	Sig.
Diameter of entry (mm)	0.208	15	0.079
Diameter of mist zone (mm)	0.149	15	0.200
Number of concentric fractures	0.126	15	0.199
Number of radial fractures	0.201	15	0.061
Thickness of mist zone (mm)	0.128	15	0.200

Source: SPSS output

INDIAN JOURNAL OF FORENSIC MEDICINE AND PATHOLOGY. VOLUME 17, NUMBER 1, JANUARY - MARCH 2024

The output of the analysis of variance (ANOVA) signifies that the diameter of entry hole and the mist zone, number of radial fractures, and thickness of the mist zone have a significant difference among the types of glasses. This indicates the different types of glasses may have variation in fracture pattern which could be useful for forensic investigators. The factors that can affect the fracture pattern may include velocity of the weapon used, type of firearm and the angle of impact. The number of concentric fractures has an insignificant difference among the types of glasses. (Refer to Table 4).

Table 4: Analysis of Variance

ANOVA		F	Sig.
Diameter of entry (mm)	Between Groups	481.22	0.000
Diameter of mist zone (mm)	Between Groups	4.11	0.044
Number of concentric fractures	Between Groups	3.64	0.058
Number of radial fractures	Between Groups	70.36	0.000
Thickness of mist zone (mm)	Between Groups	22.29	0.000

Source: SPSS output

DISCUSSION

The primary focus of the present study was to Fig. out if glass present at a crime scene can be a good source for finding gunshot residue. Gunshot residues are deposited on target surfaces in trace amounts and are not readily visible. This methodology was created with the intention of stimulating a real world situation in which a bullet strikes glass as an intermediate target and then the fragments are found at the crime scene as a piece of evidence. Altogether, the findings of this study firmly supports the consideration of glass fragments containing gunshot residue as trace evidence alongside commonly considered pieces of evidence such as bullets, cartridges, or firearms. The present study also demonstrates the effectiveness of analysis for gunshot residue to make use of a minimum quantity of gunshot residue obtained on the glass samples. In real-life crime scenarios, the quality and quantity of gunshot residue found as evidence critically determine the suitable method selected for detection and analysis.

Gunshot residue particles found on intermediate targets such as glass, clothing, furniture, etc can be considered an excellent source for detecting the residues. In the present study, the glass fractures were impacted due to bullets. The glass fracturedepicts the hole diameter, radial, and concentric fractures, and mist zone formed (Fig. 1). A minimal quantity of unburnt, partially burnt, or completely burnt gunshot residues can be recovered from intermediate target surfaces. Factors such as the angle of firing, the distance of firing, the type of ammunition used, the condition of the barrel, and the condition of the firearm can influence the fracture formed for scientific analysis.29 Hence, it is recommended that the glass pieces found at the scene of the crime should be packed carefully and transported thus aiding the analysis of gunshot residue if impacted by bullets.²⁰

The path of the bullet from the barrel till it hits the target resulted in the formation of radial and concentric fractures at different ranges. By the contact between the bullet and the glass surface, the possibility of the transfer of gunshot residuecannot be ruled out. During sample collection, the number of radial and concentric fractures differed. This could be due to the composition of the glass. In absence of evidence such as bullets, cartridge cases, or firearms, the gunshot residue composition can be equally powerful for identification and narrowing down the type of weapon used. SEM-EDX is recommended to analyse the trace amounts of gunshot residue that can be deposited on intermediate surfaces such as glass. The recommended sampling strategy for detecting gunshot residue would be in and around the bullet hole formed on the glass and the bullet hole. The area around the bullet hole helps in narrowing down the area for detection of gunshot residue to identify the traces of gunshot residue which is not visible. The variables that impact the gunshot residue deposition are based on the amount of transfer, persistence, and recovery that interests the investigators to identify and narrow down the type of weapon used. This can open ideas

on the type of firearm and statistical estimates in real-life crime scenarios.

The present study utilised glass samples used in windowpanes fired at a 25-metre range which led to the deposition of gunshot residue on glass and a significant amount of gunshot residue was recovered from the glass. The glass fragments formed after impact were preserved with sufficient support to prevent further fragmentation. Improper handling, collection and preservation may result in the fragmentation of small glass pieces. These glass pieces were found to be significantly useful in the forensic context as it retains the gunshot residue. Impact on three types of glass by INSAS LMG 5.56mm weapon was analysed for traces of gunshot residue which yielded excellent results. Fig. 2 depicts the detection of gunshot residue at a 25-metre range. SEM-EDX was preferred over other methods owing to its capability in identifying particles that contain all the critical elements and demonstrates the strong possibility for falsepositive results when total elemental analysis techniques, such as AAS, are used.^{15,21,25} It was observed that gunshot residues can be detected on intermediate glass fired over a 25-metre range. This is due to the nature of the target surface and velocity of the projectile and the constructional feature of the projectile for retention of gunshot residue.³ Fig. 3 depicts the traces of gunshot residue on the fired glass samples. Any surface which comes in contact with the bullet is capable of instantaneous transfer/deposition with few traces of gunshot residue as a bullet wipe. Nevertheless, glass samples of different compositions were capable of yielding a useful composition of gunshot residue. Gunshot residue due to the impact of the bullet can transfer onto intermediate targets which can retain them, and this happens due to impact and friction. The detection of lead, barium, and antimony is suggestive that gunshot residue is retained. The morphological (visual) results showed a nodular specific morphology of metal particles lead, barium, and antimony resulting from the gunshot residue.20,21 However, the quantity could vary due to environmental factors, while impact pattern was variable due to either composition of glass or surface defects.

Intermediate targets of different glass types were considered primarily to imitate the practical scenario of finding panes or fragments of glass in the investigation even after considerable time for analysis.

The comparison of the types of glass was performed with the diameter of entry, the diameter

of the mist zone, the number of concentric fractures, the number of radial fractures, and the thickness of the mist zone.3 The statistical testing found a significant difference among the diameter of entry, the diameter of the mist zone, the number of radial fractures, and the thickness of the mist zone with types of glass. Sodalime glass shows significantly greater diameter of entry hole and mist zone, along with number of radial and concentric fractures and thickness of the mist zone. The quantifiable difference between the impacts found on glasses could be related to the energy of the impact, combination of firearm ammunition, range of firing and tensile stress. These observations may prove useful to the forensic investigators at the scene of crime.

CONCLUSION

Intermediate targets such as glass hit by the bullet can be considered as trace evidence in addition to routinely encountered evidence like firearms, fired bullets, and cartridge cases in shooting related crimes. The sample conditions may vary from intact glass to fractured, fragmented, trace, or mixed glass samples. While the amount of gunshot residue deposited and the ease of detection might vary, it

is possible to retrieve gunshot residue from glass impacted as an intermediate target that is properly collected. It was demonstrated that the role of glass samples in retaining the gunshot residue particles is necessary to obtain information on primers and propellants that can be compared with profiles of primer and propellants for different firearms. A statistically significant difference among the diameter of entry, the diameter of the mist zone, the number of radial fractures, and the thickness of the mist zone with types of glass can provide important clues to forensic investigators to solve the crime. The detection and analysis of gunshot residue from intermediate targets such as glass are hence practically useful and area promising field to explore further.

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Epidemiologocial Profile of Medico-Legal Cases at Tertiary Care Centre in Eastern India

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ABSTRACT

INTRODUCTION: There is an increasing rate of mortality and morbidity amongst the medicolegal cases in India. Knowledge of these cases is necessary to initiate a medico-legal case, treat such cases and further disposal in hospital. It is also needed to implement changes in the law and safety at work, home and roads. The saim of the study was to determine the epidemiological profile of medico-legal cases reported to Tertiary Centre in West Bengal during the study period and to study the epidemiological profile of different medico-legal cases in the hospital.

METHODOLOGY: This study is a retrospective hospital based observational study which was conducted in the casualty of tertiary hospital in Eastern India from November 2018 to January 2021. It is a tertiary care centres with referrals from in and around the state.

RESULTS: In our study we saw a decreasing trend of Medico-legal cases as the years passed by. A male preponderance of the cases (60%) compared to females.

THE RATIO OF MALES: Female was 1.5:1. 57% of our Medico-legal cases were road traffic accident and 18% were fall from height and found dead cases respectively. 36% (505) cases were in the 31-40 years age group followed closely by the 41-50 years age group 30% (421). This was followed by 51-60 years (11%) and 21-30 years and 61-70 years (10% each).

CONCLUSION: The aim of raising a Medico-legal case is to inform the police and application of medical knowledge in practice. The attending doctor needs to tackle the case with medical bent of mind and describe the alleged circumstances in simple language and describe relevant

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INTRODUCTION

Medico-legal cases are on the rise in India. The spectra is wide and varies from road

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traffic accident to death of an individual. It depends up on the suspicion of the treating registered medical practitioner. A Medico-legal case (MLC) is defined as "any case of injury or ailment, where the attending doctor, after history taking and clinical examination considers that investigations by law enforcement agencies are warranted to ascertain circumstances and fix responsibility regarding the said injury or ailment according to the law or the case itself brought as MLC by law enforcing agencies for medical or surgical care. Medico-legal cases are an integral part of medical practice that is frequently encountered by medical officers. A case of injury or illness where the attending doctor, after eliciting history and examining the patient, thinks that some investigation by law enforcement agencies is essential to establish and fix responsibility for the case in accordance with the law of the land. Basis of Medico-legal case: Sec 39 CrPC, 201 IPC, 202 IPC is the legal backing for initiation of medico-legal cases.^{1,2,3}

Profiling of Medico-legal cases is an essential aspect for the prevention of preventable casualities in the future and to study the genuine crime in the area. It would also be helpful to the Medicolegal expert and law enforcing agencies such as the police and the judiciary and ultimately in the process of scientific crime detection and proper administration of justice at large in such cases.

Emergencies report to casualty or accident and emergency department in hospital. It involves interplay of various specialities and pivotal role of medical officer in the interdisciplinary approach. It is purely the responsibility of an attending doctor to decide, when to label a case as Medico-legal. The police should be informed in all Medico-legal cases. Any failure to report the occurrence of a MLC may invite prosecution under sections 176 and/or 202 of IPC.

Aims and Objectives

- 1. To determine the epidemiological profile of medico-legal cases reported to Tertiary Centre in West Bengal during the study period.
- 2. To study the epidemiological profile of different medico-legal cases in the hospital.

Methodology

This study is a retrospective hospital based

observational study which is conducted in the casualty of tertiary hospital in West Bengal from November 2018 to January 2021. It is a tertiary care centres with referrals from in and around the state.

The medico-legal register of casualty department is the main source of this study which comprises of information regarding various parameters. Data was tabulated as name, gender, age and manner of causation, diagnosis and disposal and date of injury and date of reporting in the hospital. It was collected from the Medico-legal case register. The collected data was analysed, observations discussed, tabulated and compared with other studies. The data was analysed and results were derived with the help of SPSS version 22, Microsoft Excel and R software.

Inclusion criteria: All cases brought to the Tertiary Centre in West Bengal during the study period with known history of medico legal implications.

Exclusion Criteria: 1. The cases with inadequate details regarding age, sex, date and time of incident, was not mentioned, or unavailable in the records. 2. The cases referred from other hospitals or clinics where Medico-legal case was already initiated

RESULTS

Table 1: Year wise distribution of the Medico-legal cases

Year	Number of Medico-legal cases	Percentage
2018	584	41%
2019	458	33%
2020	362	26%
Total	1404	100%



Table 3: Age distribution of the cases

We studied a total of 1404 cases in three years which were of Medico-legal nature. The trend of Medico-legal cases decreased with progression of years. On follow-up with the local police station, 2% of our total cases had FIR lodged and investigations carried out.

Table 2: Gender distribution of the cases

Year	Male	Percentage	Female	Percentage
2018	380	65%	204	35%
2019	247	54%	211	46%
2020	218	60%	144	40%
Total	845	60%	559	40%

60% (n=845) of our study sample was male and 40% were female (n=559). In the three years of the study the gender distribution was much the same and varied between 54-65% for males and 35-46% for females. The ratio of males: female was 1.5:1

Age Group (in years)	Number	%
0-10	3	201
11-20	25	2%
21-30	140	10%
31-40	505	36%
41-50	421	30%
51-60	156	11%
61-70	141	10%
71-80	9	10/
>80	4	1%
Total	1404	100%

In our study, 36% (505) cases were in the 31-40 years age group followed closely by the 41-50 years age group 30% (421). This was followed by 51-60 years (11%) and 21-30 years and 61-70 years (10% each).

Table 4: Profile of Medico-legal cases

Type of cases	2018	%	2019	%	2020	%	Total	%
Road traffic accident	348	60	258	56	201	55	807	57
Found dead	112	19	74	16	69	19	255	18
Domestic assault	5	-	4	-	6		15	1
Fall from height	110	18	96	21	44	12	250	18
Poisoning	5	-	14	-	12	-	31	2
Snake bite	Nil	-	Nil	-	3	-	3	-
Burns	4	-	12	-	27	7	43	3
Total	584	100	458	100	362	100	1404	100



DISCUSSION

Medico-legal cases are cases of injury or illness where the attending doctor after elicting history and examining the victim feels that some investigation by law enforcement agencies is essential to establish and fix the responsibility of the case with the law of the land. Knowledge of profiling of Medico-legal cases is essential to cater to the needs of accident and emergency department of a hospital in terms of drugs, standard operating procedure, awareness of health care workers and their suitable modifications if needed. This also helps in implementation of safety measures and change in policy or existing laws to suit the need and health of the public.^{1,2,3}

We studied a total of 1404 cases in three years which were brought to the accident and emergency department of tertiary care in Eastern India. The cases were analysed statistically. Cases of road traffic accident were a majority (57%). Fall from height (18%) was the second most common group in our study along with found dead cases (18%). A similar trend of road traffic accidents followed by fall from height were noted by Sidappa *et al.*⁶

Garg *et al*⁴ found 54% of the total medico-legal cases to be of road traffic accidents. Kumar *et al*⁵ Sidappa *et al*⁶ found maximum cases of medicolegal cases to be road traffic accidents. Haridas *et al*⁷ found road traffic accident followed closely by falls. Brought dead was 6% of their total number of Medico-legal cases. This was in contrast to us where fall from height and found dead were similar in incidence of about 18% of total Medico-legal cases.

Like in all studies, there was a male preponderance in the study. The ratio was 1.5:. 60% (n=845) of our study sample was male and 40% were female (n=559). In the three years of the study the gender distribution was much the same and varied between 54-65% for males and 35-46% for females.

In our study, 60% of the study population were male and 40% were female. This was similar to findings of Hussaini *et al*⁸, Sidappa *et al*⁶, Yatoo *et*

 al° , Kumar *et al.*⁵ The predisposition to male sex in Medico-legal cases is assumed to be due to more road exposure activities in male, construction work employment and in agriculture work. Another factor that can casue propensity of males for Medico-legal cases are high risk behaviour like using seatbelts, helmets, speeding.

In landmark judgement of Pt Parmananda Kataravs Union of India & Ors in 1989, it is now compulsory that in emergency all statues are suspended and all efforts are made to save the life of an individual. Also all hospitals can handle Medicolegal cases and to save the time and harassment of doctors, Medico-legal register is sufficient in court of law.

The unique thing we noted in this region is that most common affected age group is 30-50 years. Most of the studies have found 21-30 years as commonly affected.¹⁰⁻¹³ This being a younger age with financial independence is a prone age group for maximum number of medicoelgal cases. This could be due to multiple levels of stress in lives family, children and job. This was followed closely by 41-50 years age group. This could be due to onset of diseases in this age bracket which may make them prone for accidents on road. Further research, of the age and type of vehicle will aid in suggesting changes to the lawmakers.

CONCLUSION

The aim of raising a Medico-legal case is to inform the police and application of medical knowledge in practice. The attending doctor needs to tackle the case with medical bent of mind and describe the alleged circumstances in simple language and describe relevant findings.

Conflict of Interest: Nil

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Ethical issues: Taken from the Institute CH/Kol/2021/Aug

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An Approach to Obscure Death: A Case Series

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ABSTRACT

INTRODUCTION: An Autopsy doesn't always yield cause of death easily. In 20-25% cases detailed history, visit to scene of incident, histological, toxicological& microbiological investigations might be required. Even then circumstantial evidence plays important role.

CASE REPORTS: Article presents and discusses four cases, two of electrocution, one natural neonatal death and one accidental phosphorous poisoning. How challenging it can be to ascertain cause of death at rural hospital set up.

DISCUSSION: Various natural and unnatural causes can lead to death without any evident pathology or signs such as sudden infant deaths, biochemical disturbances, functional disorders like epilepsy, electrocution, concealed trauma, certain poisonings, vagal and anaphylactic shocks.

CONCLUSION & RECOMMENDATIONS: All necessary and possible investigations should be done in obscure deaths to exclude such causes and to prevent allegations that the death was not investigated as fully as it should have been. Special efforts are needed to raise awareness regarding use and storage of hazardous materials to prevent accidental deaths.

KEYWORDS: Obscure autopsy; Electrocution; Poisoning; Infant Deaths.

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INTRODUCTION

The importance of autopsy in determining the cause of death for certification is unparalleled. But, autopsy is by no means infallible in revealing the definite cause of death. Causes of death can be classified into Natural, Unnatural and Obscure deaths. In about 20% of cases cause of death is unclear after dissection of body in view of minimal, indefinite or no findings at all and is called asobscure autopsy.¹ In these cases detailed laboratory examination of different materials/ samples from the body and verbal autopsy can lead to cause of death. There may be no adverse medical history, the gross examination may reveal nothing abnormal and histological, toxicological & microbiological screening remains unrewarding. In such a situation, as Professor Alan Usher of Sheffieldpoints out, the case needs to be labelled as 'unascertainable'.² Such cases may be termed as cases of negative autopsy. The rate may also vary according to the competency, personality and seniority of the doctor conducting the autopsy. Several surveys in various countries have shown that in cases where a doctor offers a cause of death without the benefit of autopsy findings, the error rate is of the order of 25–50%, even in hospital deaths.²

A less experienced doctor is often hesitant to show failure in providinga cause of death, feeling that it reflects upon his ability; whereas the more experienced doctor is lessinhibited towards the same. If the death is due to interaction of multiple factors, as in case of anesthetic deaths, it may become difficult to determine correct liability of each. This article discusses four case studied where cause of death was obscure at autopsy but verbal autopsy, circumstantial evidence and/or laboratory investigations played key role in determining the cause of death.

CASE REPORTS

Following Post-mortem cases had been done at Sub District Hospital, Phaltan, Pune, histopathology examination at Sassoon Hospital and chemical analysis at regional FSL, Pune.

Case 1: 60 year old man (Fig. 1), found dead in morning at his farm, where he was working overnight watering sugarcane. An electric supply line was



Fig. 1: Abrasion over face as result of fall

present nearby. Multiple superficial injuries in the form of abrasions were present on face & limbs, which were peri-mortem in nature. Police Inquest suggested Electrocution as cause of death, but no typical entry or exit electrocution lesions were observed after meticulous examination. No deep internal organ injuries corresponding to abrasions were found on autopsy. Only positive findings were petechial haemorrhages over lungs. Viscera report for chemical analysis came negative. Skin specimen sent for histopathology showed no specific changes related to electric injury. Histopathology of heart yielded no conclusive finding except some atherosclerotic changes.

Case 2: A 28 year second time 8 month pregnant female fell unconscious in bathroom, later declared brought dead. Autopsy did not reveal any significant findings externally and internally.⁸ month gestation foetus dead inside womb with no signs of maceration or anomaly. Histopathology came negative for amniotic fluid embolism. Later, crime scene investigation concluded faulty geyser as source of electrocution.

Case 3: Neonate was brought to casualty by parents and declared 'Dead on arrival'. Medical officer on duty suspected foul play due to some marks on neck. Parents gave history of febrile illness for 3 days. On autopsy it was found that marks on the neck were due to skin fold. Internal findings suggested some inflammatory condition later confirmed as pneumonitis on histopathology.



Fig. 2: Postmortem Artefact on neck

Case 4: 23 year old recently married female admitted to primary health centre with history of nausea, vomiting and irrelevant talk since 2 days. Her condition deteriorated and died within 12

hours. Nothing remarkable could be concluded from treatment records. Later relatives told she mistakenly brushed her teeth by Ratol (Rat poison) paste few days back. Autopsy findings showed some ecchymosis patches (Fig. 3) on trunk and



Fig. 3: Ecchymosis patch on trunk

some minor injuries on hand. Internal organs were congested. Chemical analysis of viscera came negative while Ratol paste (Fig. 4) contained elemental Phosphorus.



Fig. 4: Rat poison mistaken for Tooth paste

DISCUSSION

Case 1 describes scenario where an old man found dead with minor injuries sustained due to fall. These injuries were not sufficient cause death. Wet soil in the farm might be the reason for non-development of typical entry exit wound of electrocution. Electrical mark is an important sign fora forensic pathologist to determine the cause of death, which might be the only evidence of contactwith electricity. The prevalence and appearance of electrical marks varies depending on multiple factors. In the absence of distinctive

morphological findings on the body, electrocution as a cause of death is often established by exclusion of other possible causes and supported by circumstantial evidence collected at the scene of the incident. Electrical injuries to the skin may range from superficial erythema to full thickness burns and charring involving deeptissues. Also, under some circumstances, no obvious electrical injury may be present. In a study done by Karger B et al, some extent of skin damage was observed in 79% of cases, while in remaining 21%, there were no detectable changes on theskin.3 Negative chemical analysis report for viscera and inconclusive findings of histopathology lead to establishment of cause of death on circumstantial and verbal autopsy. Old age persons are more vulnerable to complications of electrocution. In electrocution current capable of over stimulating the heart, nervous system or causing damage to internal organs leads to death. Non-electrical trauma is also quite common with source greater than 300 Volts, current might be transmitted by means of arcing, caused by formation of conductive plasma between the source and the ground. The blast effect of high-voltage arcing can throw the victim away from the source, causing fatal injuries. The distance to which an electric arc can jump is proportional to the voltage.

Case 2 of pregnant woman found unresponsive in bathroom with inconclusive autopsy and histopathology findings emphasizes the importance of crime scene visit and circumstantial evidence. Finding of faulty geyser by Investigating Officer is very crucial. Strength of current perceptibleto a human as a tingle is 1 milliamp, whereas 5 milliamp produces tremors, and 15-17 milliamp causes contracture of the muscles. Ventricular fibrillation occurs between 75 and 100 milliamp or ventricular arrest at very high currents.4 Most fatalities occur with the domestic voltage between 110 and 380 Volts. Most of the deaths from electricity are from cardiac arrhythmias, usually ventricular fibrillation leading to cardiac arrest.1 Death may occur as a result of respiratory arrest, due to paralysis of intercostal muscles and diaphragm or rarely by affecting the brain stemwhen the current enters through the head. Case 1 & 2 didn't show any entry or exit wounds. Laboratory and histopathological reports ruled out other possibilities of natural and unnatural deaths.

Case 3 raises suspicion at start but culminates to natural cause of death. In case of Infant deaths detailed history should be elicited and suspicion of foul play is important, but postmortem artifacts should be ruled out. In case of fat child natural folds of skin may resemble strangulation marks. Meticulous examination especially in decomposed bodies is required to rule out skin and underlying tissue damage.5 The cause of death in neonaticides broadly bedivided into deliberate can acts and omissions of care. The usual scenario is of anabandoned infant, where the identity of the mother is unknown. In present case baby brought to hospital by parents rules out abandonment and good weight rules out neglect. Most common unnatural causes of death are reported to be neglect, asphyxia, drowning, stabbing, and blunt head trauma.6 History of febrile illness in present case pointed towards acute infective etiology which was confirmed on histopathology as pneumonitis. It signifies importance of histopathology in obscure deaths.

Case 4 describes accidental poisoning by rat poison and delayed manifestations. There was 4 – 5 days delay of accidental brushing and clinical manifestations. Patient and relatives were unaware of poisoning and it came to notice only after investigation. Ratol contains contain 3% yellow phosphorus in a tube 15gm. Usual fatal dose is 60mg (1mg/kg body weight).⁷ There are reported cases accidental poisoning due to mistaking it for tooth paste. A single use can be fatal especially in children. Orally ingested yellow phosphorus is rapidly absorbed through the gastrointestinal system and approximately 70% is accumulated in the liver within 2 to 3 hours. It accumulates to a lesser extent in the heart (12%), kidneys (4%) and leads to acute hepatic failure.⁸

The patients are usually asymptomatic during the initial 72 h of ingestion, or they may have signs and symptoms of gastrointestinal irritation. After 72 h they develop deranged liver function, acute hepatic failure, coagulopathy. Central nervous system effects include changes in mental status like confusion, psychosis, hallucinations, and coma.9 In severe ingestions of ratol paste, patients do not have the initial asymptomatic stage, and they die due to shock and cardiopulmonary arrest in early stages itself. Cardiac toxicity includes hypotension, tachycardia, arrhythmias, and cardiogenic shock. The general status of the patient deteriorated within hours at hospital and the patient developed encephalopathy and died as a result of cardiovascular collapse. There is no specific antidote for Phosphorus, hence treatment is mostly supportive. Primary health care is ill equipped for handling such cases. Sample of vomitus was not available. Viscera chemical analysis came negative possibly due to either poison completely eliminated

from the body by vomiting / purging / lungs / metabolism or taken in small amount. Present case emphasizes the importance of detailed history, high degree of suspicion and preservation of vomitus/ gastric lavage sample.

Causes of obscure autopsy can be classified as:

- 1. Natural diseases where pathological process not conspicuously evident.
- Death precipitated by emotional stress and strain acting on a previously diseased heart orany other organ, the existence even unknown to the victim.
- Death occurring from functional failures, e.g. epilepsy, strokes, etc.
- 2. Biochemical disturbances likeuremia, hypo & hyperglycemia, hypocalcaemia, electrolyte imbalance as in potassium deficiency etc.
- 3. Endocrine dysfunctions such as adrenal insufficiency and thyrotoxicosis or myxoedema.
- 4. Concealed trauma in the form of Concussion, blunt injury to the heart, blast effect without anyexternal injury and electrocution without any external mark.
- 5. Poisoning cases such as delayed subtoxic or narcotic poisoning, anestheticover dosageor maladministration, neurotoxic or cytotoxic poisons andplant poisoning, etc.
- 6. Other causes like reflex vagal inhibition, incompatible blood transfusion, airembolism, allergic reactions, anaphylactic deaths etc.

CONCLUSION & RECOMMENDATIONS

An obscure autopsy should be approached with suspicion and ancillary investigations must be carriedout in order to exclude such causes and to prevent allegations that the death was not investigated as fully as it should have been. The saying 'eyes see what mind knows' is applicable here, so more the autopsy surgeon knows about the total scenario, the more he/she can elucidate from the autopsy. Verbal autopsy and crime scene visit are main pillars of investigation into cause of death in obscure deaths. Remedial suggestions to prevent accidental deaths like the ones reported in this article, is moral responsibility of Doctor. All standard safety equipment should be installed with periodic inspection of electric appliances. Marketed poison packaging should be distinct and alarming from regular use household items. Early

medical advice should be sought in case of ill health however trivial it may be. Special efforts are needed to raise awareness regarding use and storage of hazardous materials.

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2) Article file: The main text of the article, beginning from Abstract till References (including tables) should be in this file. Do not include any information (such as acknowledgement, your name in page headers, etc.) in this file. Use text/rtf/doc/PDF files. Do not zip the files. Limit the file size to 400 Kb. Do not incorporate images in the file. If file size is large, graphs can be submitted as images separately without incorporating them in the article file to reduce the size of the file.

3) Images: Submit good quality color images. Each image should be less than 100 Kb in size. Size of the image can be reduced by decreasing the actual height and width of the images (keep up to 400 pixels or 3 inches). All image formats (jpeg, tiff, gif, bmp, png, eps etc.) are acceptable; jpeg is most suitable.

Legends: Legends for the Fig.s/images should be included at the end of the article file.

Preparation of the Manuscript

The text of observational and experimental articles should be divided into sections with the headings: Introduction, Methods, Results, Discussion, and Conclusion. References, tables, Fig.s, legends, and Acknowledgment, Appendices and Abbreviations may be provided after the Abstract page.

Title Page

The title page should carry the following:

- 1. Type of manuscript (e.g. Original Article, Review Article, Case Report and so on).
- 2. The Title should be descriptive of the subject
- 3. A running head of not more than 50 characters (including spaces) should be on top margin and aligned to the centre

- 4. The name of each contributor is to be provided (Last name, First name and initials of middle name), with their academic degree and institutional affiliation
- 5. The name of the department(s) and institution(s) to which the work may be attributed;
- 6. The name, full address, phone numbers, and e-mail address of the corresponding author should be mentioned.
- The total number of pages, total number of photographs and word count separately for abstract and for the text (excluding the references and appendixes);
- 8. Source(s) of support in the form of grants, equipment, drugs, or all of these;
- 9. Acknowledgement, if any; and
- 10. If the manuscript was presented as part at a meeting, the organization, place, and exact date on which it was read.

Abstract Page:

The second page should carry the full title of the manuscript and an Abstract (of no more than 150 words for case reports, brief reports and 250 words for original articles). The abstract should be structured and state the Context (Background), Aims, Settings and Design, Methods and Materials, Statistical analysis used, Results and Conclusions. A minimum of 4 keywords and a maximum of 8 keywords may be provided by the author for indexing.

Introduction

State the background and purpose of the study and summarize the rationale for it. Describe in a few short sentences in simple English, the background and significance of your article in the following format.

Materials and Methods

The Meterials and Methods section should include only information that was available at the time the plan or protocol for the study was written such as study approach, study design, type of sample, sample size, sampling technique, setting of the study, description of data collection tools and methods.

Reports of randomized clinical trials should be based on the CONSORT Statement. (www.consort-statement.org) When reporting experiments on human subjects, indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975, as revised in 2000 (available at http://www.wma.net/e/policy/I7-c_e.html). Supplementary materials and technical details can be placed in an appendix where it will be accessible but will not interrupt the flow of the text; alternatively, it can be

Result

Present your results in a logical sequence in the text, tables, and illustrations, describing the most important findings first. Do not repeat the data in the tables or illustrations; emphasize or summarize only important published only in the electronic version of the journal.

Discussions

Include a summary of key findings (primary outcome measures, secondary outcome measures, results as they relate to a prior hypothesis); strengths and limitations of the study (Study question, design, data collection, analysis and interpretation); interpretation and implications in the context of the totality of evidence (is there a systematic review to refer to, if not, could one be reasonably done here and now? What does this study add to the available evidence, effects on patient care and health policy, possible mechanisms). Controversies raised by this study; and future directions (for this particular research collaboration, underlying mechanisms, clinical research). Do not repeat in detail data or other material given in the Introduction or the Results section.

References

References should be listed in alphabetical order and numbered accordingly. Each listed reference should be cited in the text. Identify references in text, tables, and legends by Arabic numerals in square bracket (e.g. [10]). Please refer to ICMJE Guidelines (http://www.nlm.nih.gov/ bsd/uniform_ requirements.html) for more examples.

Standard journal article

- Flink H, Tegelberg Å, Thörn M, Lagerlöf F. Effect of oral iron supplementation on unstimulated salivary flow rate: A randomized, double-blind, placebo-controlled trial. J Oral Pathol Med 2006; 35: 540-7.
- Twetman S, Axelsson S, Dahlgren H, Holm AK, Källestål C, Lagerlöf F, et al. Caries-preventive effect of fluoride toothpaste: A systematic review. Acta Odontol Scand 2003; 61: 347-55.

Article in supplement or special issue

• Fleischer W, Reimer K. Povidone iodine antisepsis. State of the art. Dermatology 1997; 195 Suppl 2: 3-9.

Corporate (collective) author

 American Academy of Periodontology. Sonic and ultrasonic scalers in periodontics. J Periodontol 2000;

71: 1792-801.

Unpublished article

 Garoushi S, Lassila LV, Tezvergil A, Vallittu PK. Static and fatigue compression test for particulate filler composite resin with fiber-reinforced composite substructure. Dent Mater 2006.

Personal author(s)

• Hosmer D, Lemeshow S. Applied logistic regression, 2nd edn. New York: Wiley-Interscience; 2000.

Chapter in book

 Nauntofte B, Tenovuo J, Lagerlöf F. Secretion and composition of saliva. In: Fejerskov O,

No author Listed

 World Health Organization. Oral health surveys - basic methods, 4th edn. Geneva: World Health Organization; 1997.

Reference from electronic media

- National Statistics Online—Trends in suicide by method in England and Wales, 1979-2001. www. statistics.gov.uk/downloads/theme_health/HSQ 20.pdf (accessed Jan 24, 2005): 7-18. Only verified references against the original documents should be cited. Authors are responsible for the accuracy and completeness of their references and for correct text citation. The number of reference should be kept limited to 20 in case of major communications and 10 for short communications.
- More information about other reference types is available at www.nlm.nih.gov/bsd/uniform_ requirements.html, but observes some minor deviations (no full stop after journal title)

Tables

- Tables should be self-explanatory and should not duplicate textual material.
- Tables with more than 10 columns and 25 rows are not acceptable.
- Table numbers should be in Arabic numerals, consecutively in the order of their first citation in the text and supply a brief title for each.
- Explain in footnotes all non-standard abbreviations that are used in each table.
- For footnotes use the following symbols, in this sequence: *, ¶, 1, ‡‡,

- Graphics files are welcome if supplied as Tiff, EPS, or PowerPoint files of minimum 1200x1600 pixel size. The minimum line weight for line art is 0.5 point for optimal printing.
- When possible, please place symbol legends below the Fig. instead of to the side.
- Original color images can be printed in color at the editor and publisher's discretion provided the author agrees to pay.
- Type or print out legends (maximum 40 words, excluding the credit line) for illustrations using double spacing, with Arabic numerals corresponding to the illustrations.

Sending a revised manuscript

While submitting a revised manuscript, contributors are requested to include, along with single copy of the final revised manuscript, a photocopy of the revised manuscript with the changes underlined in red and copy of the comments with the point to point clarification to each comment. The manuscript number should be written on each of these documents. If the manuscript is submitted online, the contributors' form and copyright transfer form has to be submitted in original with the signatures of all the contributors within two weeks of submission. Hard copies of images should be sent to the office of the journal. There is no need to send printed manuscript for articles submitted online.

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Approval of Ethics Committee

We need the Ethics committee approval letter from an Institutional ethical committee (IEC) or an institutional review board (IRB) to publish your Research article or author should submit a statement that the study does not require ethics approval along with evidence. The evidence could either be consent from patients is available and there are no ethics issues in the paper or a letter from an IRB stating that the study in question does not require ethics approval.

Abbreviations

Standard abbreviations should be used and be spelt out when first used in the text. Abbreviations should not be used in the title or abstract.

Checklist

- Manuscript Title
- Covering letter: Signed by all contributors
- Previous publication/ presentations mentioned, Source of funding mentioned
- Conflicts of interest disclosed

Authors

- Middle name initials provided.
- Author for correspondence, with e-mail address provided.
- Number of contributors restricted as per the instructions.
- dentity not revealed in paper except title page (e.g.name of the institute in Methods, citing previous study as 'our study')

Presentation and Format

- Double spacing
- Margins one inch on all four sides
- Title page contains all the required information. Running title provided (not more than 50 characters)
- Abstract page contains the full title of the manuscript
- Structured abstract provided for an original article

- Key words provided (three or more)
- Introduction of 75-100 words
- Headings in title case (not ALL CAPITALS). References cited in square brackets

References according to the journal's instructions

Language and grammar

- Uniformly British English
- Abbreviations spelt out in full for the first time. Numerals from 1 to 10 spelt out
- Numerals at the beginning of the sentence spelt out

Tables and Fig.s

- No repetition of data in tables and graphs and in text.
- Actual numbers from which graphs drawn, provided.
- Fig.s necessary and of good quality (color)
- Table and Fig. numbers in Arabic letters (not Roman).
- Labels pasted on back of the photographs (no names

written)

- Fig. legends provided (not more than 40 words)
- Patients' privacy maintained, (if not permission taken)
- Credit note for borrowed Fig.s/tables provided
 Submitting the Manuscript
- Is the journal editor's contact information current?
- Is the cover letter included with the manuscript? Does the letter include:
- 1. The author's postal address, e-mail address, telephone number, and fax number for future correspondence?
- 2. State that the manuscript is original, not previously published, and not under concurrent consideration elsewhere?
- 3. Inform the journal editor of the existence of any similar published manuscripts written by the author?
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