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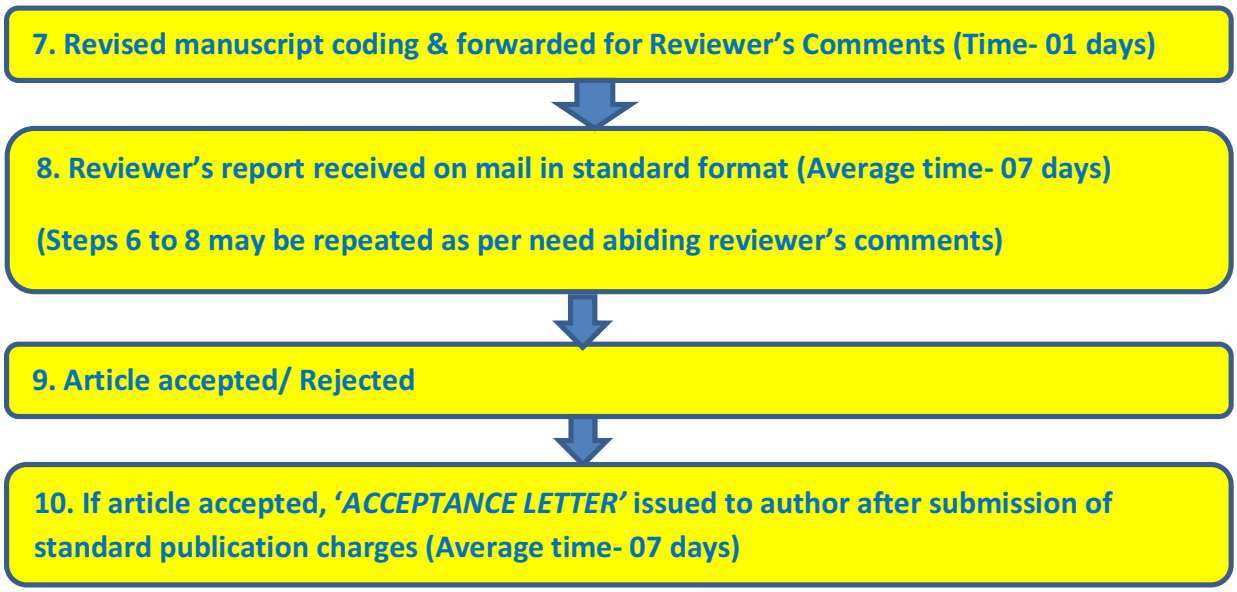

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Editorial

Research Publications: Forensic Perspective

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Introduction

Research is fundamentally most important process for societal scientific growth with new or in depth knowledge on particular subject matter or scientific field. It facilitates the growth, driving advancement and enhancing deeper understanding in a field in scientific way. It facilitates to develop new knowledge and provides information to world on decision making and solves problems and ultimately facilitates improvement and better quality of life.[1, 2]

It facilitates to expand knowledge and deepen the understanding on particular subject matter. It is the important bedrock of innovative ideas and development of new processes and products leading to scientific and technological advancement. It facilitates decision-making guidelines by fostering critical thinking attitude, with problem solving approach helps policy formation and addresses challenges and helps to improve quality of life. The ICMJE (International Committee of Medical Journal Editors) recommendations given standard guidelines which are followed by high prestige medical journals. These guidelines may be applied for writing research papers at par with international standards. Researchers using human participants as subject for their study need to follow international ethical standards. Indian national ethical standards are also similar to international standards.[3, 4]

Various details are elaborated herewith under various headings in this article as follows-

1. **What is research?**
   i. Oxford English Dictionary: "It is the systematic investigation into and study of materials, sources, etc., in order to establish facts and reach new conclusions
   ii. American Psychological Association (APA): "It is a systematic process of inquiry that involves the collection, analysis, and interpretation of data for searching an answer of a question or solve a problem."
   iii. ."Merriam-Webster Dictionary: "Research is a careful and systematic study and investigation into a subject, often involving the collection and analysis of data."

In general, research is a scientific, systemic, step-wise, original investigations or methodological enquiry carried out by the researcher/s on a topic/ issue to find out more scientific knowledge, deeper understanding and discovery of additional or new interesting facts or principles in the concerned field.

2. **Key Characteristics**
   i. Systematic: Research follows a deliberate and organized approach in scientific way.
   ii. Objective: Research aims to be unbiased and impartial.
   iii. Methodical: Research involves a careful and deliberate process of gathering and analyzing information.

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iv. Analytical: It involves systemic investigations using critical thinking which used to analyse and interpretation of data.
v. Empirical: It relies on evidence and data.

3. Forms of Research:

i. **Exploratory Research:** It is useful for defining or identifying a problem or question.
ii. **Constructive Research:** It is a problem-solving methodology which tests theories and aims to propose novel solutions to the practical and theoretical problems or questions under research and further evaluates its effect.
iii. **Empirical Research:** It aims to gain knowledge through direct observation and experience by testing feasibility of solution using the observation or experience based evidence.
iv. **Non-empirical (Theoretical) research:** This approach relies on existing knowledge and develop theory in opposition to the observation and experimentation. It aims to seek solutions to problems with the help of existing knowledge.
v. **Basic and Applied Research**: Basic research usually comprising of quest for information without any target or specific objective. On the contrary applied research is aimed specifically towards the resolution of current issue of interest.

4. Major research designs in empirical research:

i. **Quantitative research:** It is an empirical, observation-based, systemic investigation of quantitative characteristics or measurable properties and phenomena and their relationships with collecting numerical data and further statistical analysis. Analyzes numerical data to identify patterns, trends, and correlations through methods like experiments, polls, and statistical analysis. Such results further helpful to establish causal relationships or existence of association between various independent variables. Qualitative studies include various research designs such as Correlational study design, experimental study design or descriptive (survey) study design. Data collection methods include random sampling, systemic sampling, structured data collection methods.
ii. **Qualitative Research:** It involves the detailed understanding of human behavior, reasons governing such behavior by collecting vast data in narrative formats as words or images or videos, etc. by asking broad questions which further analyzed. Explores attitudes, behaviors, and opinions through methods like interviews, surveys, and focus groups.
iii. **Mixed type of research:** It includes of both types i.e., qualitative and quantitative research. In this type of research a more comprehensive understanding provided by combining the qualitative and the quantitative approaches within a single study.

5. Research Process

i. Problem Identification: Recognize a research problem or question problem through need analysis.
ii. Literature Review: Examine existing research on the topic to gain context and insights. This comprises the current scenario of the issue in research, effects of the issue, draws the ideas about the lacunae and about the methodology deployed to perform the research on particular topic.
iii. Research Methodology & Research Design: Choose a research methodology and design the study. Outline of this section includes study design[5] (type of study- experimental/ cohort/ case control/ cross sectional and logistical arrangements- prospective/ retrospective/ both), study population (time, place, person, inclusion & exclusion criteria), operational definitions, sampling procedure (convenience/ random/ systemic/ cluster), sample size, data collection procedures (who and how?), data analysis plan (data recording, software used, etc.), data safety and quality assurance plan, informed consent, human subject protection, confidentiality and ethical clearance.
iv. Results: It refer to the outcome of study which is presented in a clear and concise manner.
v. Conclusion: It summarize the main findings and implications.
vi. Take home message: Guides on community awareness or important message.
vii. Recommendations: Suggest future research directions or practical applications.

6. Literature review techniques:

i. Organizing Techniques: It includes concept Mapping, mind Mapping, outline Method, Matrix Method

ii. Searching Techniques: It includes database Searching, Keyword Searching, Author Searching, Citation Chaining.
iii. Evaluation Techniques: It includes critical appraisal, source evaluation, study design evaluation, risk of bias assessment.
iv. Synthesis Techniques: It includes thematic analysis, meta-analysis, narrative synthesis, conceptual synthesis.
v. Writing Techniques: It includes Summarization, Paraphrasing, Quotation, and Synthesis Writing.

7. Research Ethics

i. Informed Consent: Ensure subject understand the research purpose, risks, and benefits.
ii. Confidentiality: Protect participants' identities and data.
iii. Anonymity: Keep participants' identities unknown, as possible.
iv. Avoid Harm: Minimize risks and ensure participants' well-being.
v. Objectivity: Maintain impartiality and avoid bias.

8. Common Research Methods

i. Surveys: Self-report questionnaires or interviews.
ii. Experiments: Controlled studies that manipulate variables.
iii. Case Studies: In-depth examinations of a single case or phenomenon.
iv. Content Analysis: Systematic analysis of texts, images, or videos.
v. Observational Studies: Studies that observe participants without manipulating variables.

9. Research Tools and Software

i. SPSS: Statistical analysis software.
ii. Excel: Spreadsheet software for data analysis.
iii. SurveyMonkey: Online survey platform.
iv. EndNote: Reference management software.
v. NVivo: Qualitative data analysis software.

10. Research Publication:

It is a process of disseminations or sharing of research findings, arguments, conclusion and recommendations with the academic community and the general public through various media, such as journals, conferences, and books.

Unpublished written output in printed format or just posted on internet without any peer review is called grey literature. To convert our exhaustive research work into a **scholarship**, it needs to be published in peer reviewed, reputed academic journal.

11. Types of Research Publications:

i. Journal articles: It includes of original research articles, original review articles, Survey paper, Systemic meta-analysis, case series, case report, short communication, editorial, letters, clinical trial, book review, commentary, etc.
ii. Original research papers: Articles published bearing reports on the findings of study by the authors themselves in peer-reviewed journals.
iii. Conference Papers: Research papers presented at various academic conferences.
iv. Book Chapters: Contributions to edited books on scientific research topics.
v. Books: Comprehensive monographs on research topics.
vi. Theses and Dissertations: Research papers produced as part of academic degree requirements.

12. Publication Process:

i. Writing and Editing: Research manuscript is prepared and refined.
ii. Journal Selection: Researcher need to choose a suitable journal for publication.
iii. Submission: Submit the manuscript to the selected journal.
iv. Peer Review: Expert reviewers evaluate the manuscript for quality and validity.
v. Revision and Resubmission: Address reviewer comments and resubmit the manuscript.
vi. Acceptance and Publication: The manuscript is accepted and published in the journal.

13. Publication Ethics:

i. Originality: It ensure the work is original and free from plagiarism.
ii. Authorship: Authorship should reflect significant intellectual contribution. The contributor roles should be clearly defined in relation to the preparing study design, data collection, analysis, interpretation and manuscript writing.
iii. Ethics review/ breach of confidentiality, fabrication and falsification, authorship, plagiarism, etc.
iv. Conflict of Interest: Potential conflicts of interest need to be disclosed.
v. Data Integrity: Accuracy and integrity of research data to be ensured.
vi. Ethics in recent advances: The development of AI technology development in health sector is

being steered by the fundamental principles of ethics. [6]

14. Benefits of Research Publication:

i. Knowledge Sharing: Research findings will be disseminated to the academic community.
ii. Career Advancement: Authors research reputation and career prospects will be enhanced.
iii. Collaboration: It facilitate the collaboration and networking with other researchers.
iv. Impact: It contribute to the advancement of knowledge and societal impact.

15. Publication Venues for Forensic Medicine Research

i. Forensic Science International: A leading international journal for forensic science research.
ii. Journal of Forensic Sciences: A peer-reviewed journal covering various aspects of forensic science.
iii. American Journal of Forensic Medicine and Pathology: A journal focusing on forensic pathology and related topics.
iv. Journal of Forensic Medicine Science and Law (JFMSL) - It is an official publication of Medicolegal Association of Maharashtra. [7]
v. Journal of Indian Academy of Forensic Medicine (JIAFM) - It is an official publication of Indian Academy of Forensic Medicine.
vi. Forensic Medicine and Toxicology: A journal covering forensic medicine, toxicology, and related fields.

16. Challenges in Research Publication:

i. Journal Competition: There is a high competition for publication in top-tier journals.
ii. Peer Review: It is a great task of navigating the peer review process and addressing the reviewer comments.
iii. Time-Consuming: Researchers need to balance publication efforts with other research and academic responsibilities.
iv. Limited Funding: Secure funding to support research and publication efforts is important.
v. Access to Cases and Data: Obtaining access to forensic cases and data can be difficult due to confidentiality and security concerns.
vi. Interdisciplinary Collaboration: Collaborating with experts from various fields can be challenging due to differences in terminology, methods, and perspectives.
vii. Staying Current with Advances: Keeping up-to-date with the latest advances in forensic science and medicine can be challenging due to the rapid pace of technological developments.

Contributor ship of Author: All authors equally contributed.

References:

1. Erol A. Basics of Writing Original Research Papers. Noro Psikiyatr Ars. 2024; 61(3):193-194.
2. Deokar RB, Patil SS. Basics of Reaseach and Publications. J Forensic Med Sci Law 2021; 30(2):1-3.
3. *ICMJE. Recommendations for the conduct, reporting, editing, and publication of scholarly work in medical journals [Cited on 30th January 2025]. Available from:* https://www.icmje.org/recommendations/ adresinden 30.06.2024 tarihinde indirildi.
4. Indian Council of Medical Research. National ethical guidelines for biomedical and health research involving human participants. New Delhi: ICMR; 2017. *[Cited on 30th January 2025] Available from:* https://ethics.ncdirindia.org//asset/pdf/Handbook_on_ICMR_Ethical_Guidelines.pdf
5. Haynes AB, Haukoos JS, Dimick JB. TREND Reporting Guidelines for Nonrandomized/Quasi-Experimental Study Designs. *JAMA Surg. 2021; 156(9):879–80. doi: 10.1001/jamasurg.2021.0552. https://doi.org/10.1001/jamasurg.2021.0552.*
6. Deokar RB, Patil SS. Artificial Intelligence in Healthcare and Biomedical Research – Ethical aspects. J Forensic Med Sci Law. 2024;33(1):1-4.
7. Varma NM, Pawar MN, Deokar RB. Executive Summary of the Forensicon 2022 - 25th Annual State Conference of Medicolegal Association of Maharashtra (MLAM). J Forensic Med Sci Law 2023;32(2):80-84.

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Original Research Article

Age Estimation and Sex Determination using Antegonial Depth in Indian Population - A Retrospective Study

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Antegonial Depth, Orthopantomograph, Panoramic Radiographs, Antegonial Notch, Antegonial Depth.

Abstract

Introduction: Identification of an individual is crucial from womb to tomb. It has always been a challenging task. Estimation of age after death from the adult skeleton is one of the most important objectives in medico-legal cases. Among the various parameters available, skeletal age determination is considered the best. This study attempts to assess the Reliability of antegonial depth or notch as an indicator of chronological age. **Material & Methods:** A total of 400 patients (200 males and 200 females), panoramic radiograph taken for various purposes were included in the study. The patients were categorized according to age, gender. Panoramic radiographs were traced and antegonial depths were measured. **Results:** A trend of same antegonial depth with age was observed in both males and females. Furthermore, there were differences between males and females uniformly in antegonial depth. **Conclusions:** The antegonial depth remained almost same with the advancing age and in between sexes.

1. Introduction

Various authors described several changes which Occurs in the shape of the human lower jaw as age progresses. One of the notable changes is change in the gonial (mandibular) angle. The angle between the mandible body and the ramus is called the gonial angle. Surface resorption field present at the lower edge of the mandible in the ramus body junction, forming an antegonial notch or antegonial depth. Any Changes in the gonial angle is largely formed by ramus remodelling and is determined by the remodelling direction of the ramus with its condyle.

Very few studies have been carried till date in India antegonial depth and relation with determination of sex and age.[1–5] Other than age and loss of teeth, other factors may influence gonial angle changes. Panoramic radiograph is the most basic choice for Determination of ante gonial depth.[4] Thus, the aim of this study was to evaluate antegonial depth from panoramic radiographs of to

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determine their sex and age.

2. Materials and Methods

The present study titled "Age Estimation and Sex Determination using Antegonial Depth - A Retrospective Study" was conducted in the Department of Forensic Odontology, JSS Dental College and Hospital, Sri Jagadguru Sri Shivarathreeshwara Academy of Higher Education and Research (JSSAHER), Mysuru, Karnataka.

This study was undertaken with an aim of establishing certain mandibular parameters as criteria, thereby setting a population specific standard for age and sex determination. Digital orthopantomograms (OPG) archived in the Department of Oral Medicine and Radiology, JSS Dental College and Hospital, Mysuru was used for this study with Inclusion criteria of radiograph with proper contrast and density were only selected in which all the structures were clearly visible and in exclusion criteria radiograph with improper density were excluded from the study.

The study followed Stratified random sampling technique which consisted of 400 OPG (200 male and 200 female subjects) that were divided into five groups on the basis of chronological age by decades (40 in each group for male and female subjects), in the age range of 20-70 years **(Table 1)**.

Table 1: Sample size distribution

Study Groups	Age group	Male	Female
Group 1	20-30 years	40	40
Group 2	31-40 years	40	40
Group 3	41-50 years	40	40
Group 4	51-60 years	40	40
Group 5	61-70 years	40	40
	Total	200	200

Mandibular parameter antegonial depth was studied and assessed whether this will aid in estimating the age and determining the sex. Digital orthopantomograms were obtained from Planmeca Promax Scara 3 Digital OPG Machine, (70 kVp, 8 mA for 16 seconds), Manufactured by PLANMECA OY, Helsinki, Finland, with a 1:1 ratio. The digital orthopantomograms were imported into Planmeca Romexis Viewer Software 2.9.2.R., and the measurements were done. Microsoft Office Excel (2016) sheet was used for compiling the data.

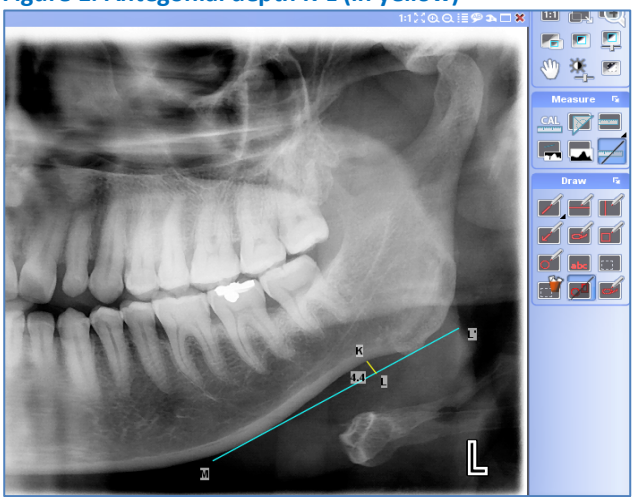
The statistical analysis was carried out using SPSS Software Package version 20 with Descriptive statistics, ANOVA test, post- hoc test, independent t-test were applied.

Methodology:

Ethical clearance ((No: JSS/DCH/IEC/2017-18 /02) was obtained from JSS Dental College & Hospital's Institutional Ethical Committee prior to conducting the study. The digital orthopantomograms were selected based on the inclusion and exclusion criteria mentioned above. The selected radiographs were imported to Planmeca Romexis Viewer 2.9.2.R software, where the antegonial depths were digitally traced and the measured values noted. Literature states that a very high degree of symmetry exists between the left and the right sides, therefore all the measurements were made on the left side of the radiograph for uniformity [6, 7]. The measurements were calibrated in millimeters (mm) and the measured values were entered in Microsoft Office Excel sheet.

Antegonial Depth (K-L): The antegonial depth was measured as the distance along a perpendicular line from the deepest point of the notch concavity to a tangent through the inferior border of the mandible (ML). This method of measurement is taken from Revant H. Chole et al., 2013 [8] and represented in the **figure 1**.

Figure 1: Antegonial depth K-L (in yellow)



3. Results and Observations

The mean values of antegonial depth for females and males in relation to different age groups depicted in table 2.

Group 1: 20-30 years

For antegonial depth females had a mean value of 0.93 mm +/- 0.96 with SEM 0.15 while males had a mean value of 1.80 mm +/- 1.57 with SEM 0.24. For antegonial depth, the mean difference between females and males was 0.875 mm.

Group 2: 31-40 years

In this age group antegonial depth showed a mean value of 0.91 mm +/- 1.02, SEM = 0.16 for females.

Males had a mean value of 1.32 mm +/- 1.71, SEM = 0.27. The mean difference between females and males was 0.4125 mm. P value obtained was 0.195 (P > 0.05), implying that males and females showed no significant differences.

Group 3: 41-50 years

In this age group mean value obtained was 0.59 mm +/- 0.97 with SEM of 0.15. For males mean value was 1.38 mm +/- 1.35, SEM = 0.21. The mean difference between females and males was 0.795 mm. The P value was 0.004, which was statistically significant (P < 0.05). In other words, significant differences are present between females and males.

Group 4: 51-60 years

The mean value in females for antegonial depth was 1.01 mm +/- 0.96, SEM = 0.15, while in males mean value was calculated to be 1.79 mm +/- 0.96, SEM = 0.15. The mean difference between females and males was 0.7825 mm. The calculated P value was 0.006 (P < 0.05). In other words, significant differences are present between females and males by 0.7825 mm.

Group 5: 61-70 years

Antegonial depth for females was 0.90 mm +/- 1.04, SEM = 0.16, for males it was 1.34 mm +/- 1.47, SEM = 0.23. The mean difference between females and males was 0.661 mm. P value calculated was found to be 0.128 (P > 0.05), thus implying that females and males do not show significant difference.

Overall Age Group: 20-70 years

Females had a mean value of 0.87 mm +/- 0.99, SEM 0.07 for antegonial depth and males had a mean value of 1.53 mm+/- 1.52, SEM = 0.10 for antegonial depth. The mean difference between females and males was 0.661 mm. The P value was statistically significant, 0.000. This shows that females and males have significant difference by 0.66 mm.

Table 2: Mean values of antegonial depth for females and males in relation to different age groups

Age group (years)	Female		Male		Statistically significant
	No.	Mean (mm)	No.	Mean (mm)	
Group 1: 20-30	40	0.93 ± 0.96	40	1.80 ±1.57	Yes (P = 0.00)
Group 2: 31-40	40	0.91± 1.02	40	1.32 ±1.71	No (P = 0.19)
Group 3: 41-50	40	0.59 ± 0.97	40	1.38 ±1.35	Yes (P = 0.00)
Group 4: 51-60	40	1.01 ±0.96	40	1.97 ± 1.45	Yes (P = 0.00)
Group 5: 61-70	40	0.90 ± 1.04	40	1.34 ± 1.47	No (P =0.12)
Overall: 20-70	200	0.87 ± 0.99	200	1.53 ± 1.52	Yes (P = 0.00)

Logistic Regression Analysis for sex determination.

The logit equation obtained using logistic regression analysis to determine the sex with the mandibular parameter bigonial width was:

Antegonial depth: Log [P/(1-P)] = - 0.482 + (0.412 x Antegonial Depth) with a standard error of 0.085mm. Where, Log is the log odd or logit value, P is the probability.

The standard error obtained was 0.085 mm. It is important to note that if P > 0.5 classifies it as male otherwise female. The overall prediction accuracy obtained was 58.8% (**Table 3**).

Table 3: Prediction Accuracy for sex determination using Antegonial Depth

	Predicted		Percentage Correct
	Male	Female	
Male	120	80	60.0%
Female	85	115	57.5%
Overall	205	195	58.8%

4. Discussion

1. Antegonial depth

According to this study mean antegonial depth was 0.87 +/- 0.99 (females) and 1.53 +/- 1.52 (males). This parameter also shows greater values for males than females. Antegonial depth is statistically significant, P value = 0.000, thus implying that females and males show significant differences for antegonial depth. In female subjects the antegonial depth remains constant in the 2nd and 3rd decade, decreases in the 4th, increases in the 5th and decreases in the 6th decade of life. Among males, it decreases in the 3rd and 4th decades, increases in the 5th decade and decreases in the 6th decade of life (**Table 2**).

Sex

The present study is in concordance with the results of the previous studies as is noted from the above table (**Table 4**) where the mean antegonial depth is larger in males than in females. It can be seen that the present study has slightly smaller values (females 0.87 mm and males 1.53 mm) than the previous studies (**Table 4**). This could be due to differences in sample size, age groups and population Chole H et al., 2013 [8], and the magnification factor, standardisation, and machine used. In a study

conducted by Chole et al., 2013 [8], correlation of age and antegonial depth was not significant ($P > 0.05$). Males had significantly greater antegonial depth than females (2.251 mm ± 1.405 and 1.14 mm ± 0.5763, resp.), irrespective of the dental status.[8] These results are similar to that obtained in the current study where males have a greater antegonial depth (1.53 mm) than females (0.87 mm). The morphological change in the antegonial region has received little attention in the literature[8]. In a study by Ghosh et al., 2010[9], the mean value of antegonial depth did not change significantly with age. Females had smaller values as compared to males.[9] According to Dutra et al.[5], the antegonial depth was significantly greater for males than females (2.12mm ± 0.09 versus 1.46mm ± 0.07, $P < 0.0001$). Edentulous individuals (1.87mm ± 0.1) had significantly greater antegonial depth than dentate and partially dentate individuals (1.60mm ± 0.1 and 1.65mm ± 0.1, respectively).[10] The results of the present study support these findings. Edentulous individuals showed a greater antegonial depth than the dentate or the partially dentate. This observation however, was made on only a few radiographs (the present study consisted of only a few edentulous OPG) and hence in order to substantiate this finding a study with a greater sample size should be conducted. Males had a larger antegonial depth than females in the current study. In a study conducted by B Rai et al., 2006 [11] the antegonial depth was significantly greater for males (2.57 ± 0.33 mm) than females (1.59 ± 0.49 mm), p < 0.01, irrespective to age.[11] Antegonial depth was measured as the distance along a perpendicular line from the deepest point of the notch concavity to a tangent through the inferior border of the mandible (8, 11, 9, 5). Similar results were obtained in the present study where the antegonial depth was significantly greater for males than females irrespective to age. It may due to hormonal differences affecting bone metabolism.[11] In the present study antegonial depth had a predictive accuracy of 58.8% (**Table 3**).

Age

In the current study, antegonial depth shows an overall decrease with age in both females and males, by 0.3 mm in females and in males by 0.46 mm except in the 5th decade where an increase is seen with increase in age (Table 2). This decline in antegonial angle with age was not consistently significant across all age groups. Ghosh et al.,2010 [9], in their study revealed that no statistically significant relation was observed between the mean antegonial depths with respect to the age, though an increase in antegonial depth with age was observed in both males and females.[9] The study was concluded by stating that the antegonial regions undergo remodelling with advancing age. The increase in antegonial depth with advancing age is influenced by tooth loss.[9]

Thus, antegonial angle is not a reliable parameter for the estimation of age. In the present study, except in group 2 (P = 0.019) and group 5 (0.12) all other groups had statistically significant P values (0.00) thus implying that significant differences exist between females and males. With respect to age, the mean value of antegonial depth did not change significantly with age. Also, antegonial depth was not selected by regression analysis for age estimation thereby showing that it is not suitable for the estimation of age. Thus, the results of the present study show that antegonial depth can be used in sex determination but is not a reliable parameter for age estimation.

Table 4: Comparison of Mean Value of Antegonial Depth in Different Studies in Indian Population

S. No	Study (mm)	Sample Population	Male	Female
1.	Chole H et al 2013 [8]	India	2.25 ± 1.40	1.14 ± 0.57
2.	Ghosh S et al 2010 [9]	India	2.25 ± 1.40	1.14 ± 0.57
3.	Rai B et al 2006 [11]	India	2.57 ± 0.33	1.59± 0.49
4.	Aruleena et al 2019 [16]	India	2.95 ± 0.53	2.81 ⍰ 0.23
5.	Present study 2021	India	1.53 ± 1.52	0.87 ± 0.99

A Study was done by estimating age from hyoid bone, this study showed that as the age advances, the incidence of degree of fusion of greater cornea with the body of hyoid bone increases.[12] Another study was done on age estimation from radiographic evaluation of various developmental stages of Maxillary Third Molars and found reliable results.[13] A Study on Estimation of Stature from Bigonial Breadth in Population of Western Maharashtra was done and found mean height, bigonial diameter were higher in males than in females.[14] Correct knowledge about recognizing a dental sample as substantial evidence by police personnel is certainly important to prevent the loss and tampering of evidence. Also dental

records prove to be the best defence for the dentist in case of a malpractice suit. To maximize dental application in forensic cases, it is necessary to train dentists in the practical aspects of this subject. Also there is a necessity in exposing dentists to the basic principles and techniques of the subject. The availability and accuracy of dental records determine the success of identification. All such measures would help to identify, recover, and interpret the dental evidence correctly, thus providing timely justice to all.[15]

5. Conclusion

This study showed that the antegonial Notch or Depth are influenced by Sex but not by age. Thus, changes taking place in antegonial depth can be used as a forensic tool for sex determination but not is not a reliable parameter for the estimation of age.

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References:

1. Francis FS. Change in the gonial angle. J Oral Rehabil. 1979;6(3):219-27.
2. Casey DM, Emrich LJ. Changes in the mandibular angle in the edentulous state. J Prosthet Dent. 1988;59(3):373-80.
3. Ohm E, Silness J. Size of the mandibular jaw angle related to age, tooth retention and gender. J Oral Rehabil. 1999;26(11):883-91.
4. Mattila K, Altonen M, Haavikko K. Determination of the gonial angle from the orthopantomogram. Angle Orthod. 1977;47(2):107-10.
5. Dutra V, Yang J, Devlin H, Susin C. Mandibular bone remodelling in adults: evaluation of panoramic radiographs. Dentomaxillofac Radiol. 2004;33(5):323-8.
6. Abu-Taleb NS, El Beshlawy DM. Mandibular ramus and gonial angle measurements as predictors of sex and age in an Egyptian population sample: a digital panoramic study. J Forensic Res. 2015;6(5):1000308
7. Demirjian A, Goldstein H, Tanner JM. A new system of dental age estimation. Hum Biol. 1973;45(2):211-27.
8. Chole RH, Patil RN, Chole SB, Gondivkar S, Gadbail AR, Yuwanati MB. Association of mandible anatomy with age, gender, and dental status: a radiographic study. ISRN Radiol. 2013; 2013 (1): 453763.
9. Ghosh S, Vengal M, Pai KM, Abhishek K. Remodeling of the antegonial angle region in the human mandible: a panoramic radiographic cross-sectional study. Med Oral Patol Oral Cir Bucal. 2010; 15(5):e802-7.
10. Ohm E, Silness J. Size of the mandibular jaw angle related to age, tooth retention and gender. J Oral Rehab. 1999; 26(11): 883–91.
11. Rai B, Anand S, Jain R. Effect of age and sex: antegonial and gonial notch of mandible. Internet J Biol Anthropol. 2006; 1(1):3.
12. James RI, Bakkannavar S, Anita S. Estimation of age from hyoid bone – is it a viable option? J Forensic Med Sci Law. 2022;31(1):33-8.
13. Ramkumar J, Ganesh R, Naveen N. Age estimation from radiographic evaluation of various developmental stages of maxillary third molars and its associated gender variation. J Forensic Med Sci Law. 2022;31(2):33-7.
14. Ghangrekar A, Ballur M, Murgod P, Kumbar R, Chavan R. Estimation of stature from bigonial breadth in population of Western Maharashtra. J Forensic Med Sci Law. 2023;32(2):9-13.
15. Vora A R, Dere R C, Application of Forensic Odontology in Forensic Investigations. J Forensic Med Sci Law 2019; 28(1):31-3.
16. Shaminey A, Murali GV, Manoharan G. Gender-based variations in morphological features of mandible in digital panoramic radiographs – a comparative study. Saudi J Oral Dent Res. 2019; 4(1):31-47.

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Original Research Article

A Study of Unnatural Deaths in Adolescent Age Group in a Tertiary Care Centre, Hyderabad, Telangana

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Key words
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Abstract

Introduction: According to UNICEF/UN0276725/Das, India has the largest adolescent population (aged between 10 to 19 years) in the world, which is 253 million. A retrospective study was conducted from 2015-2018 of unnatural adolescent deaths for which medico-legal post-mortem examinations were conducted at the mortuary of Osmania General Hospital, Hyderabad. The objective of the study was to find out the magnitude and causes of unnatural deaths in adolescents. **Material and Methods:** Autopsy findings, police or magistrate reports, and toxicology reports were reviewed. Data was gathered and reviewed retrospectively for 424 adolescents of whom 407 were unnatural deaths. **Results:** The main causes of unnatural deaths were hanging (25%), burns (20%), and head injuries (18%) and multiple injuries (16%). But considering the reasons behind the causation of head injuries andmultiple injuries, road traffic accidents are the leading cause of unnatural deaths amongst the adolescent age group in the study period. Age-wise no difference was observed in unnatural deaths. Significantly (P<.0001) more females hanged themselves compared to men (33% vs 18%). Deaths due to burns were more in females than males (32% vs 8%). Head injuries were more common (P<.0001) in men compared to females (23% vs 12%). **Conclusion:** This study showed a broad picture of unnatural deaths among adolescents in Hyderabad. Free-of-cost counselling sessions should be arranged to avoid traffic accidents and suicides among adolescents.

1. Introduction

In India, there are 253 million adolescents in the age group 10-19 years.[1] Adolescence is the age group when a child changes to turn into an adult. It is like a metamorphosis where there is physical, cognitive, and psychological development.

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This development is from puberty to legal hood. These rapid changes in the human body mark the adolescent stage as the most critical phase in the development of a healthy individual.[2] This age group comprises individuals in a transient phase of life requiring nutrition, education, counselling, and guidance to ensure their development into healthy adults. They are susceptible to several preventable and treatable health problems, like, unsafe sex leading to STI/HIV/AIDS, nutritional disorders, alcohol, abuse of substances, mental health concerns, injuries, and violence.[1]An observational study has reported adolescent aggressive behaviour determinants, including important biological, psychological, and social predictors. These are nutritional deficiency, attitude toward aggression, low family income, and unusual peer association.[3] Adolescence is staged into early (10 to 13 years), middle (14 to 17 years), and late (18 to 21 years) adolescence.[4]

There are several studies conducted on the deaths among adolescents in India. A Report by Sushmita Dey, from Times of India on 10th May 2016 mentioned self-harm is the top reason for adolescent or youth deaths in India causing close to 60,000 deaths annually in the age group of 15 to 24 years.[5]
A study was conducted in Khammam, Telangana district with 45 cases, aged between 15 to 24 years. The objective was to evaluate suicide among adolescents and youths. The suicide rate was 13.97%. The highest incidence amongst the 25[55.55%] cases was from adolescents aged from 15 years to 18 years.[6]

A cohort study of 46 post-mortem examinations carried out in Guntur Medical College reported the main cause of death was accidents (54.34%), suicides (34.95%), and homicides /abatement (8.69%).[7]A study conducted at Gandhi Medical College, Secunderabad, included all female cases of suicidal deaths in the age group of 12-24. The main motive behind the suicides was emotional disturbances (21%). The most common method adopted for suicide was "Hanging (53%)."[8] Rakhi Dandona[9] talks about the deaths due to drowning of children from 1 to 19 years old in Bihar. The survey covered 224 077 children. The findings from this large representative sample of children documented the variations in unintentional drowning deaths in Bihar. Debata's study from Northern India with 434 unnatural deaths among children 1 to 19 years old children found the most vulnerable age included children between 11–19 years (74.5%). The commonest cause of death in all ages was flame burns (58.3%), road traffic accidents 15%, electrocution 7.8%, and poisoning 6%.[10] Another study found reasons for death were motor vehicle crashes (20%); and firearm-related injuries (15%). Among firearm deaths, 59% were homicides, 35% were suicides, and 4% were unintentional injuries.[11]

Despite being thought as a healthy stage, we still note many natural and unnatural deaths happening worldwide. This study emphasizes on the unnatural causes of deaths in early and mid-adolescent aged individuals reported in a Tertiary Care Hospital in Hyderabad, India.

2. Objectives

a. To determine the magnitude of unnatural deaths.
b. To analyze male and female child deaths.
c. To find out the causes of unnatural deaths in adolescents.

3. Materials and methodology

This is a retrospective study of three years from 2015-18 of unnatural adolescent deaths for which medico-legal post-mortem examinations were conducted at the mortuary of Osmania General Hospital, Hyderabad. The data of forensic autopsies conducted in the years 2015-18 are reviewed retrospectively with autopsy findings, police or magistrate reports, and toxicology reports. Ethics committee approval was obtained from Institutional Ethics Committee, Osmania Medical College (ECR/300/Inst/AP/2013/RR-16).

Inclusion criteria: All unnatural deaths of age between 10 to 17 years which were reported to the mortuary of Osmania General Hospital, Hyderabad for medico-legal autopsy.

Exclusion criteria: All other cases which do not fit into the age criteria. Late adolescents were excluded.

Sample size: 424

Study Period: 3 years

Institutional Ethics Committee permission for waiver of consent was obtained.

4. Results

Amongst the study population, the number of unnatural deaths are of a significant number as compared to natural deaths i.e. the study sample N= 424, the number of natural deaths were 17 (4%) and unnatural deaths were 407 (96%). The gender distribution in total sample is shown in **table 1**. Out of these 407 unnatural deaths, 229 (56.27%) deaths were male and 178 (43.73 %) were female. As

mentioned in **Table 2**, the maximum deaths were by hanging followed by burns, head injury and then multiple injuries.

Table 1: Gender distribution (Total sample)

Gender	Number (%)
Male	241 (56.8)
Female	183 (43.2)
Total	424 (100)

Table 2: Gender-wise causes of unnatural death (P<.0001)

Causes of death	Male	Female	Total
Hanging	43 (18.8)	58 (32.6)	101 (24.9)
Burns	19 (8.3)	61 (34.3)	80 (19.7)
Head injury	53 (23.1)	22 (12.4)	75 (18.4)
Multiple injuries	49 (21.4)	17 (9.6)	66 (16.2)
Drowning	35 (15.3)	3 (1.7)	38 (9.3)
Poisoning	17 (7.4)	14 (7.9)	31 (7.6)
Electric shock	10 (4.4)	3 (1.7)	13 (3.2)
Strangulation and Throttling	1 (0.4)	0	1 (0.2)
Miscellaneous	2 (0.9)	0	2 (0.5)
Total	229 (100)	178 (100)	407 (100)

But considering the reasons behind the causation of multiple injuries and head injuries, road traffic accidents are the leading cause of unnatural deaths amongst the adolescent age group in the study period.

Significantly p< 0.0001, more deaths among females were because of suicidal hanging and due to burns. Unnatural deaths wereobserved morein males compared to females due to head injuries, multiple injuries, drowning, poisoning, and electric shock.

Table 3: Age category distribution

Variable	Age category	Number
Age (Years)	10 - 12	68 (16.7)
	12 - 14	32 (7.9)
	14 - 16	176 (43.2)
	>/= 16	131 (32.2)
	Total	407 (100)

As mentioned in **Table 3**, about 75% of unnatural deaths were between 14 to 17 years of age. As mentioned in Table 4, hanging was observed more in the above 14 age group, burns were observed more between 10 to 12 age group, multiple injuries were found more in the above 14 age group and head injuries were equally distributed between 10 to 17 years of age.

Table 4: Age category-wise reasons for unnatural deaths, p = 0.172

Causes of unnatural death	Age categories in years			
	10 – 12 No (%)	12 – 14 No (%)	14 – 16 No (%)	>/= 16 No (%)
Hanging	7 (10.3)	7 (22.6)	44 (25.0)	43 (32.8)
Burns	18 (26.5)	6 (19.4)	34 (19.3)	22 (16.8)
Multiple injuries	8 (11.6)	4 (12.9)	34 (19.3)	20 (15.3)
Head injury	17(25.0)	6 (19.4)	28 (15.9)	23 (17.8)
Drowning	9 (13.2)	6 (19.4)	16 (9.1)	7 (5.3)
Poisoning	7 (10.3)	1 (3.2)	13 (17.4)	10 (7.6)
Electric shock	1 (1.5)	1 (3.2)	6 (3.4)	5 (3.8)
Strangulation and Throttling	1 (1.5)	0	0	0
Miscellaneous	0	0	1 (0.6)	1 (0.8)
Total	68 (100)	31 (100)	176 (100)	131 (100)

No – Number of cases.

5. Discussion

The present study indicated that only 4% deaths were due to natural causes of death and a massive 96% of deaths were due to unnatural causes of deaths. This study of unnatural deaths was carried out on 407 adolescents aged between 10 and 17 years in Hyderabad region in which 56.27% were male. The main reasons for unnatural deaths were hanging (above 12 years of age), burns (maximum between 10 to 12 years of age), head injuries and multiple injuries (more between 10 to 12 years of age).[12] Few deaths took place because of drowning, poisoning, and electric shock.

The present study found hanging was the most common cause of unnatural death and was observed more in females compared to males. This result is consistent with a study conducted by B.J. Medical College, Pune with adolescents aged between 10 to 19 years, reported hanging (79.76 %) was the most common method used for committing suicide.[13] The same finding was reported in the study from Secunderabad.[8,14] Hanging or suicide may be because of emotional disturbances[8], love affairs, family disturbances, and addiction. [13]

There are some studies on unnatural deaths due to craniocerebral injuries[15] and natural deaths.[16] A qualitative analysis by Debata PK of post-mortem data of unnatural deaths among 1 to 19-year-olds found flame burns (58.3%) were the commonest cause of death in all ages. This was followed by road

traffic accidents15%, electrocution 7.8% and poisoning 6%.[11] Our study reported lower numbers than this study; burns at 20%, electric shock at 3.2%, and poisoning at 7.6%. In the study by C Sivagurunathan, et al[2], it was discussed that Road traffic injuries, followed by HIV/AIDS and then self-harm were the leading causes of death amongst adolescents, and injuries continue to be the leading cause of unnatural deaths. The findings of the above study are similar to this study with regards to multiple injuries. A study conducted by Rao[7], reported more males 28 (60.86%) than female deaths 18(39.13%) and our result is consistent with their study. Their study also found the highest number of deaths between 14 to 16 years. This study showed that 9% of deaths were due to drowning. However, the intentions behind the drowning were not similar to the study by Dandona.[9] The results of the present study were similar to Debata's study with 434 unnatural deaths in children aged 1–19 years.[10] The reasons for unnatural deaths were burns, electrocution, and poisoning.

In another study, by Rebecca M. Cunningham[11], the findings showed highest deaths were due to injuries (60.6%) followed by vehicle accidents (12%). In our study, injury-related accidents were 34.6%. Strict rules should be laid by the government if minors are found driving motor vehicles.[17-20] The speed limit should be maintained near residential and school areas. When the leading causes of death are found to be unnatural, then efforts should be made to decrease the number of deaths. It can be as simple as following traffic rules, or maintaining standards in the construction of roads and school buildings/residential buildings so that children don't fall off of them.

From this retrospective study, it is evident that the first most common cause of unnatural death is due to road traffic accident considering both head injuries and multiple injuries and the male gender was found to be more affected than the females in these accidents. Thus, it is evident that traffic awareness programs must be made in schools to create awareness amongst teenagers so that they understand the rules of the Motor Vehicle Act. Even parents must be made aware to not handover vehicles to their children at a vulnerable age. The second most common cause of unnatural death is due to hanging. This denotes the emergence of incorporating awareness programs regarding mental health in schools and junior colleges. It is also important to make the parents understand that psychiatric illness is just like physical illness which has to be given no less attention. Parents and children should be educated on how depression can endanger a person to self-harm. Special attention should be given to girls. Educational institutions should make sure that they do not pressure their pupils into strenuous academic activity, and score-oriented teaching. Every institute should have a counsellor available so that the child is free to go and talk about his/her issues regarding any matter.

6. Conclusion

This study showed the magnitude of unnatural deaths is enormous. Most of the causes for unnatural deaths are the same though the numbers differ in different states in India. Road traffic accidents seem to be the major reason behind unnatural deaths amongst adolescents and especially in male gender. The inquisitiveness to learn new things starts at this phase of the life, thus there should be strict disciplinary control over usage of motor vehicles before they reach the age of 18 years. Adolescents lack experience in handling situations and are mostly prone to peer pressure.

Adolescents, parents and teachers should have an open conversation. The early signs of loneliness, aggressive behaviour, and behavioural changes should be observed by the parents and staff at the educational institutions. Several offline and online counselling sessions should be arranged free of cost to avoid suicides and road traffic accidents among adolescents, and also students should be followed up to assess the effect.

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References:

1. National Health Mission (NHM), Ministry of Family Health and Welfare, Government of India. [Cited on 11th December 2023] Available from : https://nhm.gov.in/index1.php?lang=1&level=2&sublinkid=818&lid=221

2. Sivagurunathan C, Umadevi R, Rama R, Gopalakrishnan S. Adolescent health: present status and its related programmes in India. Are we in the right direction? J Clin Diagn Res. 2015; 9(3):LE01.
3. Fauzi FA, Zulkefli NA, Baharom A. Aggressive behavior in adolescent: The importance of biopsychosocial predictors among secondary school students. Frontiers in public health. 2023;11:992159.
4. Brittany A. Stages of Adolescence. American Academy of Pediatrics. Available from: https://www.healthychildren.org/English/ages-stages/teen/Pages/Stages-of-Adolescence.aspx.
5. Dey S. What's causing most youth deaths in India? [Internet]. Times of India. 2016. [Cited on 18th December 2023]. Available from: http://timesofindia.indiatimes.com/articleshow/52200642.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst.
6. Guntheti BK, Singh UP. Pattern of Suicide in Adolescents and Youth at a MGH, Khammam, Telangana. Medico-Legal Update. 2016; 16(1):15-20.
7. Rao VS, Rao PC. An Analytical study of teenage deaths in and around Guntur, Andhra Pradesh, South India. Int J Contemp Med Res. 2018; 5(8):115-9.
8. Krishnamurthy K, Jillella SR, Subedhar A. Factors Related to Deaths Due to Suicides in Females Aged 12-24 Years. Medico Legal Update. 2021; 21(1):417–21.
9. Dandona R, Kumar GA, George S, Kumar A, Dandona L. Risk profile for drowning deaths in children in the Indian state of Bihar: results from a population-based study. Inj Prev. 2019; 25(5):364–71.
10. Debata PK, Deswal S, Kumath M. Causes of unnatural deaths among children and adolescents in northern India–a qualitative analysis of postmortem data. J Forensic Leg Med. 2014; 26:53-5.
11. Cunningham RM, Walton MA, Carter PM. The major causes of death in children and adolescents in the United States. N Engl J Med. 2018; 379(25):2468–75.
12. Patil SS, Deokar RB, Vidhate SG, Tyagi S. An atypical case of suicidal cut throat injury. Egyptian J Forensic Sci. 2016; 6: 492–5.
13. Vidhate SS. Zanjad N. Suicide Among Adolescents: A Medico-legal Study at Tertiary Care Centre of Western Maharashtra, India. Medico-Legal Update. 2022; 22:34-8.
14. Shrigiriwar MB, Bhosle SH, Padole TO, Kuchewar SV. Recent trends of unnatural Deaths amongst the Children and adolescents in Yavatmal region of Maharashtra. J Forensic Med Sci Law. 2020; 29(1):4-11.
15. Salankar A, Ramteke R, Murkey PN, Shende S, Barmate N. Evaluation of Fatal Craniocerebral Injuries. J Forensic Med Sci Law 2023;32(1):20-24.
16. Jambure M, Jambure A, Khetre R, Jaybhaye P. Postmortem Study of Sudden Death with Special Reference to Cardiovascular Causes. J Forensic Med Sci Law 2023;32(1):4-9.
17. Kumar R, Punia RK, Verma LC. Profile Study of Motorcyclists Victims in Road Traffic Accidents at Jaipur Region- An Observational Antemortem Study. J Forensic Med Sci Law 2022;31(2):28-32.
18. Gupta A, Singh G, Gupta P, Kumar A, Verma A. Pattern of Fatal Injuries Sustained by Two- Wheeler Riders Due to Road Traffic Mishap in Agra Region. J Forensic Med Sci Law 2023;32(1):25-31.
19. Gouda S, Gopinath M, Karaddi S, Suraj. Injuries in Riders and Pillion Riders of Fatal Two Wheeler Road Traffic Accidents in Raichur, Karnataka. J Forensic Med Sci Law 2022;31(2):15-18.
20. Talukdar R, Ropmay AD, Slong D, Patowary AJ. A Retrospective Study of Road Traffic Accident Cases Brought For Medico-Legal Autopsy at a Tertiary Care Hospital In Meghalaya. J Forensic Med Sci Law 2023;32(1):37-40.

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Original Research Article

Estimation of Age from Roentgenographic Study of Root Development of Mandibular Third Molars

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Abstract

Background: Age estimation is important for identification of individuals as well as unknown skeletal remains. Estimation of radiological age is a matter of everyday occurrence in every part of the world. Determination of individual age is of great medicolegal importance in criminal cases as well as for civil purposes. Age estimation from teeth is generally reliable as they are naturally preserved long after all tissues and bones have disintegrated. A roentgenographic study was done to determine the age by root developmental changes using of the mandibular third molars, adopting the Leif Kullman method. **Material & Methods:** A total of 301 orthopantograms (OPG) were obtained from subjects from schools, colleges in the city and among the patients visiting the outpatient department of the teaching hospital and examined for the root development of mandibular third molars. In the end, out of 301 orthopantograms only 288 were taken into consideration for study purpose as in rest of the OPG third mandibular molar were found missing on both side. Based on stages of root development of third molar teeth, chronological age was determined. **Results & Conclusions:** There was a high correlation between the dental age & chronological age which plays an important role in medicolegal cases. The correlation of third molar development and chronological age is quite significant even though it is said to be the most valuable tooth in dentition.

1. Introduction

Age plays an important role in Forensic Medicine and is one of the prime factors employed to establish identity. Evidence of age for medicolegal purposes may be required in several types of cases. The usual cases wherein a medical man may be called upon to give his opinion with regards to age in routine medicolegal practice are infanticide, criminal responsibility, kidnapping, competency as a witness, eligibility for employment, professional and other courses, rape, judicial punishment, marriage contract, attainment of majority, criminal abortion, senior citizen concession, old age pensions, retirement disputes among many others.[1] It can be determined by developmental changes in skeletal bones and teeth.

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Like the radiographic or gross anatomical state of development and fusion of the skeletal bones, the stage of formation and the progress of age changes in teeth constitute another reliable source of information in determination of age of an individual.[2] Age estimation from dentition becomes difficult after 14 years since all the permanent teeth, except the third molar have completed their development. Eruption of third molars is most variable and controversial in dentition, but this is virtually the only biologic indicator available in the oral cavity for estimation of age by simple naked eye examination. Such a study of eruption and calcification of the third molar teeth has great medicolegal importance

A study of radiographs of teeth is a simple method to obtain dental information of an individual for age estimation of a person.[3] Though radiologically distinguishable stages of root formation are described rarely for age determination, most of these methods have their best precision and accuracy during early years of development of an individual. In present study estimation of age from roentgenographic study of root development of mandibular third molars using Leif Kullman's(1992) method was done which is considered to be a reliable guide to the determination of the age of an individual and also correlation between chronological age and dental age was studied. However, these values at their best can tend to fix the age of the person only at neat approximate age range and not the exact age.

2. Methods

The study consisted of 301 orthopantograms (OPG) out of which only 288 were taken into consideration for study purpose as in rest of the OPGs third mandibular molar were found missing on both side. The subjects were from school and colleges in Mumbai Central and patients who were visiting the Dental Surgery outpatient department in Nair Hospital, Mumbai Central, Mumbai. The selection criteria of the subjects were based on the following:

a. All subjects should be living in city region.
b. Subjects should be in the age group of 15-25 years with known date of birth as per valid age proof.
c. All subjects should be free from caries of teeth, should have good oral hygiene and normal intact teeth.
d. No evidence of malnutrition or other diseases that would affect the skeletal growth and general development of person.
e. Should voluntarily consent before proceeding for radiological examination

Informed consent was taken from each individual prior to examination in the prescribed format approved by the Institutional Ethics Committee of the college. Each participant was then subjected to OPG. Each of these digital OPG image were then studied for seven different stages of root development of the third molars by method adapted by Leif Kullman et al[4,5] for the reasons of simplicity and good results. The stages of root development are as follows:

- Ri-R1/4 (1): Root development initiated but<1/4 of the estimated root length.
- R1/4-R1/2 (2): Root development >1/4, but <1/2 of the estimated root length.
- R1/2 –R3/4 (3): Root development >1/2, but <3/4 of the estimated root length.
- R3/4 –Rc (4): Root development >3/4, but <full estimated root length.
- Rc-Aci (5): The full estimated root length is formed but apical closure not initiated.
- Aci-Ac (6): Apical closure started, but not closed.
- Ac (7): Apex is fully closed, and root development completed.

The chronological age of the person was also determined initially since the date of birth of the subject was known. Data was fed into Excel and analysed using SPSS Software. For assessing the correlation between the age determined by various methods and the chronological age, the Pearson's correlation coefficient was calculated, and its significance was tested by student's '*t*' test. "*P*" value of less than 0.005 was considered as significant.

3. Results

A total of 301 orthopantograms were obtained and examined for the root development of mandibular third molars. Out of 301 orthopantograms only 288 were taken into consideration for study purpose as in the rest of the OPG third mandibular molar were found missing on both side. **Table 1** shows the age and gender breakdown analysis of the number of subjects that had participated in the study. All the orthopantograms were studied and stages of root development of mandibular third molar on both the side were recorded. The age of each of individual in the study group was confirmed by their age document, entered in master chart, and converted into decimals while doing analysis.

A mean age was derived as the mathematical mean of age opined for each tooth individually, based on root developmental stages (Kullman) observed in the radiograph. In order to do a comparative

statistical analysis, common chronologic (true) age range was derived next for each of the root developmental stages by just noticing the lowest age and the highest age for a particular stage. Then a common mean age for each of the mandibular third molars was derived again calculating the mathematical mean of the common age range derived earlier which was depicted in **Table 2**. The difference in the age range determined by different developmental stages between almost all the left and right sided mandibular third molars was negligible as depicted in the table.

Table 1: Breakdown analysis by age and gender

Age Group as per DOB		Study Group		Total
		Male	Female	
15 to 17 yrs.	Count	15	19	34
	Percent	44.10%	55.90%	100.00%
17.1 to 19 yrs.	Count	47	51	98
	Percent	48.00%	52.00%	100.00%
19.1 to 21 yrs.	Count	73	66	139
	Percent	52.50%	47.50%	100.00%
21.1 to 25 yrs.	Count	20	10	30
	Percent	66.70%	33.30%	100.00%
Total	Count	155	146	301
	Percent	51.50%	48.50%	100.00%

Table 2: Comparative status of the common age range and mean age derived for each of the third molars for different stages of root development.

Stages	Right Mandibular		Left Mandibular	
	Age range	Mean	Age range	Mean
1	15 y-15y 9m	15y 3m	15y-15y 9m	15y 3m
2	16y-16y 9m	16y 4m	16y-16y 9m	16y 4m
3	16y 1m-17y	16y 9m	16y 1m-17y	16y 7m
4	17y 3m-17y 6m	17y 5m	17y 3m-18y 9m	17y 11m
5	17y 3m-20y 9m	17y 11m	17y 9m-20y 9m	18y 1m
6	17y 9m-21y 3m	18y 8m	17y 9m-21y 3m	18y 9m
7	18y 8m-24y 6m	20y 3m	18y 8m-24y 6m	20y 3m

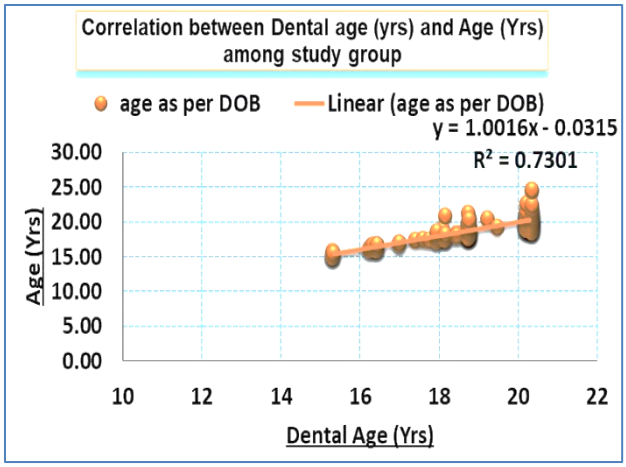
Table 4: Mean ages at attainment of stages of third mandibular molar development

Gender	Male		Female		Mean of both sexes
Stages	**Right**	**Left**	**Right**	**Left**	
1	15.31	15.31	15.3	15.3	15.3
2	16.41	16.41	16.22	16.23	16.31
3	16.97	16.97	16.42	16.33	16.67
4	17.58	17.58	17.38	18.08	17.65
5	17.76	18.09	18.12	18.15	18.03
6	18.72	18.74	18.73	18.76	18.73
7	20.33	20.32	20.21	20.18	20.26

The study revealed that that differences in the mean age at the various stages of development of right and left mandibular third molar in both male and female subjects is negligible as shown in **Table 3.** It is also evident that difference in the mean age at the various developmental stages in left and right mandibular third molar is negligible. It was observed that there was no significant difference between stages of development of right and left mandibular third molar in male as well as female as shown in **Table 4**.

From the **table 5** shown it is evident that there is no significant difference between the various stages of development of right and left mandibular third molar in male and female. A strong correlation was found between chronological age and dental development and third molar root development stages. Correlation coefficient and p value between dental parameter and chronological age were derived statistically as depicted in **Table 6**. Age determined by dental parameters is correlated with the chronological age as confirmed by the p value.

Graph 1: Correlation between dental age and chronological age



Linear regression coefficient (Pearson Correlation) is provided to assess the correlation between the third molar development and chronological age. Statistical analysis showed a strong correlation between various stages of third molar development and chronological age (**Graph 1**).

Each stage of root development of third molar strongly correlates with certain age group i.e. if we have a tooth in particular stage of development the age can be derived with reasonable accuracy.

The formula to derive the age from root development stage (Regression formula) can be stated as follows:

Decimal age in years

= 1.0016 (Age in decimal of developmental stage of mandibular left / right third molar) – 0.0315.

4. Discussion

In forensic dentistry, determination of dental age using stages of tooth development to gauge an individual's degree of maturity is one of few biological

Table 3: Mean ages at attainment of stages of mandibular third molar development and gender wise distribution of both sides

	Male: Right Mandibular Region				Female: Right Mandibular Region				Mandibular Right			
Stage	Count	Age as per DOB (decimal)			Count	Age as per DOB (decimal)			Count	Age as per DOB (decimal)		
		Minimum	Maximum	Mean		Minimum	Maximum	Mean		Minimum	Maximum	Mean
0	6	18.33	21.00	19.51	16	15.33	22.33	18.33	22	15.33	22.33	18.65
1	3	15.17	15.50	15.31	7	15.00	15.75	15.30	10	15.00	15.75	15.30
2	9	16.00	16.75	16.41	5	16.00	16.58	16.22	14	16.00	16.75	16.34
3	3	16.92	17.00	16.97	2	16.08	16.75	16.42	5	16.08	17.00	16.75
4	1	17.58	17.58	17.58	2	17.33	17.42	17.38	3	17.33	17.58	17.44
5	7	17.25	18.58	17.76	13	17.58	20.83	18.12	20	17.25	20.83	17.99
6	42	17.75	21.33	18.72	37	18.00	20.33	18.73	79	17.75	21.33	18.72
7	84	18.67	24.58	20.33	64	19.00	22.67	20.21	148	18.67	24.58	20.28
	Male: Left Mandibular Region				Female: Left Mandibular Region				Mandibular Left			
Stage	Count	Age as per DOB (decimal)			Count	Age as per DOB (decimal)				Age as per DOB (decimal)		
		Minimum	Maximum	Mean		Minimum	Maximum	Mean		Minimum	Maximum	Mean
0	5	18.17	21.00	19.38	13	16.17	22.33	18.28	18	16.17	22.33	18.59
1	3	15.17	15.50	15.31	8	15.00	15.75	15.30	11	15.00	15.75	15.30
2	9	16.00	16.75	16.41	4	16.00	16.75	16.23	13	16.00	16.75	16.35
3	3	16.92	17.00	16.97	3	16.08	16.58	16.33	6	16.08	17.00	16.65
4	1	17.58	17.58	17.58	2	17.33	18.83	18.08	3	17.33	18.83	17.92
5	8	17.25	20.42	18.09	12	17.58	20.83	18.15	20	17.25	20.83	18.13
6	42	17.75	21.33	18.74	39	18.00	20.42	18.76	81	17.75	21.33	18.75
7	84	18.67	24.58	20.26	65	19.00	22.67	20.18	149	18.67	24.58	20.26

Table 5: Stage wise gender distribution of mean ages at attainment of stages of right and left molar development in mandible

		RIGHT						LEFT					
Stage	Chronological Age (yrs)	N	Mean	Std. dev.	Unpaired T test	P value	Difference	N	Mean	Std. Deviation	Unpaired T test	P value	Difference
1	Male	3	15.31	0.17347	0.045	0.965	not significant	3	15.31	0.17347	0.021	0.983	not significant
	Female	7	15.30	0.27579				8	15.30	0.25564			
2	Male	9	16.41	0.29001	1.237	0.240	not significant	9	16.41	0.29001	0.959	0.358	not significant
	Female	5	16.22	0.24721				4	16.23	0.35600			
3	Male	3	16.97	0.04811	2.213	0.114	not significant	3	16.97	0.04811	4.347	0.012	not significant
	Female	2	16.42	0.47140				3	16.33	0.25000			
4	Male	1	17.58	.	2.887	0.212	not significant	1	17.58	.--	-0.385	0.766	not significant
	Female	2	17.38	0.05893				2	18.08	1.06066			
5	Male	7	17.76	0.48693	-1.013	0.324	not significant	8	18.09	1.04125	-0.120	0.905	not significant
	Female	13	18.12	0.84405				12	18.15	0.88272			
6	Male	42	18.72	0.69236	-0.087	0.931	not significant	42	18.74	0.68905	-0.173	0.863	not significant
	Female	37	18.73	0.67140				39	18.76	0.70991			
7	Male	84	20.33	1.14432	0.709	0.479	not significant	84	20.32	1.15033	0.853	0.395	not significant
	Female	64	20.21	0.74696				65	20.18	0.75993			

Table 6: Correlation between age determined by dental parameter and chronological (true) age

		Age as per DOB	Mandibular region Right	Mandibular region Left
Age as per DOB	Pearson Correlation		0.696	0.744
	P value		0.000	0.000
	Correlation is		Significant	Significant
Mandibular region Right	Pearson Correlation	0.696		0.738
	P value	0.000		0.000
	Correlation is	Significant		Significant

Mandibular region Left	Pearson Correlation	0.744	0.738	
	P value	0.000	0.000	
	Correlation is	Significant	Significant	

methods for monitoring physiologic development, and the dentition arguably is the only system available from prior birth to early adulthood. [6]

Dental development can also be used to estimate chronological age, such as, age at death of an unidentified person or the age of a suspect without legal documentation.[7] Younger ages can be assessed at greater accuracy because the intervals between morphological stages are shorter and therefore more precise.[8] Late in adolescence, after formation of the premolars and canines, only third molars continue to form source of age estimation. Third molars are in many respects the most variable teeth in the dentition.[9,10]

Chronological age estimation by tooth development has been used over long period. Tooth development is an accurate measure of chronological age that seems to be an independent of exogenous factors such as disease or malnutrition.[11] However age estimation based on dental methods have shortcomings especially during adolescence when the third molar is the only remaining variable dental indicator. Indeed, great variation in position, morphology, and time of formation exists. The difference between populations, the different methodology, and the dissimilarities among observers are the other shortcomings.

The single most compelling reason to rely on third molar development to estimate chronological age is that there are very few available alternative methods during the interval roughly between the mid-teens and early 20s. All of the other teeth have erupted and completed root formation.[11,12] All of the hand-wrist bones have achieved their adult morphologies, their epiphyses have fused,[13,14] and the onset of secondary sex characteristics has occurred. Consequently except for the ossification of same early fusing cranial and post axial sutures which themselves are quite variable-there are no other biological criteria by which estimation of chronological age is possible.

The third molar is far from being considered as an ideal development marker. It frequently is congenitally absent,[15,16] malformed,[17] impacted or extracted. Further, it is the most variable tooth in the dentition as regards size,[18,19] time of formation and time of eruption.[20] It is not surprising then that the association between chronological age and formation of the third molar is moderate. Nevertheless, it offers a unique advantage over other teeth in that its development tends to continue over a long period and until a later age.[21]

For medicolegal purposes, the age of 18 years is an important cut-point, but other ages (for e.g., 21 years) could be used just as easily. If a subject presents with a third molar root developmental stage anywhere between 1 and 5, there is likelihood that he or she has not attained the age of 18 years. At the other end, if the root apices are closed (Stage 7) one can be reasonably confident that the subject is indeed at least 18 years of the age.[4]

An important caveat needs reemphasis. Stage 7 (apex closed) occurs in all mature third molars regardless of age. Consequently, the age estimates for this terminal grade assume that independent criteria can be used to exclude subject over 24 years of age. The onset of root maturity in the third molar (Stage 7) is a valuable developmental event; it is the one marker in this tooth indicating that an individual is quite likely to be at least 18 years of age.[7]

In present study 155 (51.50%) boys and 146 (48.50%) girls of the age range 15-25 years from various schools and colleges and patients visiting the outpatient department of university teaching hospital were examined roentgenographically.

Demirjian,[11] Garn et al,[20] claim that tooth development is an accurate measure of chronological age that seems to be independent of exogenic factors like disease, malnutrition etc. Koshy and Tandon[22] study based on the Demirjian concluded that this method was not applicable for South Indian children due to wide ethnic difference. Similar kind of study is conducted by using Kullman's [23] method and findings were significantly accurate. Thus, we can say that when a particular method is applied for particular population then more accurate results could be obtained.

In present study no significant difference could be observed between different stages of root development, though boys were ahead of girls. These results are similar to Garn[20], Engstrom et al,[21] and Bhat Vrinda[24]. But these findings are in contradiction to Kullman et al[4] who found significant sex difference in stages of root development.

In present study, age determined by dental parameters is correlated with the chronological age as confirmed by the p value. However, age which was determined by the left mandibular third molar was found to have highest association with chronological age which was consistent with Bhat Vrinda.[25] Sumbh et al[26] used Kronfeld's method in analysis of age estimation cases using OPG. Some researchers used other methods for age estimation.[27-30]

In the present study the mean ages for the third molar developmental stages are in the same range mentioned by Kullman [23] i. e. between 15 years to 20 years. Overall, a strong correlation was observed in between third molar development and chronological age.

5. Conclusions

It can be concluded that a strong correlation was observed in the present study between third-molar development and chronologic age. The correlation of third molar development and chronological age is quite significant even though it is said to be the most valuable tooth in dentition.

Situations may arise when malnutrition or other environmental factors have influenced the somatic development of an individual. In such cases, the third molar was found to be useful in assessing chronological age as its independent of such factors. However, various studies need to be conducted in other region in order to verify the accuracy in other study populations over the country.

6. Limitation

1. This method cannot be employed if molars are absent (not formed at all)
2. Not practicable if dental X-ray services are not available.
3. Possibility of observer's error in staging of 3rd molar development.

List of abbreviations

OPG- Orthopantogram

Ethical Clearance: IEC approval was taken from the Institutional Ethical committee.

Contributor ship of Author: All authors equally contributed.

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References:

1. Modi JP, Mathiharan K, Patnaik AK. Modi's Textbook of Medical Jurisprudence and Toxicology. 23rd Ed. New Delhi: Lexis Nexis Butterworths; 2005. P. 263,277,279-286,289-291,297-308.
2. Bhaskar SN. Orbon's Oral Histology & Embryology. 11th ed. Singapore: Harcourt Asia PTE Ltd.; 1999. P. 28–48.
3. Vora A, Dere R. Application of Forensic Odontology in Forensic Investigations. J Forensic Med Sci Law. 2019; 28(1):31–3.
4. Kullman L, Johanson G, Akesson L. Root development of the lower third molar and its relation to chronological age. Swed Dent J. 1992; 16(4):161–7.
5. Ramkumar J, Ganesh R, Naveen N. Age Estimation from Radiographic Evaluation of Various Developmental Stages of Maxillary Third Molars and its Associated Gender Variation. J Forensic Med Sci Law. 2022; 31(2):33–7.
6. Smith BH. Standards of human tooth formation and dental age assessment. In: Kelley MA, Clark SL. editors. Advances in Dental Anthropology. New York: Wiley-Liss Inc; 1991. p. 143-68.
7. Mincer HH, Harris EF, Berryman HE. The A.B.F.O. Study of Third Molar Development and Its Use as an Estimator of Chronological Age. J Forensic Sci. 1993; 38(2): 379-90.
8. Hägg U, Matsson L. Dental maturity as an indicator of chronological age: The accuracy and precision of three methods. Eur J Orthod. 1985; 7(1):25–34.
9. Garn SM, Lewis AB, Vicinus JH. Third Molar Polymorphism and its Significance to Dental Genetics. J Dent Res. 1963; 42(6):1344–63.
10. Hellman M. Our Third Molar Teeth, Their Eruption, Presence, and Absence. Dental Cosmos. 1936; 78(7):750–62.
11. Demirjian A, Goldstein H, Tanner JM. A New System of Dental Age Assessment. Hum Biol. 1973; 45(2):211–27.
12. Moorrees CFA, Fanning EA, Hunt EE. Age Variation of Formation Stages for Ten Permanent Teeth. J Dent Res. 1963; 42(6):1490–502.
13. Greulich WW, Pyle SI. Radiographic Atlas of Skeletal Development of Hand and Wrist. 2nd ed. Stanford: Stanford University Press; 1959.
14. Tanner JM, Whitehouse RH, Marshall WA, Healey MJR, Goldstein H. Assessment of Skeletal Maturity and Prediction of Adult Height (TW2 Method). London: Academic Press; 1976.
15. Nanda RS. Agenesis of the third molar in man. Am J Orthod. 1954; 40(9):698–706.
16. Lynham A. Panoramic radiographic survey of hypodontia in Australian Defence Force recruits. Aust Dent J. 1990; 35(1):19–22.
17. Taylor RMS. Variation in Morphology of Teeth. Springfield: Charles C Thomas; 1978.
18. Black GV. Descriptive Anatomy of the Human Teeth. 4th ed. Philadelphia: S.S. White Dental Manufacturing Company; 1902.

19. Kieser JA. Human Adult Odontometrics: The Study of Variations in Adult Tooth Size. New York: Cambridge University Press; 1990.
20. Garn SM, Lewis AB, Bonne B. Third Molar Formation and its Development Course. Angle Orthodontist. 1962; 32(4):270–9.
21. Engstrom C, Engstrom H, Sange S. Lower Third Molar Development in Relation to Skeletal Maturity and Chronological Age. Angle Orthodontist. 1983; 53(2):97–106.
22. Koshy S, Tandon S. Dental age assessment: The applicability of Demirjian's method in South Indian children. Forensic Sci Int. 1998; 94(1–2):73–85.
23. Kullman L. Accuracy of two dental age estimation method in Swedish adolescents. Forensic Sci Int. 1995; 75(95):225–36.
24. Bhat VJ, Kamath GP. Age estimation from root development of mandibular third molars in comparison with skeletal age of wrist joint. Am J Forensic Med Pathol. 2007; 28(3):238–41.
25. Bhat VJ, Kamath GP. Age Estimation from the root development of mandibular third molars. Medicolegal update. 2000; 127–30.
26. Sumbh S, Sumbh B, Jagdhari S, Ingole R, Kokane N. Age Estimation in Children and Adolescent in Central Indian Population: A Comparative Analysis of Demirjian's and Kronfeld's Method. J Forensic Med Sci Law. 2024;33(1):5-10.
27. James RI, Bakkannavar S, Anita S. Estimation of age from hyoid bone – is it a viable option? J Forensic Med Sci Law 2022;31(1):33-38.
28. Bhalerao VP, Chaudhari SH, Paliwal RO. Estimation of age from the rib by phase analysis - an autopsy study in population of central India. J Forensic Med Sci Law 2022;31(1):39-47.
29. Parkhe S, Kadu S, Swami A, Govekar G. A Cross Sectional Study of Age Estimation from Appearance and Fusion of Acromion Process of Scapula in Shoulder Joint by Digital X-ray. J Forensic Med Sci Law 2021;30(2):10-15.
30. Bharti R. Estimation of Age from Morphological Changes in the Sternal End of the Fourth Rib Using Phase Technique. J Forensic Med Sci Law 2021;30(1):23-27.

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Original Research Article

Sexual Dimorphism in Fingerprint Ridge Density

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Abstract

Background & Aim: Aim of the study was to find the relationship between individual sex and fingerprint ridge density. As a part of identification, dermatoglyphics plays an important role and attempt is made to utilize the fingerprint ridges to speculate the individual gender. **Material & Methods:** The present prospective study was conducted on 200 participants (100 male and 100 female) between age group of 18 to 21 years. Fingerprint ridge density in 25mm² square of fingerprint of all the fingers of participants were analysed for the study. **Results:** The ridge density ranged from 11 to 17 ridges/25mm² with mean of 14.06 in males and 13 to 19 ridges/25mm² with mean of 16.05 in females. The likelihood ratio is high for prints of 12 ridges (C/C^1) in males and very high for prints of 19 ridges (C^1/C) in females. Analysis of LR and favoured odds shows that a ridge density of ≤13 ridges/25mm² is more likely to be of male origin and ridge density of ≥17/25mm² is more likely to be of female origin. **Conclusion:** As seen from favoured odds ridge density of ≤13 ridges/25mm² is more likely to be of male origin and ridge density ≥17/25mm² is more likely to be of female origin. The results varied from place to place and country to country, as seen in different studies and standardisation is necessary to use ridge density as an identification tool.

1. Introduction

Dermatoglyphics or Study of fingerprint has been present since centuries, it has been used to identify individual because of its uniqueness in itself. Every fingerprint is unique and is used to identify individual from thumbprint on a document to advanced biometrics for even online transaction. The fingerprint pattern is different, even in identical twins, and are distinctive and permanent in individuals.[1] Fingerprint remains ubiquitous throughout life and forms the most reliable criteria of identification. The pattern makes their appearance as early as 10 weeks of intrauterine life.[2] These patterns are developed entirely in utero and are permanent throughout their lifetime. Injuries like cuts, burns and, bruises can temporarily damage the quality of fingerprints but when fully healed, patterns are restored.[3] In crime scene many times the fingerprints, palm or sole prints are not found in proper formation or only available partially, then the ridge counting can be a useful tool for identification. Sex determination is one of the important identification parameters along with age, stature, race.[4]

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Though fingerprint ridge density is individualistic, it is seen to have sexual dimorphism as first observed by study conducted by Acree.[5] Following him many studies have been conducted to determine sex from fingerprint ridge density in different countries showing similar results. Among all these studies though it shows similar results standardization is yet to formed and it is seen to vary from one region to another region and from one race to another race. Owing to variation in these studies present study aims to append to existing data.

2. Methodology

Study was conducted on 200 participants in age group of 18 to 21 years (100 Male and 100 Female) taking into consideration of 10% of population falling within 18 to 23 years age group (95% confidence level and 5% margin error). In this age group growth cessation in adulthood minimizes the ridge width affection, and not practicing a manual work reduces the chances that epidermal ridges are affected.[6] Informed consent was taken after procedure and objective of study was clearly explained. Participants with permanent scars on fingers, with any hand deformities due to injury, birth defects in hand, polydactyly individuals, those having worn finger-prints, webbed fingers, were excluded from the study since it would affect the statistical outcome.

Participants were asked to wash their hands with soap and water and dry it before proceeding to the study. Then participants demographic data was recorded mainly the age and sex for analysis. Plain Fingerprint were taken on clean sheet of paper by pressing his/her fingertip lightly on the stamp pad and then to the paper of all ten fingers. Care was taken to avoid smudging of the prints. Each fingerprint was photographed (**figure 1 & 2**) using macro lens camera with reference scale of each finger of each participant. Photographed fingerprints were uploaded in computer and using scale as reference a 5 mm × 5 mm square were placed on the left and the right upper portions of fingerprint core (upper radial side) of right and the left fingers respectively. Ridges were counted in the 25mm^2 square along the diagonal, with specific criteria were observed during the counting procedure such as the dots, were not counted, and the handle of the fork and a lake was counted as two ridges.[7] Mean of all ten fingers were calculated and used as observed ridge density for further analysis. Descriptive statistics, t-test, likelihood ratio, and favored odds were analyzed using SPSS software.

Figure 1: Photographed fingerprints (Male)

Figure 2: Photographed fingerprints (Female)

3. Results

In the present study 200 subjects participated with equal ratio of male and female between 18 to 21 years of age. After tabulating and analysing the observer ridge density of males ranged from 11 to 17 with mean ridge density of 14, in females it ranged from 13 to 19 with mean ridge density of 16. (Tabel 1). Beyond 17 ridges count the number of males

decreases rapidly and after 17 there are no males. Opposite to this female ridge count started from 13 and increases up to 19 ridge count. Table 2 shows t-Test for Male and Female where t-value was -7.740 with degree of freedom (df) 198 when equal variances are assumed and 196.689 when equal variance not assumed with p<0.0001, suggesting significant difference between the means of the male and female when compared.

Table 1: Frequency distribution and Descriptive statistics of Ridge density in Male and Female

Frequency	11	12	13	14	15	16	17	18	19	Total	Minimum	Maximum	Mean	S.E. Mean	Std deviation
Male	9	12	18	15	23	17	6	0	0	100	11	17	14.06	0.172	1.716
Female	0	0	9	15	22	13	13	13	15	100	13	19	16.05	0.191	1.914

Table 2: Independent sample t-Test for Male and Female

	T-Test for Equality of Means						
	t	df	Sig(2-tailed)	Mean Difference	Std. error difference	95% Confidence Interval of the Difference	
						Lower	Upper
Equal variances assumed	-7.740	198	<0.0001	-1.990	0.257	-2.497	-1.483
Equal variances not assumed	-7.740	195.689	<0.0001	-1.990	0.257	-2.497	-1.483

Table 3: Probability density and Likelihood Ratio from ridge density in Male and Female

Ridge Density in 25mm²	Probability Density		Likelihood Ratio		Favoured Odds	
	Male(C)	Female(C^1)	LR (C/C^1)	LR (C^1/C	Male	Female
11	0.05	0.01	5	0.20	0.83	0.17
12	0.11	0.02	5.50	0.18	0.85	0.15
13	0.19	0.06	3.17	0.32	0.76	0.24
14	0.23	0.12	1.92	0.52	0.66	0.34
15	0.2	0.18	1.11	0.90	0.53	0.47
16	0.12	0.21	0.57	1.75	0.36	0.64
17	0.05	0.18	0.28	3.60	0.22	0.78
18	0.02	0.12	0.17	6.00	0.14	0.86
19	0	0.06	0	-	0	1

Table no. 4: Comparison of ridge density among different studies with present study

Ref No.	Study	Number of Subjects	Age	Min to Max fingerprint ridge	Mean Ridge density	Favoured odds	Population Region
6	Intira et al	100 Males 100 Females	>18 yrs	Male: 13-19 Female: 14-20	Male: 15.81 Female: 16.58	Male: <14 Female: >19	Thais
8	Kandel et al	350 Males 350 Females	18 to 30 yrs	Male: 10-16 Female: 13-20	Male: 13.82 Female: 15.36	Male: <13 Female: >16	Nepal
9	Regine et al	150 Males 150 Females	18-40 yrs	Male: 17.9 to 18.8 Female: 19.32 to 20.78	Male: 18 Female: 19.72	NA	Filipinos
11	Sudesh et al	250 Males 250 Females	18-60 yrs	Male: 11-15 Female: 12-15	Male: 12.8 Female: 14.6	Male: <13 Female: >15	Karnataka
12	Lalit et al	125 Males 125 Females	18-60 yrs	Male: 11-15 Female: 11-14	Male: 11.9 Female: 14.1	Male: <12 Female: >14	Uttarakhand
13	Nithin et al	100 Males 100 Females	18-81 yrs	Male: 10-16 Female 11-19	Male: 12.79 Female: 14.81	Male: <13 Female: >15	South India
14	Neeti et al	100 Males 100 Females	18-30 yrs	Male: 9-15 Female: 12-19	Male: 11.58 Female: 14.56	Male: <12 Female: >14	Central India
15	Sucharitha et al	60 Males 60 Females	<18 yrs	Male: 124-134 Female: 145-153	Male: 128.5 Female:148.67	NA	Andhra Pradesh
16	Kewal et al	97 Males 97 Females	18-25 yrs	Male: 13-20 Female: 14-21	NA	NA	North India
#	Present study	100 Males 100 Females	18-21 yrs	Male: 11-17 Female: 13-19	Male: 14.06 Female: 16.05	Male: <13 Female: >17	Kolhapur

From the observed ridge density, probability density for male (C) and female (C^1) was calculated as shown in Table 3. From probability density, Likelihood Ratio (C/C^1) and (C^1/C) was calculated. It was found that likelihood ratio is high for prints of 12 ridges (C/C^1) in males and very high for prints of 19 ridges (C^1/C) in females. Analysis of LR and favoured odds shows that a ridge density of ≤13 ridges/25mm^2 is more likely to be of male origin and ridge density of ≥17 25mm^2 is more likely to be of female origin.

4. Discussion

Fingerprints are gold standard in identification, detailed study of individual ridges to study of individual sweat pores are done to help in identification. Studying ridge density is also shown to statistically able to identify sex as seen in studies conducted throughout the world. The present study

broadens the data of sex determination from ridge density in locality of Maharashtra, since results of studies conducted in different regions shows some similarities and some dissimilarities. In present study results shows the likelihood ratio in males is high for prints of 12 ridges and in females it is very high for prints of 19 ridges. The favoured odds for male increases from 13 ridge count in males and 16 ridge count in females, this shows that ridge density of ≤13 ridges/25mm^2 is likely to be male and ridge density ≥17/25mm^2 is likely to be female, which can be seen from favoured odds. If we compare these results with studies done internationally like one of the studies done in Thai population[6] of 260 subjects (130 male and 130 female) showed ridge density in male ranged from 13 to 19 with mean ridge density of 15.81, in female ridge density ranged from 14 to 20 with mean ridge density of 16.58. In analysing likelihood ratio, it is seen that fingerprint ridge density of ≤16 ridges/25mm^2 to be male origin and ≥ 17 ridges/25mm^2 to be of female origin. This is comparable to present study, in which mean female ridge density is 16.05 and in favoured odds for females of >17 ridges/25mm^2 is likely to be of female. Noemí[8] in their study in Argentina of 335 individuals had similar results where females presented greater ridge density than males. Jwala Kandel et al[9] did study in Nepal of 700 medical students (350 males and 350 females between 18 to 30 years). Results showed mean ridge density of males was 13.82 and females was 15.36, when probability density was calculated it showed ridge density <13 ridges/25mm^2 (C/C1=5.75, P=0.86) and >16ridges/25mm^2 (C1/C=4.29, P1=0.84) have higher probability of originating from males and females respectively. Comparing to present study, our study population is less but it shows similar results for i.e., <13ridges/25mm^2 likely to be male and ridge density of >17ridges/25mm^2 is likely to be female. Regine[10] in Filipinos studied fingerprints of 300 volunteers of 18-40 age group. Study found ridge density to be sexually dimorphic ($p < 0.001$), with an average of 17 ridges / 25 mm^2 recorded among males and 20 ridges/25 mm^2 among females. Richard[11] did similar study on same Filipino population with different result were <13 ridge/25 mm^2 was likely to be male and > 15 ridges / 25 mm^2 this shows that even in same population there are variation present and extensive studies will help in standardising of identification of sex from ridge density.

Sudesh[12] in Mauritius did study on 500 subjects (250 Male and 250 female) showed similar results that a finger print ridge of <13 ridges/25 mm^{2}is more likely of male origin and finger print ridge of > 14 ridges/25 mm^2 is more likely of female origin. Mean ridge density of males was 12.8 to that of female was 14.6. In this study there is not much variation in ridge density but sample population is comparatively larger which may suggest that as sample increases, the mean and likelihood ratio of male and female is difficult to compare.

Many studies have also been done in India with common results of higher ridge density in female in comparison to males. Studies like Lalit et al [13] on 250 students showed male mean density of 11.9 and female mean density was 14.1 and study concluded that < 12 ridges/25 mm^2 are more likely of male, comparing to female it was > 14 ridges/25 mm^2. Nithin[14] studied and compared fingerprints of all fingers in 200 subjects in south Indian population and found similar results, in which mean density in males was around 12 and mean in females was around 14. Observed ridge density of <13 ridges/25 mm^2 was likely to be of male and > 14 ridges/25 mm^2 was likely to be of female. As seen in these studies though results vary, there is significant difference between ridge density of male and females and they correlate with the present study. Neeti[15] in central India conducted study on 200 subjects, but used only thumbprint for the study and showed mean ridge in male of 11.58 and mean ridge density in females was 14.56, and concluded that less 12 ridges/25 mm^2 is likely to be male and > ridges/25 mm^2 likely to be female. This study did not use all fingers but overall showed similar results of higher ridge density in females.

Sucharita[16] studied 120 medical students of equal gender and analysed fingerprint ridge density of left and right hand separately and added their ridges of all ten fingers for analysis and found mean ridge density among the females (148.67) is higher than in males (128.5). Though methodology is different from present study their results are similar. Kewal[17] in their study of 194 students of 18-25 yrs age group studied the ridges of ulnar and radial side of fingers and found ridge count between 13-14 in males and 14-21 in females, though it doesn't correlate with this study but it shows ridge density is higher in females as compared to males as seen in our study. Garg et al shows that the general distribution of the primary fingerprint pattern is related to gender and blood group 'B'.[18] Some researchers used other method for sex determination. [19,20]

In a totally different study, A comparative study was done of different articles comparing fingerprint ridge densities among them in different region of Indian and found that there is a significant difference in the epidermal ridge density between males and females of Indian origin and this comparison and analysis shows very much similar trend in ridge density.[21] In all these studies results have statistical significance and are comparable, rather than number specific results which are not comparable. If only statistical analysis of different studies is compared with present study it shows significant similar results

5. Conclusion

To conclude finger density can be used to asses sex to some extent. Variation in ridge density from male to female may be related to difference in build or body surface area and ridges may be more concentrated in female's comparative to males, though this may not be confirmed from present study. The results vary from place to place and country to country, as seen in different studies and standardisation is necessary to use ridge density as an identification tool.

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Contributor ship of Author: All authors equally contributed.

Conflict of interest: None to declare.

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References:

1. Reddy KSN, Murthy OP. The Essentials of Forensic Medicine and Toxicology. 35th ed. Jaypee Publisher; 2024. p. 62-3.
2. Sree H, Raju Y, Varma MR, Krishna PR, Deepika I. Dermatoglyphics of medical students of a tertiary teaching hospital in Srikakulam District, Andhra Pradesh. J Forensic Med Sci Law. 2023; 32(2):14-9.
3. Shribhagwan, Singh M, Agarwal HS. Fingerprint pattern distribution in a cohort of Southeastern Haryana. J Forensic Med Sci Law. 2022; 31(2):4-10.
4. Patil SS, Deokar RB, Dongare SS. Prospective study of correlation of waist circumference with stature, weight and body mass index of the individuals. J Punjab Acad Forensic Med Toxicol.2023; 23(2): 119-28.
5. Acree MA, Is there a gender differentiation in fingerprint ridge density? Forensic Sci Int. 1999; 1102(1):35-44.
6. Ali F. I, Ahmed AA. Sexual and topological variability in palmprint ridge density in a sample of Sudanese population. Forensic Sci Int Rep. 2020; 2:100151.
7. Suthipraphal I, Riengrojpitak S, Tiensuwan M. Fingerprint ridge density and characteristics in Thais. Presented at: National Symposium; 2010; p.1–8.
8. Rivaldería N, Sánchez-Andrés Á, Alonso-Rodríguez C, Dipierri JE, Gutiérrez-Redomero E. Fingerprint ridge density in the Argentinean population and its application to sex inference: A comparative study. Homo. 2016; 67(1):65-84.
9. Kandel J, Ghimire, S., Bhandari R. Sex differentiation from fingerprint ridge Density. J Nobel Med Coll. 2023; 12(1), 13–6.
10. De Mesa RY, Yapchiongco YB, Evangelista CA, Alcantara MO, Kub-ao KD, Taduran RJ. Sex determination from plain fingerprint ridge density in Filipinos. Problemy kryminalistyki. 2021; 313(3):34-41.
11. Taduran RJO, Townsend GC, Tadeo AKV, Escalona NAC. Sex determination from fingerprint ridge density and white line counts in Filipinos. Homo.2016; 67(2):163-71.
12. Gungadin S. Sex Determination from Fingerprint Ridge Density. Internet J of Med Update. 2007; 2(2): 4-7.
13. Kumar L, Agarwal S, Garg R, Pratap A, Mishra VK. Gender determination using fingerprints in the region of Uttarakhand. J Indian Acad Forensic Med. 2013; 35(4): 308-11.
14. Sam MN, Rema P, Nair BV. Sex determination using fingerprint ridge density in South Indian population. J Indian Acad Forensic Med.2014; 36(4):381-6.
15. Kapoor N, Badiye A. Sex differences in the thumbprint ridge density in a central Indian population. Egyptian J Forensic Sci.2015; 5(1):23-9.
16. Sucharitha TM, Phanindra SV, Shaik A B, A study on sexual dimorphism in fingerprint ridge density among medical students of Nellore south coastal district of Andhra Pradesh. Indian J Clin Anat Physiol. 2021; 8(3):194-7.
17. Krishan K, Kanchan T, Ngangom C. A study of sex difference in fingerprint ridge density in a North Indian young adult population. J Forensic Leg Med. 2013; 20(4):217-22.
18. Garg P, Mustaria PS, Kumar N, Bansal MK, Yadav M. Analysis of Primary Fingerprint Patterns in Medical Students of Banda District Uttar Pradesh. J Forensic Med Sci Law 2022;31(1):28-32.
19. Sudhan MS, Raj HM, Kumar SV, Sowjanya D. Morphometric Analysis of Orbital Parameters for Sex Determination. J Forensic Med Sci Law 2023;32(2):39-42.
20. Ahmad N, Purkait R. Sex Estimation from the Shaft Fragment of Humerus Bone from Samples of Central Indian Skeletal Remains. J Forensic Med Sci Law 2021;30(2):4-9.
21. Chauhan A, Shukla SK. Feasibility of Ridge Density: A comparative study of fingerprint ridge densities among different Indian population. J Forensic Sci & Criminal Inves. 2017; 4(5):555654.

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Original Research Article

Piloting and Evaluation by Forensic Pathology Registrars of a Mobile Application Created for Autopsy Reporting

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Abstract

Background: Mobile applications have shown promise in various medical settings. However, the KwaZulu-Natal Forensic Medicine department still relies on manual reporting for autopsy data recording, highlighting the need for a portable tool for data collection and statistical reporting.**Objective**: This study aimed to pilot a mobile application for portable autopsy data collection and assess user acceptability among Forensic Medicine registrars. **Methods**: A multi-methods pilot study involved four enrolled Forensic Medicine registrars who tested and evaluated the portable autopsy data collection tool. Surveys and interviews gathered their perceptions of usability, benefits, and challenges. The Technology Acceptance Model (Davis's) was used to evaluate the perceived ease of use and perceived usefulness of the tool. **Results**: Participants reported positive perceptions of the tool's usefulness, ease of use, and benefits for service, training, and research. Some concerns were voiced related to the impact of time constraints and the potential increase in workload due to unfamiliarity with the tool. The registrar's feedback also informed amendments to the tool for greater user acceptability. **Conclusion**: The portable autopsy data collection tool was well-received by department registrars, showing potential for improving service and research. Similar tools could benefit other medical departments, warranting further exploration.

1. Introduction

In Forensic Pathology involves the determination of the cause of death in "unnatural" and sudden unexpected deaths using the scientific methods of the autopsy and related investigations. In South Africa, the laws directing autopsy procedures are primarily outlined in the Inquests Act 58 of 1959.[1]

The doctors conduct an autopsy and comp-

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ile a report in affidavit form for use in court proceedings according to the Criminal Procedures Act 51 of 1977 and in terms of the Regulations and National Code of Guidelines for Forensic Pathology Practice in South Africa.[2]

In South Africa, particularly in the province of KwaZulu-Natal, autopsy reports are typed and printed in hard copy for court procedures. This process of producing an autopsy report can be lengthy, depending on the investigations required for each case, viz. histology, toxicology, and DNA analysis. A hard copy of the report is filed in the mortuary archive filing room and may be re-accessed for reporting purposes and trends. The information recorded during a post-mortem is largely anonymised because each case is given a de-identified post-mortem reference number. Identification of the deceased is recorded in a separate hard copy register by administrative staff members, resulting in multiple registers and auditing processes.

The process of accessing the hard copy reports from different facilities after archiving is a cumbersome and arduous process, which is exacerbated by human error and misfiling, which occurs at several medical institutions, nationally and internationally.[3-5] To support the National Health Insurance scheme, the South African government has prioritised bringing electronic health records to health facilities.[6] Although technology has advanced greatly and can facilitate the move to electronic record-keeping, the process is paradoxically rather complex due to the confidential nature of health records. Well-organised and comprehensive medical records that contain information regarding a patient's care are important for continuing care, assessing the quality of medical care, and determining medico-legal liability.[7] These important records are expected to be stored for many years, but their safety and security remain a challenge due to the conditions or facilities in which they are archived.[4,7]Poor record-keeping is a critical issue to address, impacting the accuracy and, therefore, reliability of the data for statistical evaluation, auditing, research, and data quality.[4,7,8] Health information services in South Africa require urgent attention because the successful implementation of electronic health records and storage will provide valuable evidence-based data to support the development and improvement of healthcare.[6] Electronic data capturing has the potential to greatly reduce the time and costs associated with reporting and data storage.[9] Internationally, primary healthcare databases are used to provide anonymised electronic health data that greatly contributes to research in the healthcare sector.[10] It is possible and realistic in the current technological age to create a low-cost, simplistically designed, accessible repository of electronic records. Underutilised information that can be gained from post-mortems will illuminate statistical and population trends, inform medical knowledge, and support research.[11]An autopsy database containing information of value for pathologists, epidemiologists, and other researchers is technically feasible and can be designed to protect the deceased's privacy.[12] Placing the autopsy database on the smartphone maximizes its access to relevant stakeholders interested in using or contributing to the database thus improving the standards of reporting and research.

The smartphone as a portable autopsy data collection tool (**PADCOT**).The PADCOT was created with the goal of developing a secure, indexed digital archive of post-mortem reports required for daily service, court, and statistical reporting. Funding was awarded to the primary author by a government organisation to produce the tool. The design was outsourced to a private software company. Key considerations in the PADCOT design were ease of access to data for service reporting and research purposes, improved accuracy of data input, and the ability to archive electronic records. Features of the tool include the ability to search the database, download functionality of autopsy reports, automatically accurate statistics with graph generation, and tiered security access. The PADCOT is a progressive web app with Wi-Fi and storage capabilities, offering real-time transfer of data. It is accessible on any smartphone device, enhancing mobility, which is an essential feature for training doctors who rotate through different facilities.[13-15] The security access via personalised usernames and passwords allows only registered users (i.e. doctors) to access the information on the application, maintains court admissibility, and conforms to the legislature by using de-identified information.[16] Supervisors have higher level tiered access to the reports, enabling auditing and supervision. Statistics are available to higher security access users, and the visual data graphs can be downloaded. Data can be entered daily, which removes the administrative barriers of manual registers. The PADCOT comprises a standardised autopsy summary with the option to

upload pertinent documents to cloud storage, including the completed autopsy report. (**Table 1**). The PADCOT cloud database can reduce laborious efforts and facilitate access to information previously available in hard copy, saving time and improving reporting for police investigations and statistical and research purposes. Portfolios of doctors will be readily available with autopsy case summaries for postgraduate training.

Table 1: Screenshots of the PADCOT

Image I: User login/Security Access

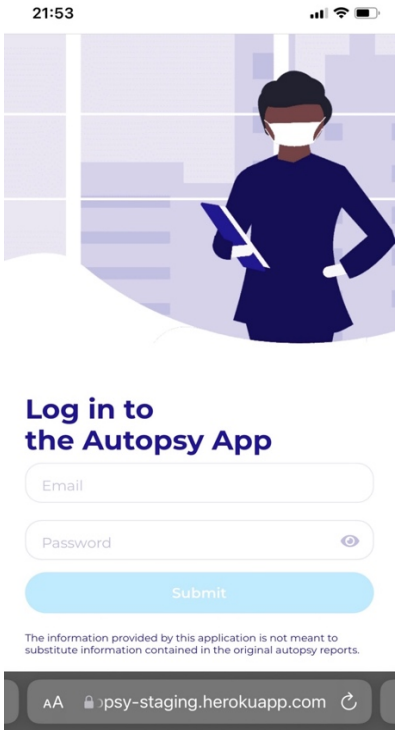


Image II: Landing page

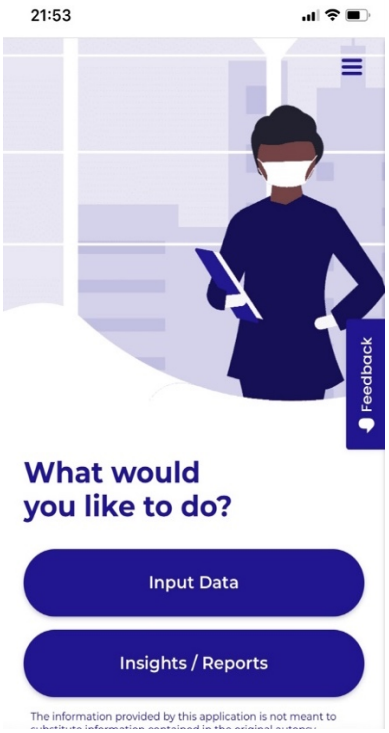


Image III: Summary of case/Data collection form

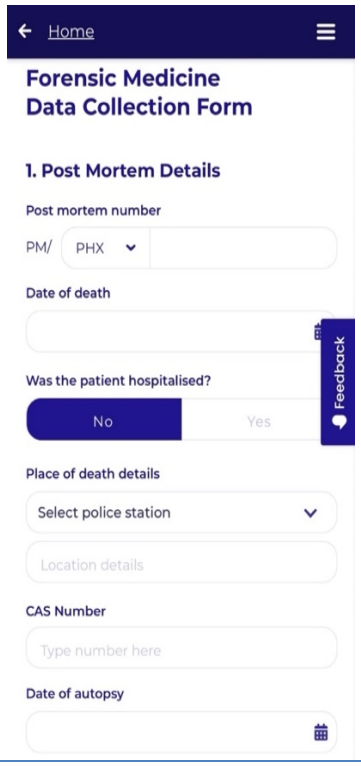


Image IV: Data dashboard

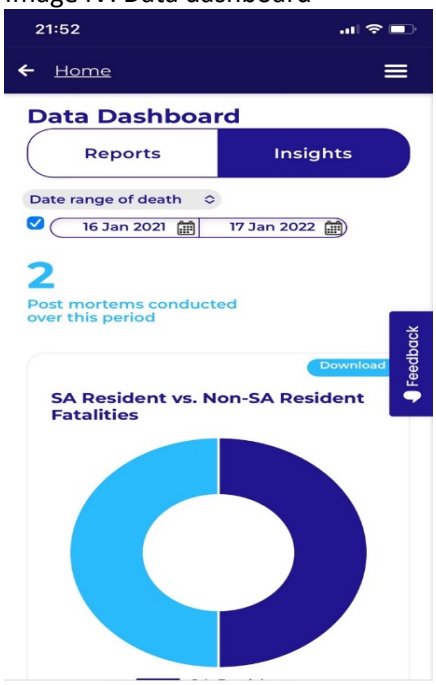
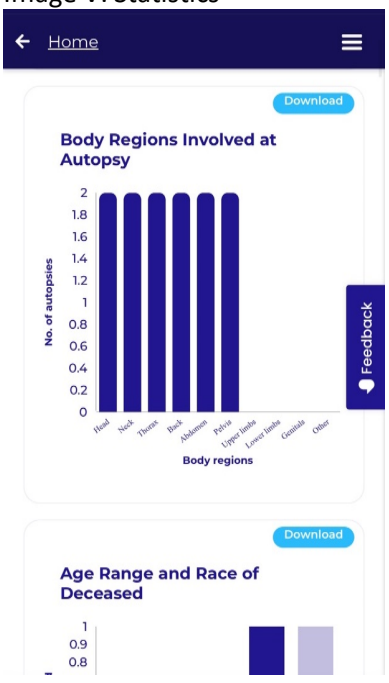
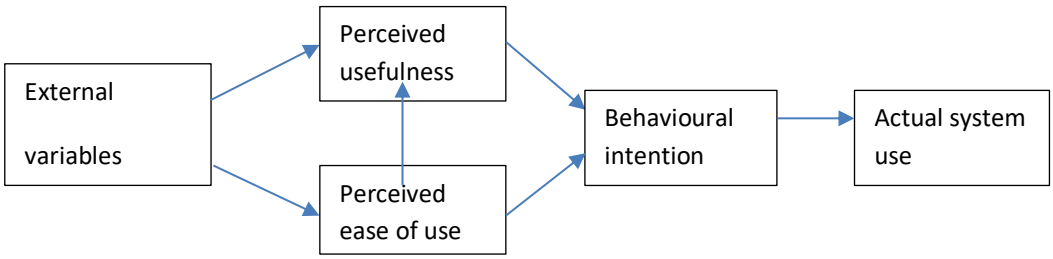


Image V: Statistics



It will create a platform for information sharing amongst trainees and supervisors to assist in training. The PADCOT has the potential to greatly reduce the time and costs associated with data collection and improve its completeness and quality.[17] An additional proposed benefit is the PADCOT database with up-to-date information from current autopsies, which can be used in undergraduate and postgraduate teaching. This phase of the study was conducted to assess the performance, feasibility, and acceptability of the application amongst the registrars in Forensic Medicine using the Technology Acceptance Model (**Figure 1**).[18] The Technology Acceptance Model (Davis, 1989), or TAM, posits that two factors determine whether a computer system will be accepted by its potential users, namely its perceived usefulness and the perceived ease of use translates to behavioural intention to use the system.[18] The key feature of this model is its emphasis on the perceptions of the potential user. The TAM was used to measure the adoption of the new technology (PADCOT) by exploring the attitudes/perceptions of future users, i.e. (registrars). User testing can also prevent recurring issues or duplication of data (seen in COVID-19 pandemic responses), improve the tool, and increase actual system use of electronic health resources.[19]

Figure 1. Davis' Technology Acceptance Model



2. Methods:

Study design

A multi-methods pilot study was conducted with a purposive sample of 4 registrars enrolled in specialisation training in the Forensic Medicine department of KwaZulu-Natal.[20] Homogenous saturation sampling of all the enrolled registrars was used because they were considered to be in the best possible position to give accurate feedback about the value, barriers, and ease of use of the tool which was specifically designed for use in this discipline.[21] The aim was to identify potential problems or deficiencies in the tool before full implementation at the institution. Basic training for the participants was provided by the software company that developed the tool. Each participant was provided with approximately 20 fabricated autopsy reports and, after training by the private software company, was asked to enter the provided data from the autopsy reports into the PADCOT. The participants were then asked to complete a questionnaire and participate in interviews to discuss issues encountered in research and recommendations to improve PADCOT.

Study setting

The study was conducted at Forensic Medicine department offices where Wi-Fi internet access was available. After obtaining consent and basic training, the participants were given approximately one month to test the PADCOT and complete the questionnaire. The interviews were conducted once the participants indicated they were ready to report on PADCOT.

Development of procedures for evaluating the application

A multidisciplinary team composed of a Specialist Forensic Pathologist, Information Technologists, and an Education Specialist/Academic Research Leader created the materials, which included the fabricated reports, the questionnaire, and the interview questions used to evaluate the PADCOT. The fabricated post-mortem reports were used to enter data into the application to test the app for its perceived usefulness and perceived ease of use and for other user feedback.

The fabricated reports were composed of a standardised autopsy reporting template with simulated data to be entered into PADCOT.

Data collection methods

Survey

The survey consisted of 10 open-ended questions regarding the daily reporting of autopsy records. The initial section captured the biographical details of the participants. The questionnaire

collected information relating to how data collection currently occurred in Forensic Medicine and the impact on the participants' ability to conduct research; how the application could improve service and practice in Forensic Medicine; and whether participants perceived the need for any additional information fields for the PADCOT. The content validity and suitability of the questionnaire were evaluated by an education expert, a university statistician, and a Specialist Forensic Pathologist.

Semi-structured interviews

The interview questions were first piloted to ensure there was no ambiguity in the questions. Permission was obtained to audio-record the interviews, which were conducted in English by the first author. The interviews were between 15-45 minutes in duration. Apart from biographical details taken at the time of the interview, the eight questions were related to current service work record-keeping, the perceived usefulness, and the perceived ease of use of the tool (based on the TAM), including their recommendations. All participants were invited to express their individual opinions and additional comments at the end of the interview.

Data Analysis of the Quantitative Data

The questionnaires were sent via email by the participants. While all four agreed to participate, only three completed and returned the questionnaires. The data from the questionnaires were then entered into a table and analysed by the authors using descriptive statistics.[22,23]

Data analysis of the Qualitative data

The interviews were audio-recorded and manually transcribed by the first author at the same time. After the interviews were completed, the audio was listened to, and transcription was re-evaluated to ensure that all the data was directly transcribed verbatim. The transcriptions were made available to all the authors and the participants to increase the validity and reliability of the data. The coding and themes were done using thematic analysis and the framework analysis of data; data familiarisation; identifying a thematic framework; indexing all study data against the framework; charting and summarisation of the data; and mapping and interpretation of patterns found within the charts as seen in **Figure 2**.

Ethical procedures followed

The study protocol was approved by the University Biomedical Research Committee. All four eligible participants provided informed consent to participate, while only three completed the questionnaire, but all four participated in the interviews.

3. Results

Participant characteristics for the survey

The three participants in the survey were female: 1 African, 1 White, and 1 Indian, with ages between 29 and 31 years. Their experience in Forensic Pathology ranged from 6 months in the registrar training programme (excluding medical officer time) to having completed the 4-year programme in 5th-year extended time.

Participant characteristics for interviews

All participants were female: 2 African, 1 White, and 1 Indian with ages between 29 and 31 years. One participant chose not to complete the questionnaire. Their experience in Forensic Pathology ranged from 6 months in the registrar training programme (excluding medical officer time) to having completed the 4-year programme in 5th-year extended time. All participants self-reported being comfortable with mobile applications and using their smartphones.

Survey results (Participants n=3)

The participants indicated that they would all continue using PADCOT. One response from a participant reported that the application was "excellent" and a "good advancement" for use in autopsies. The majority (n=2; 66,6%) of the participants were involved in research and collected data for research using hard copy reports, with only n=1 (33,3%) collecting data for research via an electronic database (Excel spreadsheet). However, all participants (n=3, 100%) were willing to use a comprehensive electronic database for research if it was available. Two of the participants agreed that the PADCOT was user-friendly, allowed easy data access, was less time-consuming than manual recording, and allowed for secure storage that is accessible (66.6%; n=2). Recommendations from the participants for PADCOT included improvement of text efficiency/text fillable sections (33.3%; n=1), a more in-depth searchable database (33.3%; n=1) and one participant suggested that a dedicated administrator be used for an in-depth database (33.3%; n=1).

Qualitative findings (Figure 2):

The following themes emerged from the data, namely Perceived Ease of Use (Usability), Usefulness (Benefits) of the application for autopsy reporting, training, and statistical analysis, the Disadvantages of using the tool, and Suggestions to

improve the tool. Verbatim quotes were used to represent the participant's voice.

Perceived ease of use (User acceptance)

One of the participants highlighted that South Africa is amongst the top countries with violent crimes resulting in death. She proposed that if employed daily, the PADCOT would become easier to use once the users are familiarised with the process. The drop-down menus in the tool were considered helpful by another participant, promoting efficiency (reported as approximately 10 minutes per report) with a subtheme of user acceptance arising from their responses.

*"*It's a quick process, not too time-consuming, and very helpful. (How long does it take to do a single case?) Less than a minute…it's clicking a drop-down screen therefore not too much typing. But it's quite helpful if I had the app, I could see what's going on. I think it works quite well." 3rd-year Registrar, Female, Age 30

"We are amongst the top countries regarding murder and forensic-related deaths. …it's very (very) easy to use… it will be easier for us to retrieve data to lean more towards using the app as time goes by. I think once people see how we can benefit from this app and use it daily for future purposes… It takes time to upload the information but it's worth it in the long run." 1st-year Registrar, Female, Age 29

Definitely shorter than doing a report, if you're going to do it properly, about 10 minutes." 4th-year Registrar, Female, Age 31

Usefulness (benefits) of the application for autopsy reporting, training, and statistical analysis/research.

This theme highlighted the perceived benefits of using the app. The theme had three subthemes, namely, the benefits of the application for service work, the benefits of training, and the benefits of statistical analysis/research.

Benefits of the application for autopsy reporting (service work*)*

The reported benefits included the mobility of PADCOT and remote accessibility to reports. Doctors are approached frequently regarding post-mortem information by investigating officers (usually by the South African Police Services), family members, and staff. Hard copy reports are archived in the facility or department and, therefore, are not easily accessible. Reports are often misfiled or misplaced, and therefore, secure storage would be beneficial for both service and research. The doctors entering their own allocated autopsy case information into the application will ensure that errors in reporting are minimised.

'…… (Won't) get physically lost. Now that I am in my Anatomical Pathology rotation, literally on a weekly basis I'm receiving messages about where a certain PM report is, and I have to explain that I'm not actually in the department this year and I don't have the time to physically (obtain the report). So, if someone needed details on my report, for example, an investigating officer, and I don't have physical access to the reports but if I have an app on my phone, the report will always be with me, and I can provide some sort of information to the officer. " 3rd-year Registrar, Female, Age 30

"Records through mortuary and register (for numbers). Some of the information is missing (case numbers) and also the history does not match with what you find at the autopsy… I think it will be beneficial, mostly, not just for research purposes but for our day-to-day work, knowing where each case is, how far it is …. It will be speeding up the process of signing out reports." 4th-year Registrar, Female, Age 31

Benefits of the application for training

The value of the application for training and quality assurance purposes was highlighted as it was believed that supervisors would be able to access reports timeously for auditing purposes conducted on all registrar autopsy reports.

"I am sure in a consultant capacity, it's also beneficial because they will be able to access any of our reports at any point in time." 3rd-year Registrar, Female, Age 30

Benefits of the application for statistical analysis/research

Data collection for research may be relatively effortless with the PADCOT. The application automatically generates demographic and common characteristics of cases that were reported by a participant to benefit her in terms of her research. One participant expressed frustration with the current manual records, which were often inaccurate, lost, misfiled, or incomplete. Autopsy reports are completed and signed out by the doctor who performs the autopsies. This process, depending on the type of case and the investigations each report requires, may take months to years. Only once the report is completed and signed out after auditing is it then archived in the mortuary or the department. The tool enables the doctor to enter information

immediately after completing the autopsy, allowing for real-time data transfer.

"The benefit for me is that I can see the app can tabulate and visually make data in a graphical form which is extremely helpful to me in terms of my own personal research." 3rd-year Registrar, Female, Age 30

"For research, it will be much easier to find information regarding what could have happened and select the cases you are interested in, selecting cases that you need and saves on time because manually looking is a lot [time-consuming]." 4th-year Registrar, Female, Age 31

"My main barrier is that not all cases have been signed out [autopsy report completed] with all information], so I am lacking a lot of information, my latest date is 2018 but there are still cases that have not been signed out which is frustrating. But it's been quite difficult because it's just going to be me manually… literally…trying to trace my way through the record room… "5th-year extended time Registrar, Female, Age 31

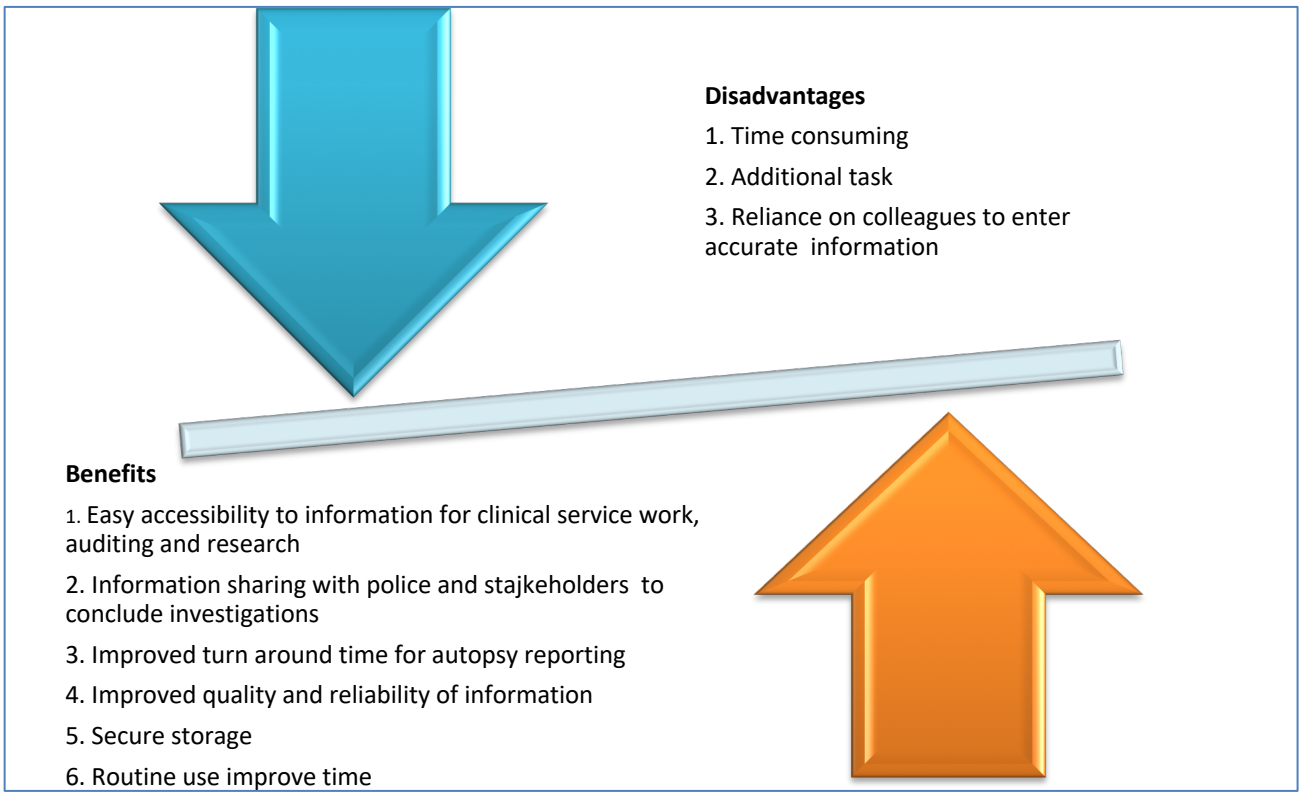
Disadvantages of using the application

The subthemes of impact on service work and the reliability of the data were of concern to two registrars.

Subtheme of impact on service time

The approximate time taken to enter each report was estimated to be between 2-10 minutes for each autopsy, depending on the type of case. While one participant reported making the application simpler or enlisting an administrative assistant to enter data due to time needed to enter each case by the pathologist, another participant suggested the need to enter more data such as blood alcohol levels (related to her research). Another issue raised brought about the subtheme of the reliability of the data. The database would only be beneficial if all the other doctors would complete the information accurately and timeously. Autopsy information is already being collected manually but inconsistently; therefore, it would be a more efficient and accurate substitute for the manual process/register already in place.

Figure 2: Registrar/participants perspectives of the portable autopsy data collection tool



"Besides it is that we will have to add another process to formulating a PM report, which means we also have to use this app. Another limitation is that you won't get intricate details of the autopsy report, you will get snippets." 3rd-year Registrar, Female, Age 30

"And it also provided that it is done properly like then you're putting your trust in the other doctors that you know have to fill in the app that they are doing it right…It will be very helpful (for portfolio purposes). The one limitation is that it is an extra step that

doesn't exist …just got to make a habit but people it must be done properly otherwise." 5th-year extended time Registrar, Female, Age 31

Suggestions to improve the tool

One of the participants suggested that an additional option be included, which is an information log indicating what stage the autopsy report was in at any given moment (completed or outstanding investigations are required) as this would be useful in their daily service work.

"Just a side note, it would be helpful if we had an option to say if the PM report was signed out or at what stage of the process the report was in." 3rd-year Registrar, Female, Age 30

4. Discussion

The many challenges facing low- and middle-income countries include imperfect or incomplete health data, which may cause limitations and compromise data integrity, limiting data sharing capability amongst the research community for wider societal benefit.[4,23,24] Many countries have utilised computerised data collection in general practice to improve the quality of care and reduce unnecessary retesting whilst accumulating exponentially growing data for statistics and research.[25] There also seems to be increasing acceptance from patients for the use of their health data for research. The use of Electronic Health Records has similarly been successfully adopted across many medical departments although some healthcare practitioners are resistant to adopting electronic record-keeping systems.[27]

This study used Davis' Technology Acceptance Model to test usability and registrars' willingness to adopt an electronic record-keeping system which theorises that developers explore the perceived usefulness and ease of use of technology before implementation to improve system design and promote the actual use of the proposed system.[17] Previously identified barriers to implementing computerised methods for medical record-keeping in Forensic Pathology include issues of costs/funding, user acceptability and customizability of the proposed system, ethical issues regarding security and privacy of the confidential data, and data ownership.[10,25,27] In Forensic Medicine, ethical concerns regarding the security and privacy of confidential information can be properly addressed with suitably designed anonymised electronic records, and legislature recognises court admissibility of electronic records when auditing and custodianship of the records are properly instituted.[16] Information from autopsies is often undervalued and overlooked.[11,29] Adopting electronic records and enforcing complete and accurate records will improve data quality, supporting statistics and research.[30] Registrars often encounter difficulties initiating and/or completing research due to unequal distribution of time because of large caseloads and service work.[31] An electronic database can support and improve time management, which has already been seen in well-established systems.[9,10,12,27,32,33]

Advanced innovative techniques also helpful in medical education regarding medicolegal autopsies.[34-38] Electronic records improve the doctor's ability to retrieve and recall patient information from structured notes in information systems. The issues of patient confidentiality and protection of personal information can be addressed using appropriate security measures with current technological advances.[12] Autopsy information is entered using de-identified post-mortem reference numbers, which address potential security issues, and auditing features can ensure the admissibility of the autopsy reports.[13,16] It is important for new tools to be evaluated for ease of use and usefulness during user testing.[17] The testing process captures and processes live data and demonstrated the registrars' willingness to adopt an electronic record-keeping system for data collection, storage, and research purposes. Adoption of similar models of the tool may benefit other medical departments and may be useful to explore as part of further research studies.

Strengths of the study

Basic training of the participants by the outsourced private software company was conducted prior to the use of the tool. The participants were invited to recommend personalised features that they would want included to improve the usefulness of PADCOT. The study is a pilot study, and further research will be conducted once PADCOT is fully adopted in the institution.

Limitations

The first author who conducted the interviews with the four participants was a consultant in the department which may increase potential research bias. The tool has yet to undergo testing in a mortuary environment with real-time autopsy data which would facilitate more comprehensive analysis with more participants.

5. Conclusion

The adoption of electronic record systems and medical applications in the healthcare industry

has been met with both affirmation and apprehension. The multitude of benefits and positive contributions concerning time management, accuracy, and data storage of health records are considered substantial. The cost and customisation of these systems are often a barrier to their successful implementation.

Abbreviations:

PADCOT: Portable Autopsy Data Collection Tool
KZN: KwaZulu-Natal
UKZN: University of KwaZulu-Natal
Registrar: Forensic Medicine Registrar

Ethical Clearance: IEC approval was taken from the Institutional Ethical committee.

Contributor ship of Author: All authors equally contributed.

Conflict of interest: None to declare.

Source of funding: None to declare.

References:

1. Government SA. Document Act South African Government Website. [Cited on 06 Aug 2023] Available from: https://www.gov.za/documents/acts
2. du Toit-Prinsloo L, Saayman G. Performance of autopsies in South Africa: Selected legal and ethical perspectives 2012. [Cited on 06 Aug 2023] Available from: http://www.cmej.org.za/index.php/cmej/article/view/2326/2188
3. Burnett SJ, Deelchand V, Franklin BD, Moorthy K, Vincent C. Missing Clinical Information in NHS hospital outpatient clinics: prevalence, causes and effects on patient care. BMC Health Serv Res. 2011; 11(1):114;
4. Ennion L. Missing medical records: An obstacle to archival-survey research in a rural community in South Africa. S Afr J Physiother. 2013; 69:15-9.
5. Thomas J. Medical records and issues in negligence. Indian J Urol. 2009; 25(3):384-8.
6. Katurura MC, Cilliers L. Electronic health record system in the public health care sector of South Africa: A systematic literature review. Afr J Prim Health Care Fam Med. 2018; 10(1):e1-e8.
7. Danladi Garba K, Yahaya I. Significance and challenges of medical records: A systematic literature review. Advances in Librarianship. 2018; 9:26-31.
8. Hoeijmakers F, Beck N, Wouters MW, Prins HA, Steup WH. National quality registries: how to improve the quality of data?. J Thorac Dis. 2018; 10(Suppl 29):S3490.
9. Khatri N. Effective implementation of electronic medical records and health information technologies. Mo Med. 2015; 112(1):41-5.
10. Herrett E, Gallagher AM, Bhaskaran K, Forbes H, Mathur R, van Staa T, et al. Data Resource Profile: Clinical Practice Research Datalink (CPRD). Int J Epidemiol. 2015; 44(3):827-36
11. Reichert CM, Kelly VL. Prognosis for the autopsy. Health Aff.1985; 4(2):82-92.
12. Kruse CS, Smith B, Vanderlinden H, Nealand A. Security Techniques for the Electronic Health Records. J Med Syst. 2017; 41(8):127.
13. Prahladh S, Van Wyk J. Advantages of an electronic recording system for medico-legal autopsies in resource-constrained contexts. J Forensic Leg Med. 2022; 88:102336;
14. Ventola CL. Mobile devices and apps for health care professionals: uses and benefits. Pharm Ther. 2014; 39(5):356.
15. Fischer F, Kleen S. Possibilities, Problems, and Perspectives of Data Collection by Mobile Apps in Longitudinal Epidemiological Studies: Scoping Review. J Med Internet Res. 2021; 23(1):e17691
16. Prahladh S, Van Wyk J. South African and international legislature with relevance to the application of electronic documentation in medico-legal autopsies for practice and research purposes. Egypt J Forensic Sci. 2022; 12(1):1.
17. Pereira IM, Bonfim D, Peres HHC, Góes RF, Gaidzinski RR. Mobile application for data collection in health research. Acta Paulista de Enfermagem. 2017; 30(5):479-88.
18. Mohamed AHHM, Tawfik H, Al-Jumeily D, Norton L. MoHTAM: A Technology Acceptance Model for Mobile Health Applications. 2011 Developments in E-systems Engineering 2011. p. 13-8;
19. Madhavan S, Bastarache L, Brown JS, Butte AJ, Dorr DA, Embi PJ, et al. Use of electronic health records to support a public health response to the COVID-19 pandemic in the United States: a perspective from 15 academic medical centres. JAMIA . 2020; 28(2):393-401.
20. UKZN website, Research Methodology Module. [Cited on 06 Aug 2023]. Available from https://medicine.ukzn.ac.za/registrar/researchmethodologymodule/
21. Patil SS, Deokar RB, Mankar DD. Study of Feedback of Survivors of Sexual Offences Subjected For Medicolegal Examination in Tertiary Care Municipal Hospital. J Forensic Med Sci Law. 2022; 31(1):16-23.
22. Althunayan A, Almuhaideb M, Alzahrani MA, Almannie R. Identifying Areas for Development of the Law of Practicing Healthcare Professionals in Saudi Arabia: A Medicolegal Committee-Based Survey Study. J Forensic Med Sci Law. 2023; 32(2):43-50.
23. Palinkas LA, Horwitz SM, Green CA, Wisdom JP, Duan N, Hoagwood K. Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. Adm Policy Ment Health. 2015; 42(5):533-44.

24. Totten V, Simon EL, Jalili M, Sawe HR. Acquiring data in medical research: A research primer for low- and middle-income countries. Afr J Emerg Med. 2020; 10:S135-S9.
25. Kaewkungwal J, Adams P, Sattabongkot J, Lie RK, Wendler D. Issues and Challenges Associated with Data-Sharing in LMICs: Perspectives of Researchers in Thailand. Am J Trop Med Hyg. 2020; 103(1):528-36.
26. de Lusignan S, van Weel C. The use of routinely collected computer data for research in primary care: opportunities and challenges. Fam Pract. 2006; 23(2):253-63.
27. de Lusignan S. Using routinely collected patient data with and without consent: trust and professionalism. Inform Prim Care. 2008; 16(4):251-4.
28. Lemma S, Janson A, Persson L-Å, Wickremasinghe D, Källestål C. Improving quality and use of routine health information system data in low- and middle-income countries: A scoping review. PLoS ONE. 2020; 15(10):e0239683.
29. Ajami S, Bagheri-Tadi T. Barriers for Adopting Electronic Health Records (EHRs) by Physicians. Acta Inform Med. 2013; 21(2): 129-34.
30. Bagher A, Wingren CJ, Ottosson A, Andersson L, Wangefjord S, Acosta S. Necessity of including medico-legal autopsy data in epidemiological surveys of individuals with major trauma. Injury. 2015; 46(8):1515-9.
31. Zhu K, Feng H, Xu Y, Mao Z, Zhang W, Chen J, et al. An analysis of 60 years of autopsy data from Zhejiang University in Hangzhou, China. PLoS ONE. 2014; 9(11):e112500-e. [Cited on 06 Aug 2023] Available from: https://pubmed.ncbi.nlm.nih.gov/25426989
32. Häyrinen K, Saranto K, Nykänen P. Definition, structure, content, use and impacts of electronic health records: a review of the research literature. Int J Med Inform. 2008;77(5):291-304.
33. Hanzlick R, Stauffenberg M. Forensic Pathology Fellowship Training Issues and Suggestions. Acad Forensic Path. 2011; 1(3):332-6.
34. Guze PA. Using Technology to Meet the Challenges of Medical Education. Transactions of the American Clinical and Climatological Association. 2015; 126:260-70. [Cited on 06 Aug 2023] Available from https://pubmed.ncbi.nlm.nih.gov/26330687
35. Deokar RB, Patil SS. Avenues in Forensic Medicine. J Forensic Med Sci Law 2023;32(2):1-3.
36. Dere RC, Kukde HG, Deokar RB, Patil SS, Kumar NB. Executive summary of the XXIV State Annual conference of Medicolegal Association of Maharashtra (MLAM): Forensicon 2021. J Forensic Med Sci Law 2022;31(1):84-88.
37. Varma NM, Pawar MN, Deokar RB. Executive Summary of the Forensicon 2022 - 25th Annual State Conference of Medicolegal Association of Maharashtra (MLAM). J Forensic Med Sci Law 2023;32(2):80-84.
38. Higgins TC, Crosson J, Peikes D, McNellis R, Genevro J, Meyers D. Using health information technology to support quality improvement in primary care. Mathematica Policy Research; 2015.

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Original Research Article

What is Considered Enough in Disclosure of Adverse Events? A Cross Sectional Study of Medicolegal Panel Members

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Medicolegal Committee, Informed Consent, Saudi Arabia.

Abstract

Objective: To assess the current understanding and practice of the medicolegal committees' members in Saudi Arabia in regard to the disclosure of adverse event of medical and surgical treatment. And to assess their opinion and recommendations concerning the reasonable amount of information needed for an adequate discloser of adverse events. **Methods:** A cross-sectional quantitative study conducted in September 2020 by sending an electronic survey to physicians working in medicolegal committees' in Saudi Arabia. The survey's content was formulated by a member of the medicolegal committee and content validation was reviewed by two other members. **Results:** 62 out of 108 medicolegal members responded to the survey (57.4% response rate). Most of the respondents believe that all surgical adverse events should be disclosed to the patient 38 (61.3%), and most respondents 24 (38.7%) either agree or strongly agree with the statement "The physician should be held liable for any surgical adverse event not discussed with the patient". **Conclusion:** Our findings show subjectivity in interpreting the law by medicolegal committees' members in regard to informed consent and the sufficient amount needed for disclosure for adverse events. We recommend policy makers to create a model that protect the patient rights and respect his autonomy and, in the other hand, decrease the physician liability.

1. Introduction

Informed consent (IC) is the process where the patient authorizes the health practitioner to initiate medical or surgical treatment, after discussion in regard to the benefit, risk and alternatives of the proposed treatment.[1] The conditions that should be part of any IC are: disclosure, comprehension, voluntary choice and authorization.[2] Violating any of these conditions is a violation to patient legal right and might subject the physician to medical litigation.

A significant number of studies revealed gaps between the real practice of IC and the anticipated IC based on its theoretical construct.[2-5] One of these challenges is how much information should be disclosed to the patient in regard to the proposed medical or surgical treatment.

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To avoid litigations, health practitioner should provide adequate information to the patient to be able to reach an informed decision. But IC codes and laws do not indicate the extent of information that should be provided.[6]Deficient disclosure is a violation to the patient autonomy, as the patient is deprived of information to make the right choice. While detailed disclosure has its limitations due to physician time constrains, increasing side effects to the patient, suboptimal treatment and increase rate of withdraw.[7-11]

IC deficiencies is one of the most common causes of physician's liability. The common understanding that IC is optimal if a patient signs is misleading and not protective in case of a law suit. Instead, IC is a process of providing the patient with adequate information relevant to his condition and ends up with the patient's approval to undergo treatment. The process of IC requires time and excellent communication skills.[12] However, clinical practice revealed some factors that negatively influenced the process of IC including: prolonged duties, increased patients numbers with lack of time, lack of quality audit, inadequate training of medical professionals, and insufficient legal regulations.[13-15]

In Saudi Arabia, the Law of Practicing Healthcare Professions (LPHP) was released in 2005.[16] The law contains many articles that regulate the following: Licensing, Duties, Professional liability and the process of investigation and trial. Later patient Bill of right and responsibilities was released.[17] In 2019, the ministry of health published the guidelines of informed consent.[18] In the law, bill and guidelines nothing mentioned about the amount of information sufficient for informed consent. We aim to assess the opinion and recommendations of the medicolegal committees' members in Saudi Arabia concerning the reasonable amount of information needed for an adequate discloser of adverse events. And to assess their current understanding and practice in the committee in regard to the adverse event disclosure of medical and surgical treatment.

2. Materials And Methods

Study Design

This was a cross-sectional quantitative study conducted in September 2020. Study sample were physicians working as consultants for the medico-legal committees in Saudi Arabia. All medical lawsuit in Saudi Arabia are trialed by medico-legal committee. Each committee consist of three physicians of different specialties and one judge. Physician working in these committees are the most expert physicians in medical litigation, thereby their opinion is highly respected. They meet weekly to trial 5-10 medical lawsuit. A total of 36 medicolegal committee was included. The database was obtained from the ministry of health. An electronic survey was sent to all physician-members of these committees.

Survey Content

An electronic survey was constructed using Google Forms (Google Form, Mountain View, CA, USA). The survey's content was formulated by a member of the medicolegal committee and content validation was reviewed by two other members. The questionnaire consists of two sections. The first section contains demographic information including: age, sex, specialty, number of years working with the medicolegal committee and the number of cases trialed per year. The second section contain questions focusing on the participants' opinions and recommendations regarding adverse events disclosure for medications and surgical procedures. This section focused on how much disclosure is enough, liability of physicians in cases of non-disclosed adverse event, and suggested changes to the law. A detailed list of the questionnaire items is shown in (**Table 1-4**).

Statistical Analysis

Statistical analysis was performed using SPSS version 23 (IBM Corp. Released 2015. Version 23.0. Armonk, NY: IBM Corp). All demographic frequencies were calculated and the responses to all questionnaire items were analyzed. We compared the responses of medical and surgical respondents; dentists were excluded due to the low number of respondents. Because the data for some variables did not have a normal distribution and the assumption of variance homogeneity was violated for some of the variables, both independent samples *t*-tests and Mann-Whitney *U* tests were computed. We used Kolmogorov-Smirnov and Shapiro-Wilk to assess the normality of responses to certain survey items. A Chi-square test for independence was performed to test the associations between specialty and specific responses to the questionnaire. Correlation analyses were performed to compare responses based on demographics (age, years of experience, and the number of cases reviewed per year). We also tested for relationships between questionnaire items and demographics. Spearman's *rho* coefficients were calculated due to the non-normality of the data. A p-

value of less than 0.05 was determined to be significant.

Ethical Considerations: We obtained approval from the ministry of health to contact panel members and conduct the study. Also, institutional review board approval was granted. An electronic approval from each participant was obtained prior to beginning the survey.

Table 1. Responses to questionnaire items regarding surgical adverse events

Question	Responses				n (%)
For surgical procedures, what adverse events should be discussed with the patient prior to surgery?	All adverse events				38 (61.3%)
	All adverse events except ones that occur in < 1%				13 (21%)
	All adverse events except very rare ones				8 (12.9%)
	All adverse events except ones that occur in < 2%				0 (0%)
	All adverse events except ones that occur in < 5%				3 (4.8%)
The physician should be held liable for any surgical adverse event not discussed with the patient.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	15 (24.2%)	9 (14.5%)	19 (30.6%)	9 (14.5%)	10 (16.1%)

Table 2. Responses to questionnaire items regarding medications adverse events

Question	Responses				n (%)
For medications, what adverse events should be discussed with the patient prior to administering the medication?	All adverse events				24 (38.7%)
	All adverse events except very rare ones				21 (33.9%)
	All adverse events except ones that occur in < 1%				4 (6.5%)
	All adverse events except ones that occur in < 2%				3 (4.8%)
	All adverse events except ones that occur in < 5%				8 (12.9%)
	All adverse events except ones that occur in < 10%				2 (3.2%)
The physician should be held liable for any medication adverse event not discussed with the patient.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	8 (12.9%)	10(16.1%)	18 (29%)	12(19.4%)	14 (22.6%)
In cases of adverse events secondary to medications, physicians are liable because the consent is usually verbal, and the disclosure is not documented	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	16(25.8%)	12(19.4%)	16(25.8%)	10(16.1%)	8(12.9%)

Table 3. Responses to questionnaire items of suggested regulations in disclosure of adverse events

Question	Responses	n (%)
Which of the following suggested laws (regarding medical adverse events) do you consider practical, respects patient autonomy, and reduces physician liability?	All adverse events in the label have to be discussed	25(40.3%)
	All adverse events in the label have to be discussed except very rare adverse events	18(29%)
	All adverse events in the label have to be discussed except events that occur in < 2%	6(9.7%)
	All adverse events in the label have to be discussed except events that occur in < 5%	9(14.5%)
	All adverse events in the label have to be discussed except events that occur in < 10%	4(6.5%)
Which of the following suggested laws (regarding surgical procedures adverse events) do you consider practical, respects patient autonomy, and reduces physician liability?	All adverse events have to be discussed	24(38.7%)
	All adverse events have to be discussed except very rare adverse events	17(27.4%)
	All adverse events have to be discussed except adverse events that occur < 2 %	5(8.1%)
	All adverse events have to be discussed except adverse events that occur < 5 %	3(4.8%)
	All surgical adverse events should be provided in the consent form	13(21%)

Table 4. Responses to questionnaire items regarding inconsistency of verdicts and the need of training to healthcare providers

Question	Responses				
If a malpractice lawsuit was trialed by multiple medicolegal committees, it will have the same verdict every time.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	10(16.1%)	16(25.8%)	20(32.3%)	1 (17.7%)	5(8.1%)
The "Law of Practicing Healthcare Professions" needs further elaboration on what is necessary to disclose to patients in regard to adverse events.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	34(54.8%)	14(22.6%)	10(16.1%)	4(6.5%)	0(0%)

Table 5. Comparison between medical and surgical groups – t-test and Mann-Whitney U test

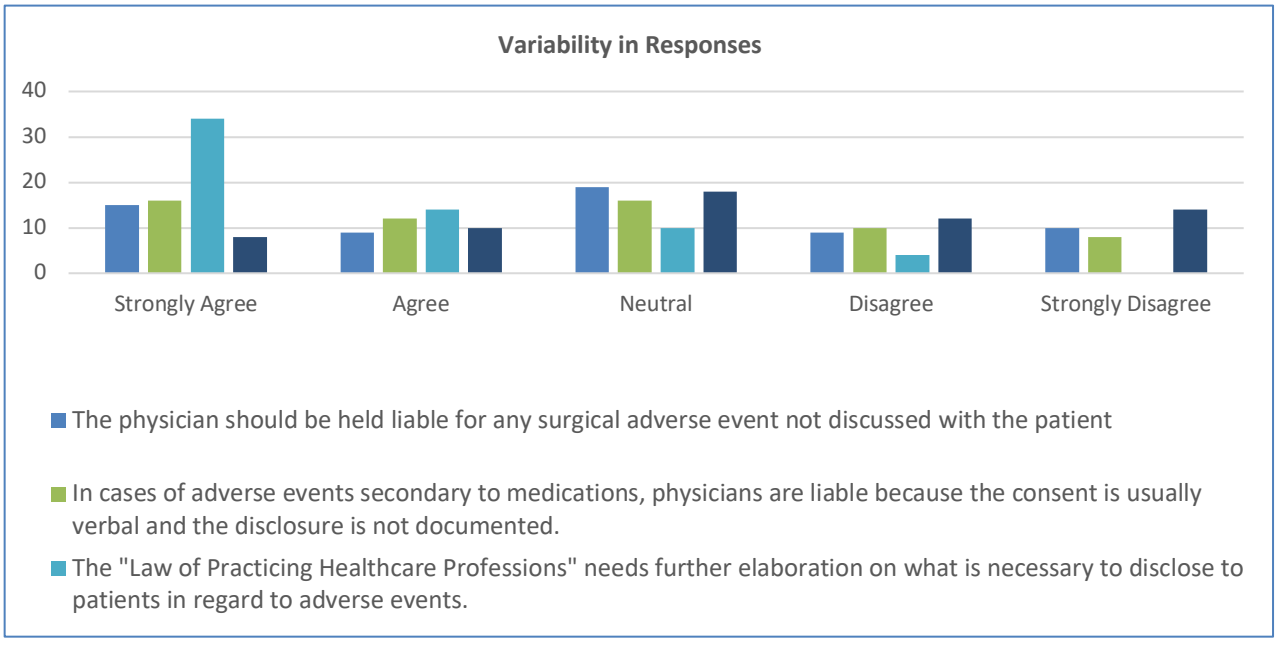
Question	t/U	p
If a malpractice lawsuit was trialed by multiple medical-sharea panels, it will have the same verdict every time.	0.93	.358
How much percentage of the cases you examine fall in the previous category?	0.27	.792
The physician should be held liable for any surgical adverse event not discussed with the patient.	1.27	.210
The physician should be held liable for any medication adverse event not discussed with the patient.	1.30	.198
In cases of adverse events secondary to medications, physicians are liable because the consent is usually verbal and the disclosure is not documented.	1.08	.287

Table 6: Correlation analysis based on demographics

Question	Age	Years	Cases
If a malpractice lawsuit was trialed by multiple medical-sharea panels, it will have the same verdict every time.	-.10	.24	.19
The physician should be held liable for any surgical adverse event not discussed with the patient.	.10	.04	**.30***
The physician should be held liable for any medication adverse event not discussed with the patient.	.00	.04	.24
In cases of adverse events secondary to medications, physicians are liable because the consent is usually verbal and the disclosure is not documented.	.10	.01	-.19
The physician should be held liable for any adverse event due to off-label medication use.	-.25	.00	.00
The physician should disclose if the medication is used as off-label.	-.03	-.02	-.20
The "Law of Practicing Healthcare Professions" needs further elaboration on off-label prescriptions.	.09	-.07	-.23

*p < .05

Figure 1. Variability in responses among certain items in the survey



3. Results

Demographic data

The questioner was sent to 108 members of 36 medico-legal committee. 62 medicolegal members responded to the survey (57.4% response rate). All responses were complete and were included in the study. Mean age was 49.84 years (*SD* = 8.60). Mean number of years serving in the panel was 12.34 years (*SD* = 10.96). With regard to number of lawsuits per year, the most frequent answer was 91-100 lawsuits per year (22.6%), followed by 0-10 lawsuits per year (11.3%) and >210 lawsuits per year (11.3%). Most of the respondents (62.9%) were from surgical specialties, followed by medical specialties (29%), and finally dentistry (8.1%).

Surgical adverse events

Most of the respondents believe that all surgical adverse events should be disclosed to the patient 38 (61.3%), and 13 (21%) believe that disclosure should be done except for rare adverse events. 24 (38.7%) respondents either agree or strongly agree with the statement "The physician should be held liable for any surgical adverse event not discussed with the patient", and only 19 (30.6%) respondents either disagree or strongly disagree with the same statement (**Table1**). When asked about the suggested laws regulating disclosure of surgical adverse events that are considered practical, respects patient autonomy, and reduces physician liability: the most frequent law suggested was "All adverse events have to be discussed" 24 (38.7%), followed by *"All surgical adverse events should be provided in the consent form"* 13 (21%). Responses to the questionnaire are presented in (**Table 3**).

Medication adverse events

Most of the responded believe that all medications adverse events should be disclosed to the patient 24 (38.7%), and 21 (33.9%) believe that disclosure should be done except for rare adverse events. 18 (29%) respondents either agree or strongly agree with the statement "The physician should be held liable for any medication adverse event not discussed with the patient", and 26 (42%) respondents either disagree or strongly disagree with the same statement (**Table2**). When asked about the suggested laws regulating disclosure of medication adverse events that are considered practical, respects patient autonomy, and reduces physician liability: the most frequent law suggested was "All adverse events have to be discussed" 25 (40.3%). Most responders 28 (45.2%) either agree or strongly agree with the statement "In cases of adverse events secondary to medications, physicians are liable because the consent is usually verbal, and the disclosure is not documented". Responses to the questionnaire are presented in (**Table 3**).

Variability in responses among medicolegal committees' members

To assess the variability of responses, we conducted both Kolmogorov-Smirnov and Shapiro-Wilk tests to quantify normality of distribution. Both normality tests revealed statistically significant results showing all responses to be not normally distributed. **Figure 1** represents the responses to tested items, with a clear presentation of non-normally distributed data. Moreover, we assessed the skewness of data in each item. All responses were not skewed Except for the statement "The Law of Practicing Healthcare Professions needs further elaboration on what is necessary to disclose to patients in regard to adverse events".

Comparison between surgical and other medical specialties

Firstly, comparisons between medical and surgical groups were conducted (since there were only five dentistry participants, they were excluded from this analysis). Due to non-normality of the data as well as violations of variance homogeneity for some of the variables, both independent samples *t*-test and Mann-Whitney *U* test were computed. Results are shown in (**Table 5**). A Chi-square test of independence was also performed and did not result in statistically significant results.

Comparisons based on demographics

A correlation analysis was performed as well to test for a relationship between questionnaire items and demographics (age, number of years in the panel, number of cases). Spearman's *rho* coefficients were calculated due to non-normality of the data. Results are shown in (**Table 6**). The more cases the respondent had, the stronger they agreed with a statement that physician should be held liable for surgical adverse effects not discussed with the patient. All other comparisons were not statistically significant.

4. Discussion

The adequate disclosure of adverse events of a treatment is considered a challenge to physicians.[19] According to the doctrine of IC, adequate information should be provided to the patient in order to reach an informed decision. It will be practical for physician to know what they need to disclose, to fulfil their ethical

duty and avoid litigations. Unfortunately, laws and regulations do not specify in details the amount of information that is needed to be disclosed.[6] Although it seems reasonable to mandate disclosure of all adverse events for surgical procedures, this does not apply to medical treatment. Is it realistic to disclose all adverse effects in the print of a medication, even if the rate is one in 100000 or even less? This might lead to tremendous decrease to the efficiency of the healthcare system and probably will increase treatment waiting time and cost.[8]

Time constrain is not the only limitation of full disclosure, a large number of studies have shown that detailed disclosure might have additional disadvantages leading to higher incidence of experiencing the side effect and withdraw from the treatment.[20-22] In one study on aspirin (n=555), the group that was informed about the gastrointestinal side effects developed these symptoms sixth-fold higher than the group not told about these side effect.[21] Another study on finasteride (n=120) revealed, the group that was informed about the sexual side effects developed those side effects three-fold higher than the control group.[20] This phenomenon is called nocebo effect and it can be harmful. Moreover, the information given to patients can shape the adverse events that they will experience, in a study with two placebo groups: one placebo acupuncture and placebo pill, showed that the development of side effect in each group was dependent on the information given.[23] Even word choice can influence the rate of occurrence of side effects. For example, using the word cool sensation instead of pain can reduce the rate of pain development after starting treatment.[24]

Nocebo effect is believed to be the result of the patient's anxiety and negative expectations.[25] It has many consequences including: psychological distress, excess costs, decrease compliance, increased clinical visits, and increase the medications prescribed to treat the nocebo response.[8] It was also found that changing medication due to side effect can result in more complications and less suboptimal disease control.[7,26] In 1995, the estimated hospital cost associated with drug adverse events was 76.6 billion dollars and the estimated emergency department cost was 17 million for the same reason.[27]

Our study was done on physicians who are working with the medicolegal committee. Their job is to provide consultation in each medical lawsuit and they are considered the most expert physician in medical litigations, their opinion could alter the judgment of any case. We assessed their opinion in regard to the amount of disclosure of adverse events for surgical or medical treatment and the liability in case of the occurrence of an adverse event. We found their responses to be variable and not normally distributed (Table1-3) and (figure 1). This finding has to conclusions: first conclusion, the law in regard to amount of disclosure is subjective, and it relay on the members interpretation of the law and their personal opinion. Second conclusion, in case of a litigation due to adverse events, there may be different verdicts for the same case depending on the medicolegal member involved.

Another dilemma, is the appropriate type of consent needed to avoid liability. For surgical procedures, the consent is usually written and the authorization is clear, but for medication the consent is usually verbal except for certain medications.[19] The magnitude of these dilemma can be observed if there is a litigation due to a medication adverse events with the patient denying the disclosure. In this situation, what will prove the occurrence of disclosure and prevent physician unnecessary litigation. In our study, the responses to our question "In cases of adverse events secondary to medications, physicians are liable because the consent is usually verbal, and the disclosure is not documented" showed that (45.2%) of medicolegal committee member either agree or strongly agree with this statement. This high agreement validates the importance of having a clear laws and regulations to avoid unnecessary liability.

When we asked the medicolegal members "Which of the following suggested laws do you consider practical, respects patient autonomy, and reduces physician liability?" there responses were not randomly distributed and not homogenous, which substantiate the lack of objectivity in IC. For surgical adverse events disclosure, most of the member (38.7%) believe all adverse events should be disclosed, while (27.4%) believe that disclosure should be done except for very rare adverse events. Only (21%) believe that all adverse events should be documented in the consent form. For medications adverse events disclosure, surprisingly, most of the members (40.3%) believe that all adverse events described in the medication label should be disclosed. All answers were not normally distributed and skewed which indicate that our question need to be addressed by policy makers.

Some models have been developed to resolve the limitations of the current IC theoretical construct including: the reasonable patient standard, the subjective standard, and the reasonable physician standard.[1] But these methods are subjective and does not resolve the question "how much adverse event disclosure is enough". We found that the responses of the medicolegal members were not normally distributed and not skewed, which prove the subjectivity of the model adapted by members. This fact might affect the verdict of a certain lawsuit depending on the opinion of the member and not due to a clear law statement. This was also shown by the question "If a malpractice lawsuit was trialed by multiple medicolegal committees, it will have the same verdict every time", only 41.9% of members either agree or strongly agree to this statement. The only response which was normally distributed was "The Law of Practicing Healthcare Professions needs further elaboration on what is necessary to disclose to patients in regard to adverse events", this finding corporate the previous findings which emphasis on the subjectivity and lack of objectivity. So practically, IC is the process where the physician provides sufficient information in order for him to make an informed decision.[28] But what is the information that is considered enough and will achieve the following goals: Respect patient autonomy, Not violating patient rights, Avoid harm to patient, Not paralyze the health system and Protect physician from litigations. Thus, to achieve these goals a model has to be developed and the information given to the patient has to be tailored. Also, implementing technology is also suggested to achieve the ethical goals of IC.[29-32]

5. Conclusion

Our findings show subjectivity in interpreting the law in regard to IC. We recommend policy makers to create a model that protect the patient rights and respect his autonomy and, in the other hand, decrease the physician liability.

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References:

1. Shah P, Thornton I, Turrin D, Hipskind JE. Informed Consent. 2020 Aug 22. Stat Pearls. Treasure Island (FL): Stat Pearls Publishing. 2020.
2. Grady C. Enduring and Emerging Challenges of Informed Consent. New England Journal of Medicine. 2015; 372(9): 855–62.
3. Hall D, Prochazka A, Cmaj AF, 2012 undefined. Informed consent for clinical treatment. Can Med Assoc [Internet]. [Cited on 11th July 2021]. Available from: https://www.cmaj.ca/content/184/5/533.short
4. Leclercq WKG, Keulers BJ, Scheltinga MRM, Spauwen PHM, Van Der Wilt GJ. A review of surgical informed consent: Past, present, and future. A quest to help patients make better decisions. World J Surg. 2010; 34(7):1406–15.
5. Joffe S, practice RTT ethics of consent: theory and, 2010 undefined. Consent to medical care: the importance of fiduciary context. books.google.com [Internet]. [Cited on 11th July 2021]. Available from: https://books.google.com/books?hl=en&lr=&id=8279gsRogHgC&oi=fnd&pg=PA347&dq=Joffe+S,+Truog+R.+Consent+to+medical+care:+the+importance+of+fiduciary+context.+In:+Miller+FG,+Wertheimer+A,+eds.+The+ethics+of+consent:+theory+and+practice.+New+York:+Oxford+University+Press,+2010:357-373.&ots=mqGgCY3kxX&sig=dGRemEygy2TMudU3VhA4vO949XE
6. Murray B. Informed consent: What must a physician disclose to a patient? Virtual Mentor. 2012; 14(7):563–6.
7. Psaty BM, Koepsell TD, Wagner EH, Logerfo JP, Inui TS. The Relative Risk of Incident Coronary Heart Disease Associated with Recently Stopping the Use of β-Blockers. J Am Med Assoc. 1990; 263(12):1653–7.
8. Barsky AJ, Saintfort R, Rogers MP, Borus JF. Nonspecific medication side effects and the nocebo phenomenon. J Am Med Assoc. 2002; 287(5):622-7.
9. Davies SJC, Jackson PR, Ramsay LE, Ghahramani P. Drug intolerance due to nonspecific adverse effects related to psychiatric morbidity in hypertensive patients. Arch Intern Med. 2003; 163(5):592–600.
10. Deokar R B, Patil S S, Chavan K D. Current Medical Ethical Issues. Int J Educ Res Health Sci. 2019; 2(3):1-3.
11. Khairkar CB, Consent in Context to medical Practice. J Forensic Med Sci Law.2018; 27(2):15-8.
12. Deokar RB, Patil SS. Bhise SS. Medicolegal Cases in Hospitals. J Forensic Med Sci Law 2018; 27(2):1-2.

13. Ekmekci PE, Güner MD, Toman İN, Karaca G, Karakoyunlu B, Çatal R, et al. Does content of informed consent forms make surgeons vulnerable to lawsuits? Asian J Surg. 2020; 43(3):497–503.
14. Ekmekci PE, Ekmekci AB, Karakaş Ö, Kulduk A, Arda B. Evaluation of the informed consent procedure for total knee arthroplasty patients in Turkey. Acta Orthop Traumatol Turc. 2016; 50(4):400–4.
15. Xu W, Xie J, Wu H, Guo Z, Guo L, Feng X. The Association between Chinese Doctor's Workload and Medical Disputes. J Psychol Psychother. 2016; 6(2): 1-5.
16. Regulations - Regulations List [Internet]. [Cited on 22nd June 2020]. Available from: https://www.moh.gov.sa/en/Ministry/Rules/Pages/default.aspx
17. Health Tips and Guidelines - Patient Rights and Responsibilities Document [Internet]. [Cited on 26th June 2020]. Available from: https://www.moh.gov.sa/en/HealthAwareness/EducationalContent/HealthTips/Pages/001.aspx
18. MOH Announcements - MOH: Saudi Guidelines for Informed Consent Issued [Internet]. [Cited on 26thJune 2020]. Available from: https://www.moh.gov.sa/en/Ministry/MediaCenter/Ads/Pages/Ads-2019-12-09-001.aspx
19. Ziegler DK, Mosier MC, Buenaver M, Okuyemi K. How much information about adverse effects of medication do patients want from physicians? Arch Intern Med. 2001; 161(5):706–13.
20. Silvestri A, Galetta P, Cerquetani E, Marazzi G, Patrizi R, Fini M, et al. Report of erectile dysfunction after therapy with beta-blockers is related to patient knowledge of side effects and is reversed by placebo. Eur Heart J. 2003; 24(21):1928–32.
21. Myers MG, Cairns JA, Singer J. The consent form as a possible cause of side effects. Clin Pharmacol Ther. 1987; 42(3):250–3.
22. Mondaini N, Gontero P, Giubilei G, Lombardi G, Cai T, Gavazzi A, Bartoletti R. Finasteride 5 mg and sexual side effects: how many of these are related to a nocebo phenomenon? J Sex Med 2007; 4(6):1708-12.
23. Kaptchuk TJ, Stason WB, Davis RB, Legedza AR, Schnyer RN, Kerr CE, et al. Sham device v inert pill: randomised controlled trial of two placebo treatments. BMJ. 2006; 332(7538):391-7.
24. Lang EV, Hatsiopoulou O, Koch T, Berbaum K, Lutgendorf S, Kettenmann E et al. Can words hurt? Patient–provider interactions during invasive procedures. Pain. 2005; 114(1-2):303-9.
25. Benedetti F, Lanotte M, Lopiano L, Colloca L. When words are painful: unraveling the mechanisms of the nocebo effect. Neuroscience. 2007; 147(2):260-71.
26. Davies SJ, Jackson PR, Ramsay LE, Ghahramani P. Drug intolerance due to nonspecific adverse effects related to psychiatric morbidity in hypertensive patients. Arch Intern Med. 2003; 163(5):592-600.
27. Johnson JA, Bootman JL. Drug-Related Morbidity and Mortality: A Cost-of-Illness Model. Arch Intern Med. 1995; 155(18):1949–56.
28. Simpson JK, Innes S. Informed consent, duty of disclosure and chiropractic: where are we? Chiropr Man Therap. 2020; 28(1):1-2.
29. Deokar RB, Patil SS. Artificial Intelligence in Healthcare and Biomedical Research - Ethical aspects. J Forensic Med Sci Law. 2024;33(1):1-4.
30. Amrita A, Deokar RB. Clinical Forensic Psychology: It's Emergence, Significance and Application in India. J Forensic Med Sci Law 2022;31(2):80-83.
31. Patil SS, Deokar RB, Dere RC. Euthanasia and Living Will-Right to Die with Dignity: A Literature Review. J Forensic Med Sci Law 2023;32(2):75-79.
32. Schenker Y, Meisel A. Informed consent in clinical care: practical considerations in the effort to achieve ethical goals. JAMA. 2011; 305(11):1130-1.

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Review Article

The Role of Firearms, Ballistics and Impression Evidences in Criminal Investigation

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Abstract

Background: Firearms, ballistics, and impression evidence play crucial roles in criminal investigations, aiding law enforcement in identifying suspects, reconstructing events, and establishing connections between the crime scene, weapons, and individuals involved. **Methods:** This article reviews current literature and case studies on the applications of firearms, ballistics, and impression evidence in forensic investigations. By examining existing methodologies, forensic standards, and case examples, the article analyses the effectiveness of these types of evidence in identifying suspects, reconstructing crime scenes, and presenting findings in court. **Discussion:** The use of firearms, ballistics, and impression evidence has proven invaluable in criminal investigations. Firearms analysis reveals details such as the calibre and model of the weapon used, while ballistics testing allows for trajectory analysis and, in some cases, shooter positioning. **Conclusion:** Firearms, ballistics, and impression evidence are essential forensic tools that aid in the accurate identification of weapons and suspects in criminal cases. These forms of evidence provide reliable information that can corroborate witness statements, reconstruct crime scenes, and establish links between suspects and the crime.

1. Introduction

Firearms, ballistics, and impression evidence play crucial roles in forensic investigations, aiding in the identification of suspects and the reconstruction of crime scenes. Firearms and ballistics evidences are concerned with the examination and analysis of firearms, ammunition, and the effects of projectiles.

Those evidences help the law enforcement agencies to solve the crime by following the procedures and mechanisms of forensic science. This study provides an overview of Firearms, ballistics, and impression evidence and their significance in criminal investigations.[1]

2. Overview of Firearms

In the study of firearms, experts examine the mechanical workings and characteristics of firearms, such as pistols, rifles, and shotguns. Firearms examiners use various techniques, including comparison microscopy and computerized databases, to analyse these marks.

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The projectile is propelled by explosive force in firearms. Firearms come in various types and have been used for different purposes like hunting, self-defence, and military purposes. Firearms consist of several essential components, it includes a long, cylindrical tube called a barrel is used to fire projectiles.[2]

Firearms can be broadly categorized into three main types. The first one is the Handguns, which include pistols and revolvers, are made to be used with just one hand. Pistols are Semiautomatic handguns that use a self-loading mechanism to chamber a round after each shot. The Revolvers are handguns with a rotating cylinder that holds multiple rounds, each fired through a separate chamber. The second type of fire arms includes Rifles which is a long-barrelled firearms with spiral grooves inside the barrel (rifling) to impart spin to the bullet for accuracy. The rifles include Bolt-Action Rifles, Semi-automatic Rifles and Assault Rifles.

3. Importance of Firearm Forensic Identification

In criminal investigations and judicial actions, forensic identification of guns is vital. To ascertain their role in a crime, it entails analysing and contrasting firearms, ammunition, and relevant evidence. This process relies on various scientific techniques and principles to establish links between a firearm, a fired projectile, and a suspect. The next step in firearm identification involves the examination of the ammunition. Forensic experts examine the recovered fired cartridges for unique characteristics, including the calibre, head stamp, and firing pin impression.[3] The analysis of gunshot residue (GSR) is a key component of firearm identification. When a gun is fired, GSR is released into the air, leaving residue on the shooter's hands, clothing, and surroundings. Forensic scientists collect samples from the suspect's hands, clothing, and the crime scene to analyse the presence of GSR. The study entails recognising recognisable particles that are frequently present in GSR, such as lead, barium, and antimony.[4]

Thus, forensic identification of firearms is a vital component of criminal investigations. In order to prove a connection between a firearm and a crime, forensic professionals must examine and contrast weapons, ammunition, and other relevant evidence. This process involves various techniques, including the examination of firearms and ammunition, the use of comparison microscopes, the analysis of gunshot residue, digital forensics, and the examination of gunshot wounds. Forensic experts carefully handle and package firearms, ammunition, and related items to prevent contamination or damage.[5]

4. Role of Gunshot Residues (GSR) in Criminal Investigations

Gunshot Residues (GSR) refer to the microscopic particles that are deposited on surfaces when a firearm is discharged. These residues can be useful forensic evidence in criminal investigations, allowing investigators to establish whether a firearm was discharged, how close it was to a certain surface, and perhaps even establish a relationship between a suspect and a crime scene. We shall examine the components of GSR, its techniques of detection, and its importance in forensic science in this article. Gunshot residues consist of three main components: lead, barium, and antimony.[6]

GSR analysis is not limited to surfaces. It can also be conducted on clothing, the shooter's hands, and other relevant items. Techniques like swabbing or tape-lifting are frequently utilised to gather samples from these surfaces. The collected samples are then processed and analysed using the aforementioned techniques to detect and identify GSR particles. It's crucial to be aware of the limitations of GSR analysis even though it can be a useful tool in forensic investigations.

To overcome these limitations, forensic scientists rely on a combination of GSR analysis, other physical evidence, and witness statements to build a comprehensive case. The context and circumstances surrounding a crime scene play a crucial role in interpreting GSR findings. For example, the absence of GSR on a suspect's hands does not necessarily rule out their involvement in a shooting if they were wearing gloves. In recent years, advancements in GSR analysis techniques have led to improved sensitivity and accuracy.[7] GSR analysis is not limited to crime scenes involving firearms. In circumstances of self-defence or unintentional discharges, it may also be used. Differentiating between intentional shootings and accidental discharges can be crucial in determining the nature and severity of the crime committed. In addition to its application in criminal investigations, GSR analysis has been used in research and experimental settings. It helps evaluate the performance and safety of ammunition and firearms, contributing to the improvement of ballistics and forensic firearm examination techniques. It is important to note that the interpretation of GSR analysis requires expert knowledge and careful consideration of various factors.

5. Forensic Firearms and Ballistics Evidences in a Crime

Forensic firearms and ballistics are a branch of forensic science that involves the examination and analysis of firearms, ammunition, and the effects of projectiles. It plays a crucial role in criminal investigations by providing valuable information about the firearms used in crimes, the trajectory of bullets, and the manner in which injuries were inflicted. Firearms examination is the first step in forensic firearms and ballistics. It involves the identification and classification of firearms based on their characteristics, such as type (pistol, revolver, rifle, shotgun), make, model, and calibre. Sun Shot Residues can be assessed through forensic science. When a firearm is discharged, it releases tiny particles of unburned propellant and other substances onto the shooter's hands and clothing. GSR particles can be collected for the examination of firearm explosion. GSR analysis involves techniques like scanning electron microscopy and atomic absorption spectroscopy.[8]

Ballistics analysis focuses on the study of projectiles, their trajectories, and the effects of their impact. By examining bullet trajectories, experts can determine the angles at which shots were fired and the sequence of shots. This information is crucial for reconstructing crime scenes and establishing the positions of victims, suspects, and witnesses. Forensic ballistics also involves analysing the effects of bullets on their targets. This analysis includes the examination of entrance and exit wounds, as well as the distribution of gunshot residue around the entry area.[9] By studying these effects, forensic experts can infer the range from which a firearm was discharged and the angle at which the bullet struck the target. Furthermore, the study of gunshot wounds helps forensic experts determine the manner in which injuries were inflicted.[10]

Forensic firearms and ballistics analysis are a multidisciplinary field that requires the collaboration of various experts, including forensic scientists, firearms examiners, pathologists, and crime scene investigators. Their combined efforts help unravel the mysteries surrounding firearm-related incidents and provide crucial evidence for legal proceedings. One of the important tasks in forensic firearms and ballistics analysis is the reconstruction of shooting incidents.

Bullet trajectory analysis is another crucial aspect of forensic firearms and ballistics. By examining the entry and exit wounds, as well as the paths taken by bullets through the body or other objects, experts can determine the direction and angle from which the shots were fired.[11] This information can help corroborate or refute the accounts provided by witnesses or suspects and provide critical insights into the dynamics of a shooting incident. In addition to the physical aspects, forensic firearms and ballistics analysis also involves the examination of gunshot residue (GSR) and firearm-related injuries. GSR analysis entails taking samples from people who are thought to have fired a gun from their hands, clothing, and other surfaces. This analysis can provide valuable information about an individual's recent involvement in a shooting.

The examination of firearm-related injuries, both fatal and non-fatal, is an essential aspect of forensic ballistics. Pathologists and forensic medical examiners study the nature and characteristics of gunshot wounds to determine the type of firearm used, the range from which the shot was fired, and the potential angles of entry. They assess the severity of injuries, the potential pathways of bullets through the body, and the presence of any defensive wounds.[12] This information contributes to the overall understanding of the shooting incident and can assist in determining the cause and manner of death.

To enhance the efficiency and accuracy of forensic firearms and ballistics analysis, technology plays a significant role. Digital photographs of ballistic evidence gathered from crime scenes and recovered weapons are kept in computerised databases like the National Integrated Ballistics Information Network (NIBIN). These databases enable the rapid comparison and identification of ballistic evidence across different cases and jurisdictions, aiding in the detection of patterns, links between crimes, and potential associations with known offenders. Therefore, we can say, forensic firearms and ballistics analysis is a crucial field within forensic science. By examining firearms, ammunition, and the effects of projectiles, experts can provide valuable information for criminal investigations and legal proceedings.

6. Impression Evidence

Impression evidence refers to any type of evidence that is created when two objects come into contact with each other, resulting in the transfer of physical characteristics from one object to another. For example, a fingerprint left at a crime scene can be used to identify a suspect or eliminate innocent individuals from suspicion. Shoeprints or tire tracks can help establish the route taken by a suspect,

provide information about their size, and even indicate their gait or manner of walking. In hit-and-run cases, vehicle tire tracks can help identify the type of vehicle involved. The collection of impression evidence requires careful techniques to ensure the preservation and accuracy of the evidence.

For two-dimensional impressions, methods such as photography, lifting, or casting are commonly employed. Photography involves capturing detailed images of the impression using specialized equipment, such as macro lenses or alternative light sources to enhance the visibility of the impression. Lifting involves using adhesive materials, such as tape or gel-lifters, to transfer the impression onto a suitable backing material for further analysis.[13] Three-dimensional impressions are typically collected through a process called impression casting. This involves carefully excavating the impression from the surrounding material to preserve its shape and detail. The impression is then filled with a casting material, which solidifies and creates a replica that can be further analysed.

Forensic Impression Evidence

Forensic impression evidence is essential and important to criminal investigations, when it comes to identifying and connecting suspects to crimes. This sort of evidence entails the study and comparison of diverse imprints, such as footprints, tyre tracks, tool marks, bite marks and fingerprints, left at a crime scene or on objects. These impressions can link suspects to a crime, corroborate witness statements, and help establish timelines. Moreover, impression evidence can be presented in court to support the prosecution's case, providing a scientific basis for identifying suspects and establishing their involvement in criminal activities.[14]

Techniques for Analysing Impression Evidence*:*

Footwear Impressions: Footwear impressions left at crime scenes can be analysed using various techniques, such as casting, photography, and computerized image enhancement. Investigators can compare these impressions with known shoe patterns to determine if they match.

Tyre Impressions: Similar to footwear impressions, tyre tracks left at a crime scene can be analysed by comparing them to known tire patterns. Tire impressions can reveal information about the type of vehicle, tire size, and unique tread characteristics, which can assist in identifying suspects and vehicles involved in a crime.

Tool Marks: Tool marks left on objects, such as doors, windows, or safes, can provide valuable evidence about the tools used in a crime. Forensic experts can examine these marks under magnification and compare them with known tools or tool marks databases to determine if they were made by a specific tool.

Bite Marks: Bite marks can be seen on people's bodies or on items. Forensic odontologists analyse bite marks using dental records, comparing tooth patterns, and identifying unique features that can link the bite mark to a specific individual.

Fingerprints: Through the process of fingerprint identification, fingerprints are one of the most popular sorts of impression evidence. By comparing ridge patterns and minutiae points, forensic experts can determine if a fingerprint found at a crime scene matches those of a suspect.

In spite of its importance, forensic impression evidence faces certain difficulties and restrictions. The accuracy of the analysis and comparison can be impacted by the impression quality, such as fragmentary or distorted marks. Weather and other environmental factors can weaken impression evidence and make it more challenging to analyse. Furthermore, the uniqueness and individuality of impression evidence can vary. Therefore, it is important to consider the probative value and the weight that impression evidence carries in each case. Forensic impression evidence is a valuable tool in criminal investigations, providing investigators with crucial information to identify suspects, establish connections, and reconstruct events. Footwear impressions, tire tracks, tool marks, bite marks, and fingerprints, all contribute to building a comprehensive case.[15,16]

7. Various legal framework in India and related things:

1. Firearms Regulations and Provisions: Firearm Control Laws: Firearms are regulated under various national laws, such as the Gun Control Act (U.S.), which governs the possession, sale, and transfer of firearms. In some jurisdictions, carrying and using firearms must comply with licensing requirements. Criminal Use of Firearms: Statutory provisions criminalize unlawful possession, discharge, or trafficking of firearms. Statutes related to armed offenses, such as murder or armed robbery, often carry enhanced penalties. Forensic Use of Firearms Evidence: Firearms evidence, like spent cartridges, bullets, and gunshot residue, is often collected under

provisions that guide forensic analysis. Legal statutes such as the Federal Rules of Evidence (FRE) in the U.S. govern how firearms evidence is admitted during trials.

2. Ballistics Evidence: Statutory Framework: Ballistics Forensics: Ballistics evidence, which involves the study of projectiles (bullets) and their movement, is critical in linking firearms to crimes. Forensic experts analyse bullet trajectory, markings on projectiles, and gunpowder residue. Legal Admissibility of Ballistic Evidence: Jurisdictions have specific statutory guidelines under which ballistic evidence is presented in court. In the U.S., the Daubert Standard helps determine if forensic ballistics testimony is scientifically valid and relevant to the case. Chain of Custody Requirements: Legal statutes typically require law enforcement to maintain a clear chain of custody for ballistic evidence to ensure its integrity from the crime scene to the courtroom.

3. Impression Evidence: Footprints, Tire Marks, and Tool Marks: Types of Impression Evidence: Footprints, tire marks, and tool marks fall under impression evidence, which is governed by rules on collection, analysis, and presentation in legal proceedings.[17] Statutory Standards for Forensic Analysis: Statutes often reference forensic standards, like those from the International Association for Identification (IAI) or other accrediting bodies, to ensure that impression evidence is properly handled and interpreted. Admissibility in Court: Similar to ballistics, legal standards such as the Frye Test or Daubert Standard govern how impression evidence is presented in court. This ensures that the forensic techniques used meet scientific and legal scrutiny.

4. Criminal Procedure: Search and Seizure of Firearm and Impression Evidence: Fourth Amendment Considerations (U.S.): Legal statutes protect individuals from unlawful searches and seizures, meaning law enforcement must often obtain a warrant before seizing firearms, ballistic, or impression evidence from a crime scene. Exclusionary Rule: Evidence collected in violation of statutory provisions related to search and seizure may be excluded from trial under the exclusionary rule, which protects against unlawful gathering of evidence.

5. Expert Testimony and Evidence Presentation: Forensic Experts: Statutory provisions regulate the qualification of forensic experts who present firearms, ballistic, and impression evidence in court. These experts must meet specific legal and scientific criteria to testify.[18]

6. The Bharatiya Sakshya Adhiniyam, 2023: This law governs the admissibility of evidence in courts. In the context of firearms, ballistics, and impression evidence, Sections 45 and 46 are particularly relevant as they allow the testimony of experts in specialized fields (such as ballistics experts) to be admissible in court.

7. Arms Act, 1959: The Arms Act regulates the acquisition, possession, and use of firearms in India. It is essential in criminal investigations involving firearms as it determines whether the use or possession of a firearm is legal. The Act also provides a framework for tracking illegal firearms, which can serve as evidence in crimes involving shooting incidents or illegal weapons possession.

8. The Bharatiya Nagarik Suraksha Sanhita, 2023: The BNSS outlines the process of investigation, including the collection and preservation of evidence. Sections dealing with searches, seizures, and arrests are critical when dealing with firearms and ballistics. Investigating officers have the authority to seize firearms and other relevant evidence, including ballistic materials, for forensic analysis, which forms a part of the criminal investigation process.

Forensic Science Laboratories (FSLs): While not directly under statutory law, forensic science laboratories play a significant role in the examination of ballistic and impression evidence. Ballistics experts in FSLs conduct tests to identify the type of firearm used, match bullets to guns, and analyses gunshot residue, all of which are critical in solving cases involving firearms. There are many advancement and innovations with inclusion of Artificial intelligence in Forensic Medicine and evidence collection techniques.[19,20]

Impression Evidence: Impression evidence such as fingerprints, tool marks, and shoe prints is crucial in criminal investigations.[21] The Indian Evidence Act allows for the admissibility of such evidence, while modern forensic techniques enhance the accuracy of identifying suspects through impression marks left at crime scenes.

8. Conclusion

Firearms, ballistics, and impression evidence play crucial roles in forensic investigations, aiding in the identification of suspects and the reconstruction of crime scenes. Firearms and ballistics are concerned with the examination and analysis of firearms, ammunition, and the effects of projectiles.

Thus, firearms, ballistics, and impression evidence are critical forensic disciplines used in criminal investigations. The analysis of firearms and ammunition can provide valuable information about the weapon used, while the examination of bullet and cartridge casing markings can help establish connections between firearms and crime scenes. Impression evidence, such as shoeprints, tire tracks, and tool marks, can assist in identifying suspects and reconstructing the events of a crime.

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References:

1. Kennedy B, Lillie R, James S. The use of 3D surface scanning in firearms identification. Forensic Sci Int. 2018; 282:139-47.
2. Brodbeck M, Weller R, Broséus J, Weyermann C. Developing a decision support system for firearm forensics—the combination of different marks and image analysis. J Forensic Sci. 2021;66(3):829-36.
3. Petraco N, Ricci J, Chumbley L, Moore A, Pan J, Hockensmith R, et al. Impression evidence: Digital scanning, virtual comparison microscopy, and computed tomography of tool marks on bone. Forensic Sci Int. 2019; 298:168-77.
4. Safford H, Lee Y, Word J, Stoney D. The potential of 3D laser scanning for firearm examination: A pilot study. J Forensic Sci. 2018;63(2):529-35
5. De Kinder J, Van de Voorde W, Bekaert K. From the crime scene to the courtroom: a review on the contemporary use of firearms examination methodologies. Forensic Sci Int. 2019; 297:156-70.
6. Hatcher JS, Jury FJ, Weller J. *Firearms Investigation, Identification and Evidence.* Stackpole Books; 1977.
7. Heard BJ. Handbook of firearms and ballistics: examining and interpreting forensic evidence. 2nd ed. Chichester: Wiley-Blackwell; 2013.
8. Peterson JL, Midkiff L. Forensic firearm examination and identification. Springfield (IL): Charles C. Thomas Publisher; 1999.
9. Di Maio VJM. Gunshot wounds: practical aspects of firearms, ballistics, and forensic techniques. Boca Raton (FL): CRC Press; 1999.
10. Biasotti AA. A statistical study of the individual characteristics of fired bullets. J Forensic Sci. 1959;4(1):34–50.
11. Brundage DJ. The identification of bullets and cartridge cases. Forensic Sci Rev. 2000;12(2):74-9.
12. Uchiyama T, Takahashi S, Watanabe K, et al. Characteristics of firearm and toolmark examinations in forensic science. Forensic Sci Int. 2012;216(1-3):5–10.
13. National Forensic Science Technology Center. Firearms and Toolmark Identification. [cited on 25th September 2024]. Available from: https://www.nfstc.org
14. FBI Laboratory Services: Firearms/Toolmarks Unit. [cited on 25th September 2024]. Available from: https://www.fbi.gov
15. Prakash A, Thangaraj K, Sanjeev K, Singh OG. A Suicide Claimed as a Homicide - Role of Medical Evidence to Untie. J Forensic Med Sci Law. 2023; 32(1):106-9.
16. Garg P, Mustaria PS, Kumar N, Bansal MK, Yadav M. Analysis of Primary Fingerprint Patterns in Medical Students of Banda District Uttar Pradesh. J Forensic Med Sci Law 2022; 31(1):28-32.
17. Kattamreddy AR, Ganja CD, Khan MT. A Strong Need for Digitalization in Medico-Legal Practice in India. J Forensic Med Sci Law. 2021;30(1):69-71.
18. Gupta S, Parekh U. Evaluation of perceptions of Postgraduate Medical Residents about effectiveness of workshop on Medical Certificate of Cause of Death. J Forensic Med Sci Law 2022;31(1):3-7.
19. Deokar RB, Patil SS. Avenues in Forensic Medicine. J Forensic Med Sci Law 2023;32(2):1-3.
20. Deokar RB, Patil SS. Artificial Intelligence in Healthcare and Biomedical Research - Ethical aspects. J Forensic Med Sci Law. 2024;33(1):1-4.
21. Das A, Biswas S. Forensic Journalism and Its Socio-ethical Aspects. J Forensic Med Sci Law 2020;29(2):39-42.

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Review Article

Environmental Toxicology- Introduction & Legislation

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Abstract

Environmental toxicology is a field of study that determines the harmful impacts of chemical, biological, and physical substances on living beings. This paper traces the evolution and significance of environmental toxicology, mainly driven by global and uniquely Indian concerns. This paper traces critical events in its evolution: **The Green Revolution**, the Bhopal Gas Tragedy, and the use of Agent Orange in the Vietnam War, which help us understand the environmental impacts. The paper also considers how industrial and agricultural growth contributed to several global environmental changes, including concerns mandated by Climate Change, Air and Water pollution, and Ozone Depletion. An analysis of the impact of environmental toxicity from heavy metals, pesticides, and industrial chemicals on human health and ecosystems is discussed. **Legal frameworks** such as the Water Act, the Air Act, the Environment Protection Act, and the National Green Tribunal Act work in an interdisciplinary fashion to prevent pollution. The paper discusses the involvement of **forensic personnel** in examining environmental disasters and highlights the importance of environmental toxicology in safeguarding the health of organisms and the environment.

1. Introduction

In Environmental toxicology is a multidisciplinary field of science concerned with the study of the adverse impacts of various chemical, biological, and physical agents on living organisms. Environmental toxicology has expanded its scope in the last twenty years. Toxins from pollutants, herbicides, insecticides, and fertilizers may impact every living creature. Toxicity levels might differ based on where an organism is positioned in its food chain. Bioaccumulation is the process in which an organism accumulates toxins in its adipose tissue. This may result in a trophic cascade, where some toxins undergo bio magnification. Biodegradation produces carbon dioxide and water as by-products that are released into the environment. Environmental toxicology focuses on investigating the impact of toxins, whether intentionally introduced (such as pesticides) or resulting from human mistake or negligence in industrial activities, on both health and the environment.[1] Toxicants are substances that are eliminated into the environment that may harm the health of living species, such as people, animals, and plants.

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Environmental toxicology developed not just to understanding that the survival of humans depends on other species and on an environment with clean air, water, and food, but also because both anthropogenic and naturally occurring chemicals can cause deleterious effects on living organisms and ecological processes. Environmental toxicology is very important in understanding the impacts of pollutants on the structure and function of ecological systems.[2]

2. Environmental toxicology in the international and Indian context

Development of industries in the later part of the 18th century, which continued up to the first half of the 20th century, converted western agricultural societies into industrialized societies. After the end of World War II (1939-45), chemical industries evolved speedily. Synthesis of chemical fertilizers, pesticides, and herbicides in 1960s transformed the global agricultural sector. This development came to be known as the 'GREEN REVOLUTION'. In India, also during mid-20th century the development of chemical fertilizers and new high-yield strains of cereals, has increased the production of food grains. A number of food-deficient nations, including India were producing enough quantities of grain food to satisfy their requirements.

The general decline in air and water quality is symptomatic of the adverse effects of such progress. This development has led to increase in diseases due to environmental pollutants, particularly in human-beings due to food products they consume. Some industrial agents released into the general environment or in the work-place are known or suspected to be carcinogenic. A physician, Percival Pott of London, made the first note of occupational (industrial) cancer in 1775. He observed an unusually high incidence of scrotal cancer among the chimney-sweeps of London and associated (rightly) this with soot. The rise in deaths due to urban smog and danger due to toxic substances like sulphur dioxide and nitrogen oxides alarmed the world.[1]

Rachel Louise Carson (May 27, 1907 – April 14, 1964) was the American marine scientist and environmentalist who made environmental toxicology a distinct field in 1962 through her book SILENT SPRING. Its publication led to a reversal in national pesticide policy and then nationwide ban on DDT and other pesticides. It was the beginning of a grass root environmental movement, including the creation of the U.S. Environmental Protection Agency.[2,3,4] In May 1985, a team of British researchers discovered a hole in the earth's protective ozone layer. So, the increased ultraviolet radiation reaching the earth's surface may lead to an increase in skin cancer, slow the growth of crops, and may disrupt the food chain of marine species. The gradual addition of carbon dioxide due to the combustion of fossil fuels leads to greenhouse effect (1986) with its consequences.[3,5,6]

Agent Orange in Vietnam War: From 1962 to 1971, the United States military used about 20,000,000 U.S. gallons of chemical herbicides and defoliants in Vietnam. The Vietnamese Ministry of Foreign Affairs said that 4.8 million Vietnamese were affected with 400,000 fatalities and 500,000 children born with congenital disabilities. Dioxin, 2,4-D, and 2,4,5-T, which are Phenoxy herbicides, were used as a chemical weapon. The objective was to defoliate the forested area and deny food to guerrillas. The initiative was also a part of a strategy of forced urbanization, The report given by Vietnam Red Cross mentions 3 million Vietnamese were affected by Agent Orange and 150,000 children had birth abnormalities. The primary harmful impact is hepatocellular carcinoma.[3]

Greatest acute chemical disaster- Bhopal Gas Tragedy, 1984: The Bhopal Gas Tragedy is the most infamous example of environmental toxicity in India. The incident occurred on December 2, 1984, when forty tons of the extremely hazardous chemical methyl isocyanate (MIC) spilled from a pesticide plant. The gas spread into the densely populated neighboring areas, resulting in the deaths of at least 4000 people and injuries to over 150,000. The lung was the primary organ affected by MIC.[3,7]

3. Environmental changes due to industrial & agricultural growth

1. Global climatic changes
2. Increased air and water pollution
3. Acid rain
4. Mounting amounts of solid waste
5. Destruction of the ozone layer by chlorofluorocarbons (CFCs)
6. Presence of a rising number of endocrine disrupters in the environment

4. Sources of environmental toxicity

Various sources of environmental toxicity may introduce hazardous substances into our food, water, and air:

1. Organic and inorganic pollutants
2. Pesticides & Biological agents

3. Specific sources of contamination such as drainage from a particular plant.
4. Non-point sources, such as rubber from automobile tyres, include various chemicals and heavy metals.

5. Effects of pollutants

Heavy metals such as mercury, arsenic, gold, cadmium, lead, and silver have a tendency to accumulate in the kidneys, rendering this organ very susceptible to their effects. They have the power to modify genetic composition, affect the human neurological system, and induce memory loss, mental confusion, irritation, allergies, high blood pressure, exhaustion, skin rash, and immune system malfunction.[8]

Lead (Pb)- is not essential for the human body's dietary needs. Lead contamination mostly impacts metropolitan areas but may also extend to agricultural land, lakes, and rivers, potentially contaminating animal food sources. Pica is a contributing factor to lead poisoning. Airborne lead poisoning may result from factories and automotive exhaust. However, the use of unleaded gasoline and better industrial emission control has decreased lead emissions. The Centre for Disease Control and Prevention (CDC) states that lead poisoning is the most prevalent and severe environmental illness that impacts young children. Lead has several hazardous consequences such as hindering the development of RBCs, kidney damage, and harming neurological system.[1,2,3,9]

Cadmium (Cd) - toxicity may result from contamination of the air, water, or soil. An outbreak of a chronic ailment known as "itai-itai-byo" or "ouch-ouch disease" occurred around the Jintsu river. The individual had intense bone pain and finally the weakened bones disintegrated even under little strain, resulting in fractures. The mine's wastewater, together with cadmium-laden vapors, contaminated the grown rice and drinking water when utilized for irrigating the rice crop by the inhabitants. Cadmium poisoning produces renal tubular damage, lung cancer, and hepatotoxicity.[3]

Mercury (Hg)- is a common water contaminant. The metal accumulates in living organisms and may dissolve in fats. Mercury from the atmosphere is deposited on land by rainfall and then transported into lakes, ponds, and rivers. Mercury poisoning in humans causes severe neurological abnormalities, including numbness, unsteady walking, slurred speech, tunnel vision, hearing loss, convulsions, lunacy, and death. Divalent mercury inorganic salts are very harmful to the gastrointestinal system. Under anaerobic circumstances, it is transformed into very poisonous methyl- and dimethyl mercury by methylation by bacteria. These chemicals easily pass through biological membranes and accumulate in fish/shellfish. An epidemic of mercury poisoning (methylmercury)- "Minamata disease" occurred in Japan. Infants with severe neurological disease were born to women who these contaminated salmon.[1,3,10]

Dichlorodiphenyltrichloroethane (DDT) -is an organochlorine pesticide that was extensively used by farmers to eliminate agricultural pests. Its metabolite, DDE (dichlorodiphenyldichloroethylene), was also often employed. Bio magnification impacts bird species by causing the accumulation of DDT and DDE in their tissues, leading to egg-shell thinning and decline in bird population. DDT accumulates in soil as it does not readily break down. Water systems become contaminated, leading to the accumulation of DDT in the tissues of marine organisms like fish and shellfish. Animals that eat fish also ingest the chemical, showing bio magnification in the food chain. DDT adversely affects the liver, nervous system, and reproductive system in humans and may also result in preterm births. In 1972, the US Environmental Protection Agency (EPA) prohibited the use of DDT. Public concern is about the health risk posed by pesticide residues, which are probable carcinogens, found on fruits and vegetables.

Polychlorinated biphenyls (PCBs) - are organic pollutants (not insecticide) that are still found in the environment even though they were prohibited by the ministry in 1986 under the Environment (Protection) Act. These are chlorinated hydrocarbons present in water contaminated by factory effluent. They may lead to skin irritation, neurological issues, pregnancy loss, and congenital abnormalities. Several aquatic species, such as wild salmon (Salmo salar) in the Baltic Sea, have elevated amounts of this molecule. Due to their chemical stability and non-flammability, they are widely used in several commercial and industrial practices.[3]

PFAS chemicals- also known as per and poly-fluoroalkyl (chemicals forever) compounds, are a category of almost 15000 chemicals. The first PFAS compound, polytetrafluoroethylene (PTFE), known as Teflon, exhibited resistance to water, oil, and high temperatures. They are used in many household items like nail paint, cosmetics, shampoos, soaps, toothpastes, menstruation products, garments,

contact lenses, and toilet paper.[1,3] PFAS can cause changes in kidney and thyroid function, ulcerative colitis, weakened immune system, low birth weight, fertility problems, and various malignancies (kidney, testicular, and liver).[11,12,13]

CFCs (Chlorofluorocarbon) - might lead to stratospheric ozone depletion. In the 1930s, they were developed and widely used in many industrial applications such as propellants for aerosols, plastic-foam blowing agents, refrigeration and air conditioning fluids, cleaning fluids for electronic equipment, fire extinguisher fluids. They have the benefit of being chemically stable, non-flammable, and nontoxic. Now a days R-22 (Freon) and R410A (Puron) are used.

Rubber and Asbestos- Tyre wear is nearly 360 mg/km per vehicle, pollutants, mostly concentrated on the highway and its surroundings. Rubber particles from tyres add to air and water pollution. Tyres are mostly made of natural latex. Natural latex proteins are recognized as antigens that may trigger hypersensitivity reactions.[1]

Indoor Air Pollution- Sick building syndrome is a condition that may lead to many ailments including headaches, depression, exhaustion, irritability, allergy-like symptoms, heart disease, and cancer due to exposure to several chemicals like xylenes and decane. They are found in some new buildings at levels 100 times greater than in the outside air. As buildings become older, their density significantly declines.[1]

Nitrates- Due to their high water solubility, they leach readily from the soil, leading to contamination of surface, groundwater, and enter food chain. Nitrites, when consumed by water, may lead to methemoglobinemia and hypertension in children. Nitrites reacting with some pesticides may produce nitrosamines (carcinogenic and mutagenic).[14] Nitrogen dioxides can play a role in acid deposition by forming nitric and nitrous acids.

Sulfur dioxide - produced by the burning of coal and petroleum products, petroleum refining. It undergoes conversion in the atmosphere to sulfuric acid. Sulfuric acid is transported by wind and deposited on the earth's surface via precipitation, known as acid rain.[1, 2]

VOC (Volatile organic compounds)- are petroleum hydrocarbons- aliphatic and aromatic. They can cause irritation, inflammation, nausea, vomiting, narcosis in CNS, pulmonary edema, asphyxia. Benzene is known carcinogenic.

5. Legal framework

The Water (Prevention and Control of Pollution) Act, 1974- It aims to prevent and regulate water pollution and preserve the purity of water in different water sources. CPCB and SPSB are regulatory entities established by this act. They are authorized to set and enforce effluent regulations for industries that release pollutants into water bodies. It regulates the release of sewage and industrial effluent by accepting, denying, and issuing discharge permits.

The Air (prevention and control of pollution) act, 1981- It aims to prevent, regulate, and reduce air pollution. It also mandates the creation of boards at national and state levels to enforce the act. Air pollution sources including internal combustion engines, industries, cars, power plants, etc., are prohibited from emitting particulate matter, lead, carbon monoxide, sulfur dioxide, nitrogen oxide, volatile organic compounds (VOCs) or other harmful pollutants above set limits.

The Environment (Protection) Act, 1986- The umbrella legislation to enforce the resolutions made at the United Nations Conference on Human Environment at Stockholm in June 1972. They pertain to safeguarding the human environment and preventing risks to humans, living beings, plants, and property. Additionally, ensure coordination of actions in accordance with other environmental legislation such as the Water Act and the Air Act.

The National Green Tribunal Act, 2010- It aims to provide legal and regulatory assistance to those affected by toxins and environmental harm. It aligns with Article 21 of the Constitution, which provides everyone with the right to a healthy environment. The National Green Tribunal (NGT) adjudicates civil matters pertaining to environmental issues governed by seven specific legislations. The Central Pollution Control Board, a division of the Ministry of Environment and Forests, has released guidelines for setting up and accrediting environmental labs in accordance with the Environment (Protection) Act of 1986.[15]

Amendments: There is need of constant policy change and amendments in laws related to poisons.[16-18]

6. International covenants

In USA to protect the environment, the National Environmental Policy Act (NEPA) was written. The main point that NEPA brings to light is that it "assures that all branches of government give proper consideration to the environment prior to

undertaking any major federal actions that significantly affect the environment." This law was passed in 1970 and also founded the Council on Environmental Quality (CEQ). The importance of CEQ was that it helped further push policy areas. CEQ created environmental programs including the Federal Water Pollution Control Act, Toxic Substance Control Act, Resources Conservation and Recovery Act (RCRA and the Safe). CEQ was essential in creating the foundation for most of the "current environmental legislation except for Superfund and asbestos control legislation."[19] Throughout most of the last century, international environmental law primarily reflected bilateral or regional disputes over shared resources, such as rivers or lakes that cut across national boundaries. In addition to the peaceful resolution of environmental conflicts, international environmental law also is relied on to balance the planet's ecological limits with the world's ever-growing economy to prevent irreversible environmental harm in the first place.

The United Nations first convened countries to address the global environment at the 1972 UN Conference on the Human Environment in Stockholm. The Stockholm conference highlighted the international aspects of emerging environmental challenges and legitimized the environment as an area for international cooperation. The Stockholm conference also created the United Nations Environment Programme (UNEP). Since the 1972 Stockholm Conference, the world has met regularly in a series of major summits aimed at shifting the world generally toward a path of sustainability. The most important by far has been the 1992 UN Conference on Environment and Development (UNCED), also known as the Rio "Earth Summit.' At both Stockholm in 1972 and at Rio in 1992, the countries adopted a set of basic principles (see, e.g., the Rio Declaration on Environment and Development). Some of these principles are emerging as customary law, helping to resolve environmental disputes and guide negotiations of the various environmental treaties. Beginning in the late 1970s scientists warned that certain widely used chemicals could be depleting the earth's protective stratospheric ozone layer. In response, countries first negotiated the 1985 Vienna Convention for the Protection of the Ozone Layer.

International environmental law has successfully addressed many serious issues. Many harmful chemicals are now controlled, the ozone layer is recovering, and populations of important wildlife species, including whales and sea turtles, are increasing because of international environmental agreements. The strong record of international environmental cooperation from Stockholm to Paris provides hope for the future.[20]

7. Role of forensic personnel

Protection of site, establishment of identity of victims, preservation of viscera and other trace evidence, proper preservation and handling of remains, determine cause of death & time since death, photography and documentation, provide information to press and relatives, counselling the relatives, aid in determining cause of disaster and maintain chain of custody for physical evidence.

8. Conclusion

Environmental Toxicology is the examination of poisons present in the environment and their effects on all living species in the surrounding ecosystem. It is a fast expanding and crucial subject of research that plays a vital role in safeguarding the well-being of all living beings and their surrounding environment.

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References:

1. Zakrzewski SF. Environmental toxicology. Oxford University Press; 2002.
2. Landis W, Sofield R, Yu MH. Introduction to Environmental Toxicology: Molecular Substructures to Ecological Landscapes, 5th edition. CRC Press; 2017. p 491.
3. Yu MH, Tsunoda H. Environmental toxicology: biological and health effects of pollutants. 2nd edition. Boca Raton: CRC Press; 2004. p 368.
4. Reddy KN, Murty OP. The Essentials of Forensic Medicine & Toxicology. 35th edition. New Delhi: Jaypee Brothers Medical Publishers; 2022. p 550.
5. Pillay VV. Textbook of Forensic Medicine & Toxicology. 20th edition. Hyderabad: Paras Medical Publisher; 2023. p 640.
6. Bhoi SB, Meshram SK, Waghmare SA, Kamle RA, Rathod VV. Epidemiological Study of Poisoning During Autopsy in Solapur Region. J Forensic Med Sci Law. 2023; 32(2):34-8.
7. Sriramachari S. "Health Effects of the Toxic Gas Leak from Union Carbide Methyl Isocyanate Plant in Bhopal Technical Report on Pathology and Toxicology (1984–1992). New Delhi: Indian Council of Medical Research. 2010.
8. Mishra K, Maharik SS, Mishra M. Evolution of Arsenic as a Toxic and Therapeutic agent through ages- A

Scientometric Study. J Forensic Med Sci Law. 2023; 32(1):85-90.
9. Akter S, Jolly YN, Kabir MJ, Mamun KM. Analysis of Heavy Metals and Other Elements in Soil Samples for its Physicochemical Parameters Using Energy Dispersive X-Ray Fluorescence (EDXRF) Techniques. Austin J Environ Toxico. 2023; 9(1):1- 6.
10. Tchounwou PB, Yedjou CG, Patlolla AK, Sutton DJ. Heavy metal toxicity and the environment. Exp Suppl. 2012; 101:133-64.
11. Demir E, Kacew S. Environmental Toxicology and Human Health. Int J Mol Sci. 2024; 25(1):555.
12. Malm E, Vilhelmsson A, Hogfeldt H, Deshayes I, Källén K, Hansson SR, et al. Maternal Serum Concentrations of Per- and Polyfluoroalkyl Substances in Early Pregnancy and Small for Gestational Age in Southern Sweden. Toxics. 2023;11(9):750.
13. Satpute A, Pandey A. Importance of Polycyclic Aromatic Hydrocarbons as a Chemical Marker in Forensic Studies. J Forensic Med Sci Law. 2023; 32(1):80-84.
14. Seyyedsalehi MS, Mohebbi E, Tourang F, Sasanfar B, Boffetta P, Zendehdel K. Association of dietary nitrate, nitrite, and n-nitroso compounds intake and gastrointestinal cancers: A systematic review and meta-analysis. Toxics. 2023;11(2):190.
15. Laboratory analytical techniques series lats/9/2008-2009 (revised & updated version) guidelines for recognition of environmental laboratories under the environment (protection) act, 1986. central pollution control board (ministry of environment & forests), Delhi, 2008. [Cited on 03rd March 2019]. Available from: https://cpcb.nic.in/upload/List-Recognized-Laboratories/3_recognitionoflabAct-1986.pdf
16. Yadav A, Adarsh K, Thejsavi HT, Jaiswal AK. Parenteral Mercury Poisoning – An Interesting and Rare Case. J Forensic Med Sci Law 2022;31(2):97-100.
17. Deokar RB, Patil SS. Avenues in Forensic Medicine. J Forensic Med Sci Law 2023;32(2):1-3.
18. Sharma N, Sutay S. Cannabis - Dilemma on Law Amendment. J Forensic Med Sci Law 2022;31(1):71-76.
19. "1988 Article on NEPA: Past, Present, and Future". [Cited on 03rd March 2019].Available from : https://archive.epa.gov/epa/aboutepa/1988-article-nepa-past-present-and-future.html
20. Hunter D. International treaties and principles protect the environment and guard against climate change. International Environmental Law. 2021; 19(1): 205.

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Review Article

Conundrum on Laws Related to Unnatural Sexual Offences in Bhartiya Nyaya Sanhita

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Abstract

"**Unnatural sexual offenses**," as defined under Section 377 of the Indian Penal Code, originally referred to sexual acts that were deemed non-procreative or contrary to the natural order. This primarily included: Same-Sex Acts: Penetrative sexual acts between individuals of the same sex (anal and oral sex). Bestiality: Sexual acts among humans and animals. The Bharatiya Nyaya Sanhita, 2023, overlooks provisions included in Section 377, which states that "whoever voluntarily has carnal intercourse against the order of nature with any man, woman or animal commits unnatural offence." There is no mention of anything resembling what is enclosed in **Section 377 of the IPC**. With exclusion of Section 377 in the BNS, a man or a transgender person imperilled to non-consensual penile penetrative sex has no option under law for any remedy as it is no longer an offence. Similarly, there is no mention of offence for sexual intercourse of man, women or transgender with an animal. The law requires that if there is a legal wrong there must be a remedy. Not providing a remedy for acts covered under Section 377 is not only illegal but unconstitutional.

1. Introduction

Sexual assault and other sex-related crimes are indeed among the most serious and devastating offenses, both for the immediate victims and for society as a whole. The rising rates of sexual assault worldwide are alarming and highlight a number of systemic issues, including gender inequality, cultural attitudes toward consent, and inadequate support for victims. Sexual violence is not only a legal or criminal issue, but also a profound public health concern.[1]

Section 377 of the Indian Penal Code, enacted in 1860, indeed criminalized "unnatural offenses," which were primarily understood to encompass same-sex relations and certain non-procreative sexual acts. "Unnatural sexual offenses," as defined under Section 377 of the Indian Penal Code, originally referred to sexual acts that were deemed non-procreative or contrary to the natural order. This primarily included: Same-Sex Acts: Penetrative sexual acts between individuals of the same sex (anal and oral sex). Bestiality: Sexual acts among humans and animals.[2] The law's rationale was rooted in the belief that sexual activity should be oriented towards procreation.

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The interpretation that only penetrative acts fell under this section reinforced a narrow understanding of sexuality, deeming anything outside of heterosexual procreative sex as "unnatural."[3]

2. Amendments related to laws of unnatural sexual offences:

Section 377 of the Indian Penal Code (IPC) was indeed enacted in 1861 under the British colonial administration, but it was inspired by British laws, such as the **Buggery Act of 1533,** which made "buggery" (typically anal intercourse) a capital offense. However, while Thomas Macaulay is often credited with drafting the Indian Penal Code, it's important to note that Macaulay's actual drafting work was done in the early 1830s, and the code itself was enacted in 1861 under British colonial rule.[4]

The Delhi High Court's ruling in the Naz Foundation case and the Supreme Court's decision in Navtej Johar were pivotal in redefining the legal landscape surrounding consensual sexual relations in India. Both courts emphasized the importance of consent in determining the criminality of sexual acts traditionally viewed as "unnatural" under Section 377 IPC.[5]

Naz Foundation Case (2009): The Delhi High Court decriminalized consensual same-sex relations by ruling that the criminalization of consensual sexual acts between adults violated the fundamental rights to privacy and equality. The court asserted that if the acts were consensual, they should not be considered criminal.[6]

Navtej Johar Case (2018): The Supreme Court upheld the Delhi High Court's reasoning, further affirming that the essence of the law should be based on consent. The ruling clarified that only non-consensual acts—such as sexual violence or exploitation—would remain punishable under the law.[7] As a result of these landmark decisions, Section 377 was effectively rendered inapplicable to consensual acts between adults, thereby protecting the rights of individuals engaged in such relationships. This shift marked a significant advancement for LGBTQ+ rights in India, emphasizing dignity, autonomy, and the principle that consensual adult relationships should not be criminalized. Thus, finally it resulted that only non-consensual sexual acts included in Section 377 were liable for punishment. [8] The Supreme Court's recognition of transgender persons' rights, particularly in the landmark 2014 NALSA judgment, emphasized that individuals should be recognized based on their self-identified gender. This pivotal decision laid the groundwork for legislative reforms aimed at protecting the rights of transgender individuals in India.[9]

The Transgender Persons (Protection of Rights) Act, 2019 further institutionalized these rights, providing a framework for the recognition and protection of transgender individuals. **Criminalization of Sexual Abuse**: Section 18 of the Act specifically addresses sexual abuse against transgender persons. It prescribes penalties of up to two years of imprisonment, fine, or both for such offenses, thus recognizing the unique vulnerabilities faced by the transgender community. Overall, the Act represents a significant advancement in the legal recognition and protection of transgender rights in India, affirming their dignity and autonomy while aiming to address the discrimination and violence they often encounter.[10]

The **Protection of Children from Sexual Offences (POCSO) Act**, enacted in 2012, represents a crucial legal framework in India aimed at safeguarding children from sexual exploitation and abuse. Key features of the POCSO Act include: The Act is explicitly gender-neutral, meaning that it applies equally to all individuals—men, women, and transgender persons—who engage in sexual activities with minors. This inclusive approach helps to address sexual offenses without bias regarding the perpetrator's or victim's gender.[11]

The amendments to the definition of rape under **Sections 375 and 376 of the Indian Penal Code (IPC)** in 2013 marked a significant evolution in India's legal approach to sexual violence. These amendments were primarily a response to public outcry following high-profile cases of sexual assault, and they aimed to broaden the understanding and definition of rape. Historically, the law defined rape in a gender-specific manner, stating that only a man could be charged with raping a woman. The law did not recognize the possibility of a woman raping a man, which limited the understanding of sexual violence and excluded male victims from legal protection.[12] Thus, rape tends to persists as gender-specific crime, a man raping a woman, but it is no longer limited to non-consensual peno–vaginal sex, and now comprises all other sexual acts. [13,14] As per Section 377 of the IPC, a person, man or a transgender is liable for punishment if there is non-consensual penile penetrative sex. Chapter V of the BNS comprises of offences against women and children and a sub-chapter of that, Sections 63 to 73 deals with sexual offences. The Bharatiya Nyaya Sanhita, 2023, overlooks provisions included in

Section 377, which states that "whoever voluntarily has carnal intercourse against the order of nature with any man, woman or animal commits unnatural offence."[15] There is no mention of anything resembling what is enclosed in Section 377 of the IPC. With exclusion of Section 377 in the BNS, a man or a transgender person imperilled to non-consensual penile penetrative sex has no option under law for any remedy as it is no longer an offence. Similarly, there is no mention of offence for sexual intercourse of man, women or transgender with an animal. [16]

On August 28, 2024 The Delhi High Court questioned the central government representation to a petition against the elimination of penal provisions for the offences of unnatural sex and sodomy from the Bhartiya Nyaya Sanhita (BNS), which substituted the Indian Penal Code. The court instructed the Central government to quickly take decision, preferably within six months.[17]

3. Critical analysis & Conclusion

Considering the conditions like Necrophilia where dead woman or man is subjected to sexual exploitation which was earlier included in unnatural sexual offences, now finds no place in law where relatives can seek for justice. In comparison to this if living female is subjected to sexual violence, there is provision for her to seek for justice as per law. On the same note, earlier if the males were subjected to sexual violence, there was provision of punishment as per section 377 IPC but now there is no method of proceeding further with complaint in BNS.

There are significant number of cases of necrophilia with no remedy available for the same. The famous case of Nithari where more than 15 girls were murdered and raped and accused was charged under section 377 IPC.[18] Similarly, in 2020, there was case of necrophilia with 14 years old girl in Assam.[19] But absence of section related to necrophilia will set the offenders scot-free. Hence the provision of necrophilia to be included in the legal framework to ensure the justice to the victim to each and every offence and impart the punishment to the offenders. The absence of these legal provisions led to ambiguity situations for the investigating authorities to conduct the investigation. This is absolute paradox of the aim of judiciary to impart justice to each and every individual of the country.

The introduction of the Bhartiya Nyaya Sanhita led to creation of a grey area in respect to Unnatural sexual offences against homosexuals, men, animals and women. The implication of non-inclusion of the provisions of Section 377 IPC covered in BNS is totally flouting the crimes of unnatural nature, creating a vacant space in the area of Criminal law in the Indian subcontinent. The desertion of this area of crime significantly shakes the Right to Life and personal liberty of the citizens of India.[20]

4. Recommendations

1. With regard to Section 377 of the Indian Penal Code, the Supreme Court in 2018 partially struck down provisions of this section and the non-consensual sexual acts performed were upheld by the Apex Court. These offences to be included in the existing sections or new sections can be added.
2. Non-consensual sexual offences on males can be incorporated in section 63 of BNS by making the that law gender neutral which can resolve the issue. Currently only males can be offenders as per this section.
3. Due to the growing cases of Bestiality in the Indian Subcontinent, there should be recognition given to this area of crime and stricter laws should be introduced in the Indian criminal justice system. The new Bill should be inclusive of the provisions dealing with the crime of Bestiality and should be properly defined in the definition clause followed by precise explanation of the crime along with punishment for the same.
4. On the same lines, provisions of necrophilia to be included in the law and punishment for the same.

The law requires that if there is a legal wrong there must be a remedy. Not providing a remedy for acts covered under Section 377 is not only illegal but unconstitutional.

Abbreviations: -

1. Indian Penal Code: - IPC
2. Bhartiya Nyaya Sanhita: - BNS
3. Protection of children from Sexual offences: POCSO

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References:

1. Khurana S, Khutell A, Kumar M, Anand A, Nalvani L. Retrospective Analysis of Pattern of Rape Accused Examined at a Tertiary Care Centre in South-West Delhi. J Forensic Med Sci Law 2021;30(2):36-40.
2. Section 377 IPC. Unnatural offences. [Cited on 15th October 2024] Available from: https://www.indiacode.nic.in/show-

data?actid=AC_CEN_5_23_00037_186045_152326676 5688&orderno=434
3. Bharatiya Nyaya Sanhita Bill scraps 'unnatural sex' offence, in a move away from colonial laws. Economic times. Aug 13, 2023. [Cited on 15th October 2024] Available from: https://economictimes.indiatimes.com/news/india/bharatiya-nyaya-sanhita-scraps-unnatural-sex-offence-in-a-move-away-from-colonial-laws/articleshow/102692857.cms?from=mdr
4. Singh S Gupta A. Beyond Decriminalization: The Ripple Effects of Section 377 Repeal on India's Criminal Justice System. Manupatra Article Feb 12 2024. [Cited on 15th October 2024] Available from: https://articles.manupatra.com/article-details/Beyond-Decriminalization-The-Ripple-Effects-of-Section-377-Repeal-on-India-s-Criminal-Justice-System
5. Patil SS, Deokar RB, Pathak HM. Overview of rape related laws and its necessary recommendations. J Forensic Med Sci Law. 2019; 28(1): 17-21.
6. Naz Foundation vs Government Of NCT Of Delhi And Others on 2 July, 2009. [Cited on 15th October 2024] Available from: https://indiankanoon.org/doc/100472805/
7. Navtej Singh Johar v. Union of India, (2018) 10 SCC 1. [Cited on 15th October 2024] https://indiankanoon.org/doc/168671544/
8. Dixit P, Kumari M, Aravindan U, Chawla H. Exploring amended Indian laws in context of forensic medicine: A comprehensive review. IP Int J Forensic Med Toxicol Sci. 2024;9(2): 66-72.
9. National Legal Ser.Auth vs Union of India & Ors on 15 April, 2014. [Cited on 15th October 2024] Available from: https://indiankanoon.org/doc/193543132/
10. The Transgender Persons (Protection of Rights) Act, 2019. [Cited on 15th October 2024] Available from: https://www.indiacode.nic.in/bitstream/123456789/13091/1/a2019-40.pdf
11. The Protection of Children from Sexual Offences (POCSO) Act, 2012. [Cited on 15th October 2024] Available from: https://www.law.cornell.edu/women-and-Justice/resource/the_criminal_law_(amendment)_act_2013
12. Criminal amendment act 2013. [Cited on 15th October 2024] Available from: https://www.indiacode.nic.in/show-data?actid=AC_CEN_5_23_00037_186045_152326676 5688&orderno=424
13. Patil SS, Deokar RB, Mankar DD. Study of Feedback of Survivors of Sexual Offences Subjected for Medicolegal Examination in Tertiary Care Municipal Hospital. J Forensic Med Sci Law 2022;31(1):16-23.
14. Nath A, Ranjit Kumar Das RK, Homeswar Sarmah H. A Cross-Sectional Study on Profile of Survivors of Sexual Assault at Agartala City. J For Med Sci Law 2023;32(2):30-33.
15. Bharatiya Nyaya Sanhita 2023, Offences Against Woman And Children [Cited on 15th October 2024] Available from: https://devgan.in/bns/chapter_05.php#s64
16. Grover A. The leaflet. The Thoughtless section 377 IPC oversight in BNS June 28 2024. [Cited on 20th October 2024]Available from : https://theleaflet.in/the-thoughtless-section-377-ipc-oversight-in-the-bns/
17. Decide on plea against exclusion of penal provision for unnatural sex offence in BNS, HC tells Centre. THE HINDU BUREAU. August 28, 2024 [Cited on 20th October 2024] Available from : https://www.thehindu.com/news/cities/Delhi/decide-on-plea-against-exclusion-of-penal-provision-for-unnatural-sex-offence-in-bns-hc-tells-centre/article68576747.ece
18. Nithari Killings Case: Who are Surinder Koli, Pandher. What's the case? Here is all about the 20-year old case. Economic times. 17th October 2023. [Cited on 20th October 2024]. Available from: https://economictimes.indiatimes.com/news/how-to/nithari-killings-case-who-are-surinder-koli-pandher-whats-the-case-here-is-all-about-the-20-year-old-case/articleshow/104486117.cms
19. Assam man arrested for necrophilia. The New Indian Express. 22nd May 2020. [Cited on 20th October 2024]. Available from: https://www.newindianexpress.com/nation/2020/May/22/assam-man-arrested-for-necrophilia-2146703.html
20. Nanda A, Gupta A. Critical analysis of the Bharatiya Nyaya Sanhita bill 2023 with special regard to laws concerning rape and unnatural offences. Maglaw [Internet]. 2023 [Cited on 20th October 2024];2(1). Available from: https://maglaw.puchd.ac.in/index.php/maglaw/article/view/111

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Systemic Review Article

Assessment of the Behavioral Profile of Serial Killers Across Various Continents in the 19th, 20th and 21st Centuries: A Systemic Review

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Abstract

The study will utilize a qualitative approach to analyse various case studies of serial killers from Asia, Europe and America, exploring their backgrounds, motives, and patterns of behaviour. The findings of the systematic review will help to shed light on the psychological and social factors that contribute to the emergence of serial killers, including childhood experiences, mental illness, and societal pressures. The study will also consider the impact of social and cultural factors on the development of serial killers and violent offenders. Overall, the research aims to provide an insight into the complex phenomenon of serial killing and contribute to the development of more effective prevention and intervention strategies. The present systemic review aims to examine the behavioural profile of serial killers in the 19th, 20th and 21st centuries and provide usable analytical results.

1. Introduction

There is likely a complex interplay of genetic, hormonal (specifically testosterone), and environmental factors that contribute to the development of serial killers.[1,2] While there is evidence to suggest that certain genetic and hormonal factors, particularly high levels of testosterone or brain lesions, may increase the likelihood of violent behaviour, it is not sufficient on its own to cause someone to become a serial killer. Environmental factors such as childhood trauma, exposure to violence, and social influences such as media and peer groups may also play a significant role.[3,4] Continuous research into the various factors that contribute to the development of serial killers may help to identify individuals who are at risk and prevent future incidents. The present systemic review aims to assess the behavioural profile of serial killers in the 19th, 20th and 21st centuries and provide usable analysis.

2. Rationale:

The following are some of the uses of this study:

1. **Forensic Purposes**:
   - Understanding the behavioural patterns and motives of serial killers can assist forensic experts in creating offender profiles, which

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can aid in the identification and apprehension of perpetrators.

- Knowledge of the psychological factors underlying serial killings can help forensic psychologists and psychiatrists in evaluating suspects, determining their mental state, and providing expert testimony in court proceedings.

2. Investigative Purposes:

- Insights into the backgrounds, motives, and behavioural characteristics of serial killers can assist law enforcement agencies in conducting more targeted and efficient investigations.
- Recognizing the warning signs and red flags associated with serial killers can help investigators identify potential suspects early in their criminal activities, potentially preventing further victimization.

3. Mental Health Purposes:

- Understanding the psychological and social factors contributing to the emergence of serial killers can inform mental health professionals' efforts in assessing and treating individuals at risk of engaging in violent behaviour.
- Knowledge of the developmental pathways and underlying psychopathology of serial killers can aid mental health practitioners in designing targeted interventions and treatment programs aimed at reducing the risk of future violence.

2. Methodology:

Systemic reviews seek to collate evidence that fits pre-specified eligibility criteria.[5] The serial killers within the timespan of crime ranging from the year 1891 to the year 2017 were selected by random sampling from various sources like research articles, case studies and court verdicts (**Table 1**). Information about physiological factors, childhood, parental influence, paraphilias, impulsive urges, psychosexual thrill, narcissism, double lives, manipulative capacity and substance abuse was collected.

The study will employ both qualitative and quantitative approaches to analyse various case studies of serial killers, delving into their backgrounds, motives, and behavioural patterns. By conducting a systemic review, the research aims to illuminate the psychological and social factors underlying the emergence of serial killers, including childhood experiences, mental illness, and societal pressures. Additionally, the study will explore the influence of social and cultural factors on the development of serial killers and violent offenders.

The present research also contains arrest records of over 100 serial killers, which have been included in Pie Chart No. 1. These have been selected at random to find the probability of a serial killer to have been arrested prior to their killing spree.

Out of these 100, 47 killers have been selected for an in-depth analysis.

Inclusion Criteria:

1. The criminal must have committed at least two murders.
2. The criminal must be convicted and sentenced by the court of law in context to the serial killings.
3. The serial killers within the timespan of crime ranging from the year 1891 to the year 2017 were selected by random sampling.

Exclusion Criteria:

1. Incomplete information about physiological factors, childhood, parental influence, paraphilias, impulsive urges, psychosexual thrill, narcissism, double lives, manipulative capacity and substance abuse.
2. Unidentified killers or cold cases.

3. Observations

To assess the different behavioural patterns in these criminals, the following data has been collected from the various verdicts of convicted serial killers across the Asian, American and European continents. Most killers see violence and rape as a way of “venting” their repressed emotions and bizarre sexual fantasies. These killers have an interest in conducting various sexual and mutilating experiments on inanimate objects in early childhood, and on animals during their teenage years. They often claim to have been made killers due to “disappointment, contempt, and disdain” from their family members, usually mothers or abusive fathers/stepfathers.[4, 6]

Paraphilias refer to sexual desires or behaviours that deviate from societal norms or expectations, often involving unconventional objects, activities, or situations.[7, 8, 9,10,11,12] In the context of serial killers, paraphilias play a significant role in shaping their fantasies, desires, and motivations for committing heinous crimes. These individuals may experience intense and persistent sexual urges that are associated with specific paraphilic interests, such as sadism, necrophilia, or voyeurism. Paraphilias can further be classified into pre and post mortem paraphilias. In the case of pre mortem paraphilias, the killers enjoy torturing their victims and are, by

definition, sadists. In the case of post mortem paraphilias, however, we observe that the killing simply serves as the means to an end (in this case, the acquisition of a body). The actual enactment of the paraphilia begins after the victim is dead.

Some serial killers may experience sudden, intense urges to kill that they feel compelled to act on immediately.[13, 14] These impulses may be associated with abnormal changes during post-puberty or childhood trauma. Additionally, exposure to violent materials, such as guns and knives, and familial circumstances such as divorce or abuse by step-parents may contribute to the development of these impulses. Prior history of sexual offenses may also be a risk factor.[15,16, 17] Some serial killers tend to revisit their crime scenes, potentially to “relive” the experience of the kill, often for psychosexual reasons.[18,19] They exhibit narcissistic behaviour and an unexplained attraction to fame, frequently following their own case investigations and taunting law enforcement and the media by writing letters, typically using a signature name and symbol. Serial killers may also take souvenirs or keepsakes from their crime scenes. Some killers have a “God” complex, which means they believe they are above others and have the right to decide who lives and dies.[20,21] They firmly believe in this ideology and may use it to justify their actions.

Many serial killers lead “double lives” and masquerade in society with two completely contrasting personalities.[13,18] This skill is mastered by several psychopaths to make themselves appear “normal” and avoid suspicion. Some serial killers are able to use their charm and manipulation skills to gain the trust of others, making it easier for them to carry out their crimes.[14,22,23,24] Ted Bundy is a prime example of a killer who was able to use his good looks and charming personality to lure victims to their deaths. Substance abuse plays a significant role in the behaviour of some serial killers, contributing to the escalation and intensity of their violent actions.[25,26] Alcohol and drugs can impair judgment, lower inhibitions, and increase aggression, making individuals more prone to acts of violence and murder.

4. Discussion

The aim of this discussion is to isolate, summarise and present as many factors as possible that could lead to the development of such violent behaviour. Out of the following ten criteria, at least one (and almost always more than one) have been observed in all the cases studied so far. Hormonal imbalances and brain abnormalities could potentially contribute to the development of serial killers. Specifically, high levels of testosterone, scarring, injury or legions to the frontal and temporal lobes, and conditions like schizophrenia have been found to contribute to violent and antisocial behaviour. Although these are the rarest of all discussed factors, these anomalies must be taken into consideration while investigating serial homicide. Traumatic events during childhood, such as physical, emotional, and sexual abuse, neglect, and exposure to violence, could lead to the development of serial killers. These experiences can lead to feelings of anger, mistrust, and an inability to form healthy relationships.

Poor parental role models, absent or neglectful parents, and overbearing or controlling parents may contribute to the development of serial killers. This can lead to feelings of isolation, rejection, and a lack of empathy or compassion for others. Some individuals may have persistent fantasies related to killing, often associated with sexual gratification. They might also exhibit unusual sexual desires, including (but not limited to) sadism, masochism, voyeurism, frotteurism, transvestism, fetishism, paedophilia and exhibitionism. Other less common fantasies include necrophilia, cannibalism and coprophilia. These fantasies may become more frequent and intense over time, leading to the desire to act them out in reality.

Some people may experience sudden, intense urges to kill that they feel compelled to act on immediately. These impulses may be associated with abnormal changes during post-puberty or childhood trauma, exposure to violent materials, familial circumstances such as divorce or abuse by step-parents, and prior history of sexual offenses.

Some serial killers tend to go back to their crime scenes to "relive" the experience of the kill, often for psychosexual reasons. They display narcissistic behaviour and an unexplained attraction to “fame”, usually following up on their own case investigations and writing taunting letters to the police and media, usually claiming a signature name and a sign. They might fake conditions like schizophrenia or psychosis and take a souvenir from the crime scene.

Many killers are associated with a “God” complex, which is a classical trait of narcissistic personalities. They believe themselves to be above everybody else, and think that they get to decide who lives and who dies. Many serial killers lead "double

lives" and masquerade in society with two completely contrasting personalities. This skill is mastered by several psychopaths to make themselves appear "normal" and avoid suspicion. Some serial killers are adept at using their charm and manipulation skills to gain the trust of others, which helps them carry out their crimes. This ability to manipulate may be a key factor in their success as serial killers, and they may use it not only to lure victims but also to evade capture and prosecution.

Substance abuse is a common factor in many (but not all) violent offenders, particularly because alcohol and drugs lower inhibitions, increase aggression and suppress any feelings of guilt or remorse, further aggravating a person's violent or paraphilic tendencies. In general, we observe that physiological factors, childhood trauma, parental influence and inherent narcissism (either vulnerable or grandiose) serve as the causes of a deviant or violent mindset, along with undue exposure to violent or pornographic material. On the other hand, paraphilias and psychosexual thrill determine the nature of the crime. Manipulation, substance abuse, and leading double lives serve only as tools for these killers to get what they want.[27] Forensic neuroscience may play a pivotal role to develop and refine etiological models of crime-related behaviours.[28] Additionally, history of previous crimes i.e. criminal records, also give us significant information about the nature of an individual. Several serial killers were arrested prior to their killing sprees on a number of different charges, as evidenced later (**Chart 1**). So, the observation is that they were released from prison (presumably, following a psychiatric evaluation), and yet, their antisocial behaviour either went unnoticed, or was largely ignored. **Chart 2** shows prevalence of the various factors in the 47 cases listed in **Table 1** with factors in **table 2.**

Chart 1: Given below is a chart, depicting a distribution of 100 serial killers, and whether or not they were arrested prior to their killing spree

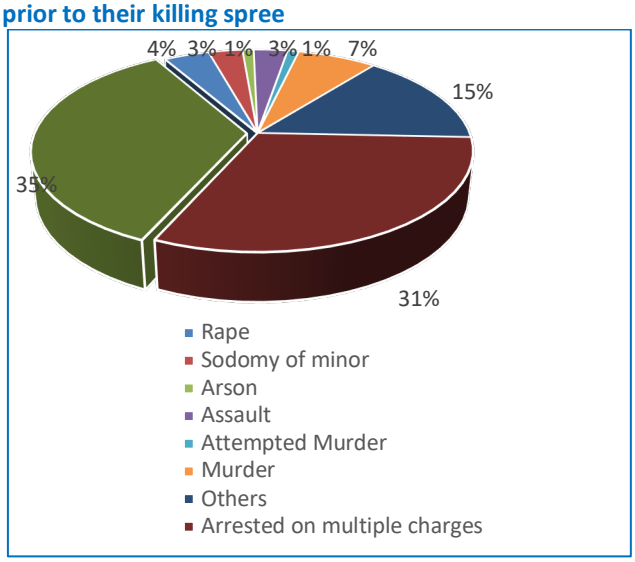

Table No. 1: Information of the psychological patterns of 47 selected serial killers

Name of killer	Factors observed	Years active	Arrested prior to killings?
1. H.H. Holmes	4B, 7B, 8, 9	1891–1894	No
2. Charles Panzram	2A, 3A, 4A, 5, 7A, 9, 10	1899–1929	Yes
3. Fritz Haarmann	3B, 4A, 6, 7B, 8, 9	1918–1924	Yes
4. Albert Fish	1, 2A, 3A, 4A, 4B, 5, 6, 7A, 9	1924–1932	Yes
5. Earle Nelson	1, 3A, 4B, 9	1926–1927	Yes
6. Ed Gein	1, 3A, 4B, 5	1947–1957	No
7. Donald Henry Gaskins	2A, 3A, 4A, 5, 7A, 9	1953–1982	Yes
8. Patrick Kearney	2A, 3B, 4A, 4B, 9	1962–1977	No
9. Edmund Kemper	3A, 4A, 4B, 5, 6, 7A, 9	1964–1973	Yes
10. Richard Speck	1, 2A, 3A, 4A, 5, 7A, 9, 10	1966	Yes
11. Richard Cottingham	2A, 4A, 6, 7B, 8, 9	1967–1980	Yes
12. Jerry Brudos	2A, 3A, 4A, 4B, 5, 6, 7A, 8, 9	1968–1969	Yes
13. Rodney Alcala	2B, 4A, 4B, 6, 7B, 8, 9	1968–1979	Yes
14. Pedro Lopez	2A, 3A, 4A, 5, 6, 7A, 9, 10	1969–1980	Yes
15. Dean Corll	3B, 4A, 6, 7B, 9	1970–1973	No
16. Donald Harvey	2A, 4A, 5, 7A, 9	1970–1987	No
17. Samuel Little	2B, 3A, 4A, 4B, 5, 6, 7A, 9	1970–2005	Yes
18. Juan Corona	4A, 4B, 5, 6, 9	1971	No
19. Randy Kraft	2B, 3A, 4A, 5, 6, 7B, 8, 9, 10	1971–1983	No

20. Robert Hansen	2A, 3A, 4A, 5, 6, 7A, 8, 9	1971–1983	Yes
21. John Wayne Gacy	2A, 3A, 4A, 6, 7A, 8, 9	1972–1978	Yes
22. Arthur Shawcross	1, 2A, 3A, 4A, 4B, 5, 6, 7A, 9	1972–1989	Yes
23. Theodore Bundy	4A, 4B, 5, 6, 7B, 8, 9	1974–1978	No
24. Carl Watts	4A, 5	1974–1982	No
25. Joseph DeAngelo	2A, 3A, 4A, 6, 7A, 8, 9	1974–1986	No
26. Daniel Barbosa	2A, 3A, 4A, 7A, 9	1974–1986	Yes
27. Dennis Rader	3B, 4A, 4B, 6, 7A, 8, 9	1974–1991	No
28. Peter Sutcliffe	3A, 4A, 4B, 5, 6, 7A, 8, 9	1975–1980	No
29. Harold Shipman	3B, 7B, 9	1975–1998	No
30. David Berkowitz	1, 3B, 4A, 6, 7B, 9	1976–1977	No
31. Montie Rissell	3A, 4A, 5, 7A	1976–1977	Yes
32. Richard Chase	1, 2A, 4B, 5, 10	1977–1978	No
33. Dennis Nilsen	2A, 4B, 5, 9, 10	1978–1983	No
34. Andrei Chikatilo	2A, 3A, 4A, 4B, 5	1978–1990	Yes
35. Jefferey Dahmer	2A, 3A, 4B, 9, 10	1978–1991	Yes
36. Gary Ridgway	2A, 3A, 4A, 4B, 5, 8, 9	1982–1998	Yes
37. Robert Pickton	2A, 3A, 4A, 5, 7A, 9, 10	1983–2002	Yes
38. Richard Ramirez	1, 2B, 4A, 4B, 5, 7A, 10	1984–1985	No
39. Larry Gene Bell	4A, 6, 7B, 9	1985	No
40. Lee Choon Jae	2A, 4A, 5, 6, 7B, 8, 9	1986–1994	No
41. Gary Heidnik	2A, 3A, 4A, 4B	1986–1987	Yes
42. Aileen Wuornos	2A, 3A, 4A, 5, 7A, 10	1989–1990	Yes
43. Luis Garavito	2A, 3A, 4A, 4B, 5, 6, 7A, 9, 10	1992– 1999	No
44. Alexander Pitchushkin	1, 2A, 3A, 4A, 7A, 9	1992–2006	No
45. Mikhail Popkov	3A, 4A, 4B, 5, 7A, 8, 9	1992– 2010	No
46. Israel Keyes	2A, 3A, 4A, 7A, 8, 9	2001– 2012	Yes
47. Bruce McArthur	2A, 3A, 4A, 7A, 9	2012– 2017	Yes

Chart No. 2: Shows prevalence of the various factors in the 47 cases listed in Table No.1.

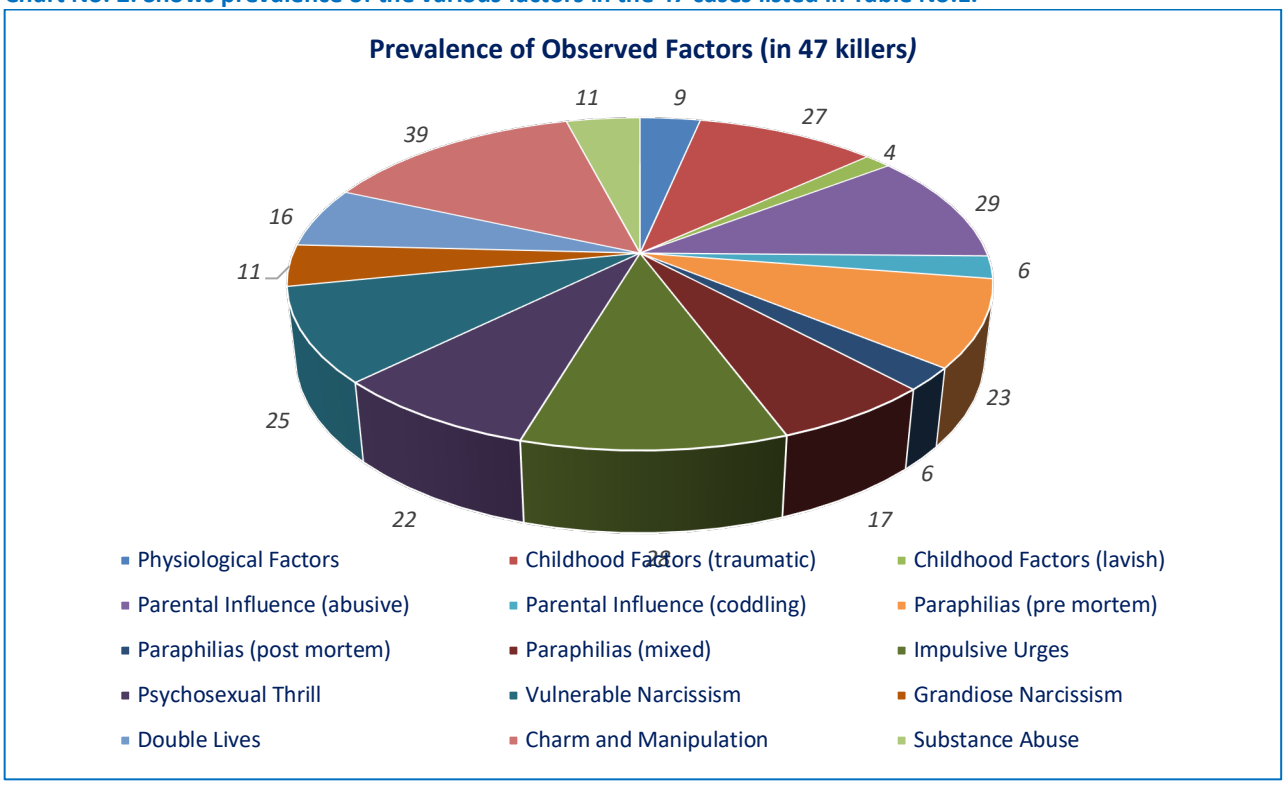

Table No. 2: Shows the factors listed in Table No. 1.

Factor number	Factor name
1	Physiological Factors
2A	Childhood (A) – Abuse by relatives, bullying, mockery, etc.
2B	Childhood (B) – Lavish social life, popularity, bad influences, etc.
3A	Parental Influence (A) – Abusive, overbearing, absent parents
3B	Parental Influence (B) – Pampering, overcoddling parents
4A	Premortem Paraphilias (A) – Sadism, torture, paedophilia, etc.
4B	Postmortem Paraphilias (B) – Thanatophilia, necrophilia, etc.
5	Impulsive Urges
6	Psychosexual Thrill
7A	Vulnerable Narcissism
7B	Grandiose Narcissism
8	Double Lives
9	Charm and Manipulation
10	Substance Abuse

5. Conclusion

When studying serial killers arrested prior to their killing spree, we discovered that 65% of them had prior criminal records, with nearly 31% being arrested for multiple charges including assault, arson, rape, attempted murder, theft, sodomy, and even murder. Individual charges include assault (3%), arson (1%), rape (4%), attempted murder (1%), others (15%), sodomy (3%) and murder (7%). We also isolated and studied 10 distinct factors on which we evaluated 47 serial killers. In this study, we observed that 46 out of 47 killers showed a strong tendency for paraphilias (either pre or post mortem, or both), many of which reflected in their crimes. Paraphilias is by far the most observed factor in these killers, followed by manipulation (39 out of 47), narcissism (36 out of 47), parental influence (35 out of 47), childhood factors (31 out of 47) and impulsive urges (28 out of 47). The factors least observed, but still in a significant quantity, are physiological abnormalities (9 out of 47), substance abuse (11 out of 47), double lives (16 out of 47). The factor with a moderate occurrence is psychosexual thrill (22 out of 47).

Based on the discussed cases and the present data, the authors conclude that there is much scope in the diagnosis, identification, assessment, and treatment of violent individuals.

There is a need for better and more effective diagnosis of antisocial personality disorder, and its related disorders (narcissistic, histrionic and borderline personality disorders). That being said, there is also a need in investigative science, to study the modus operandi and circumstances of crime in relation with the psychology of the criminal. If given more importance, this field promises to be of great yield to law enforcement, to forensic medicine and to the public as a whole.

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References:

1. Beaver KM, Barnes JC, Boutwell BB. The neurobiology of antisocial behaviour: Integrating empirical and theoretical findings. Psychiatric Clinics. 2014;37(3):1-16.
2. Raine A, Yang Y. Neural foundations to moral reasoning and antisocial behaviour. Soc Cogn Affect Neurosci. 2006;1(3):203-13.
3. Widom CS. Understanding the consequences of childhood victimization. J Interpers Violence. 2014;29(5):773-80.
4. Wilson K, Brewer N. An exploration of the relationship between childhood maltreatment and psychopathy among male and female prisoners. J Interpers Violence. 2017;32(15):2307-30.
5. Higgins JP, Green S, editors. Cochrane handbook for systematic reviews of interventions. John Wiley & Sons; 2011.
6. Ressler RK, Burgess AW, Douglas JE. Sexual homicide: Patterns and motives. Lexington Books; 1988.
7. Butcher JN, Mineka S, Hooley JM. Textbook of abnormal psychology. 17th ed. Pearson Books: India; 2017, Chapter 12, pp 484-91.
8. Kafka MP. Hypersexual disorder: A proposed diagnosis for DSM-V. Arch Sex Behav. 2010; 39(2):377-400.
9. Bartels RM, Gannon TA. Sexual sadism and sexual masochism: A review of assessment issues. Aggress Violent Behav. 2011; 16(6):519-28.
10. Greenberg DM, Bradford JM. Factors influencing the emergence and maintenance of paraphilic sexual

preferences in adult males. J Sex Res. 2000; 37(4):339-57.
11. Marshall WL, Barbaree HE, Eccles A. Early onset and deviant sexuality in child molesters. J Interpers Violence. 1991; 6(3):323-36.
12. Hare RD, McPherson LM. Sexual offenders against male children: Sexual preferences. Behav Res Ther. 1984; 22(5):479-91.
13. Hickey EW. Serial murderers and their victims. 7th ed. Cengage Learning; 2013.
14. Meloy JR. The nature and dynamics of sexual homicide: An integrative review. Aggress Violent Behav. 2000; 5(1):1-22.
15. Moga H, Parmar AP. Study of Profile of Homicidal Deaths at Mortuary Complex of a Tertiary Care Centre in Bhavnagar Region. J Forensic Med Sci Law.2020; 29(1):12-5.
16. Gavale PS, Zanjad NP. A Case Report of Dyadic Death with Husband as a Perpetrator. J Forensic Med Sci Law 2022; 31(1):101-4.
17. Kamble NP, Parakhe SN, Swami AA, Patil VB, Deokar RB. A Retrospective Study of Homicidal Deaths Autopsied at a Tertiary Care Centre in Maharashtra. J Forensic Med Sci Law 2023; 32(1):32-6.
18. Douglas JE, Burgess AW, Burgess AG, Ressler RK. Crime classification manual. Lexington Books; 1986.
19. Holmes RM, Holmes ST. Serial murder. 2nd ed. Sage Publications; 1998.
20. Keppel RD, Birnes WJ. Signature killers. Pocket Books; 2003.
21. Meloy JR. The psychology of wickedness: Psychopathy and sadism. Psychiatr Clin North Am. 1998; 21(2):397-412.
22. Keppel RD. Signature killers. Academic Press; 2005.
23. Schlesinger LB, Revitch E. Serial offenders: Current thought, recent findings. CRC Press; 2008.
24. Vronsky P. Serial killers: The method and madness of monsters. Berkley Books; 2004.
25. Graham K, Bernards S, Knibbe R, Kairouz S, Kuntsche S, Wilsnack SC, et al. Alcohol-related negative consequences among drinkers around the world. Addiction. 2011; 106(8):1391-405.
26. Compton WM, Volkow ND. Abuse of prescription drugs and the risk of addiction. Drug Alcohol Depend. 2006; 83(Suppl 1): S4-S7.
27. Kumar DA, Ghormade P, Akhade S, Sarma B. Analysis of Injury Characteristics in Victims of Interpersonal Violence: Clinical Forensic Medicine Unit Perspective in a Tertiary Care Centre. J Forensic Med Sci Law. 2023; 32(2):4-8.
28. Ravat PS, Deokar RB, Ravat SH. Future and Scope of Forensic Neurosciences in Criminal Investigation System towards Justice. J Forensic Med Sci Law 2022;31(1):77-82.

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Review Article

Breaking the Silence: Gender Power Imbalances, Stealthing, and the Fight for Sexual Autonomy

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Condom Use.

Abstract

In this study, gender inequities and power dynamics influence condom use and other safer sexual practices. Power disparities make women vulnerable to STIs, unwanted pregnancies, and psychological trauma. Stealthing, the non-consensual removal or tampering with condoms during intercourse, illustrates gender inequity in sexual interactions. Stealthing undermines bodily autonomy and has severe physical and psychological effects like sexual violence. Stealthing is common, but legal frameworks don't address it, reflecting social struggles to recognise and confront gender-based violence. Based on feminist viewpoints and Michel Foucault's theories on power and subjectivity, this research shows how power-knowledge interactions affect sexuality and autonomy. Legal reform, societal education, and balanced power dynamics are needed to promote safer, consenting, and healthier sexual relationships.

1. Introduction

In This power disparity ultimately leads to gender disparities in sexual conduct. Men often have more sexual partners than women and historically have had the authority to determine the circumstances of sexual encounters, which can hinder women's ability to effectively discuss and implement safer sexual practices, such as condom use. Power dynamics in sexual interactions greatly influence the significance and understanding of condom use, as well as the decision-making process around condom use.

In a partnership, having higher power or resources to promote condom use can be essential. When one lacks the authority in a relationship to propose using condoms, even if they have a favourable view of condoms, they may find it challenging to discuss or promote condom use due to the prevailing power imbalances. Condom use can create a barrier to communication, leading individuals to avoid difficult conversations in their relationships, which can reduce condom use.

Women's autonomy in decision-making and negotiation over the time of sexual intercourse and condom use significantly impacts sexual and reproductive health outcomes. Recent research and sociological theories recognise the enduring presence of structural power imbalances in heterosexual sexual interactions. Power disparities impact decisions about contraception, condom use, and the timing of sexual activity. Power in relationships consists of two main

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aspects: 'power to' (the capability to act by one's wishes) and 'power over' (the capacity to enforce one's desires, especially when faced with opposition).[1]

A study by Pulerwitz et al. in 2010[2] indicates that gender-based power disparities may hinder women's negotiation capacity. Subsequent studies utilising the Sexual Relationship Power Scale (SRPS) revealed that women with elevated power levels are five times more inclined to use condoms compared to those with lower power levels consistently. The results validate that power dynamics within relationships significantly influence decision-making related to practising safe sex. Alam and Alldred's[3] research focuses on trust and power dynamics in heterosexual relationships, particularly regarding deceitful sexual behaviours like 'stealthing'. Stealthing, the covert act of removing a condom by a partner without consent, is recognised as a type of gender-based violence. This study demonstrates how gender-based inequality influences discussions on safer sex, often leading to women's autonomy in safer sex decisions being compromised.

An imbalance arises in the power dynamics between women engaged in prostitution and their clients due to the significant influence of the client's preferences on condom usage. Despite efforts to promote the significance of using condoms to prevent STIs and HIV/AIDS, only a tiny percentage of women engaged in prostitution are willing to ask clients to use condoms, and some even decline if the customer refuses.

2. Discussion

The Phenomenon of Stealthing and its Implications

The act of stealthing, characterised by the non-consensual removal or alteration of a condom during sexual intercourse[4], represents a concerning issue that warrants critical examination. This action entails a partner—irrespective of gender—tampering with or compromising a condom without the other partner's awareness or agreement. Various factors drive this behaviour, such as the desire to assert dominance in a relationship by controlling the type of sexual activities, the engagement in risky sexual practices that could result in unintended pregnancies or sexually transmitted infections (STIs), acts of revenge, particularly among those who may carry STIs, a perceived entitlement to reproductive autonomy, especially in heterosexual dynamics where men may feel entitled to biological fatherhood, a pragmatic belief that condom use reduces sexual pleasure and psychological influences like the fear of losing a partner and the intention to induce pregnancy. Regardless of the varying motivations, the actions taken—such as removing or damaging a condom—result in comparable detrimental effects. It is crucial to differentiate between consensual unprotected sex and situations where consent is either manipulated or misrepresented. In certain instances, the manipulation of condoms takes place well ahead of time, as evidenced by methods showcased in online videos that illustrate discreet approaches to undermine condoms, ultimately compromising their effectiveness in preventing pregnancy or STIs.

Excluding scenarios where a woman wishing to become pregnant falsely asserts the use of hormonal contraception is essential, as these instances stem from distinct motivations and do not align with the concept of stealthing. Stealthing refers to the covert act of removing or altering condoms during sexual intercourse without the consent of the other party. The scope of misconceptions surrounding contraceptive methods goes beyond this definition. Similar to different types of sexual violence, stealing causes considerable physical and psychological damage to its victims. Engaging in unprotected sex presents significant physical consequences, including the potential for unintended pregnancies, the transmission of sexually transmitted infections, and an elevated risk of HIV/AIDS. Victims often undergo psychological experiences characterised by shame, a sense of violation, and a diminished sense of dignity and autonomy—emotional reactions that align closely with those documented among rape survivors. Stealthing and rape both violate a victim's autonomy and subject them to physical dangers they aimed to evade, frequently leading to comparable long-term consequences.

In 1974, psychologists Ann Burgess and Lynda Holmstrom[5] carried out a study that examined the psychological effects of sexual violence. The findings indicated that rape victims exhibited increased levels of depression, anxiety, fear, and challenges in social and sexual adjustment when contrasted with non-victimised women. A subset of victims exhibited post-traumatic stress disorder (PTSD), characterised by symptoms that may endure for decades or potentially a lifetime. The symptoms associated with Rape Trauma Syndrome demonstrate the significant psychological impact of sexual violence. The reliability

of Rape Trauma Syndrome has encountered some criticism; however, the National Institute of Mental Health acknowledges that violence has a profound effect on women's mental health, frequently resulting in significant and lasting psychological damage. While stealthing and rape are distinct in their characteristics, both actions violate bodily and sexual autonomy, resulting in comparably severe repercussions for the victims involved.

Presently, there is no legislation that clearly defines stealthing as an illegal act in many jurisdictions. While numerous countries classify sexual violence as a criminal offence, there are distinctions made between sexual violence and rape, often employing terms such as "sexual contact" and "sexual intercourse." This review posits that stealthing ought to be prosecuted under current sexual violence laws, rather than under existing or proposed rape laws; therefore, this section will concentrate solely on sexual violence laws. Moreover, although the laws regarding sexual violence differ across nations, they universally hinge on the presence or absence of consent for the sexual activity involved.

Moreover, obtaining consent during sexual activity is crucial to the sex-positive movement, which seeks to eliminate the stigma and shame associated with all sexual choices. Stealthing, characterised by the non-consensual removal of a condom, presents a serious challenge to the core tenets of the sex-positive movement. Victims often experience feelings of guilt or shame, which undermines efforts to reduce the stigma associated with rape and other forms of sexual violence.

Stealthing, Gender Inequality, and Power Dynamics

Due to their incapacity to use condoms, women in violent relationships are more likely to get HIV or other STIs. In gender disparity partnerships, women typically have no control over their partners' dangerous sexual behaviours, leaving them vulnerable to infection. Male violence increases when women request condoms because it is seen as a challenge to male authority or a sign of distrust. Gender power disparities prevent women from protecting themselves from their partners' sexual risks, increasing HIV or STI transmission.

Unknown rape victims are also in danger of STIs, including HIV. Studies show that men who commit intimate partner violence often engage in high-risk sexual behaviours like unprotected anal sex, sexual relations with intravenous drug users, and multiple sexual partnerships without condoms, which increase the risk of HIV or STI transmission.

Abused adolescents are also at risk. Over half of teenage girls with HIV or STIs reported intimate relationship violence. STIs are more common in victims of physical and sexual abuse.[6] Fear of rejecting sex, condom use, or addressing protection, abstinence, or faithfulness increases infection risk. Trauma, such as childhood sexual abuse, has been related to higher-risk sexual behaviours, such as having many sexual partners or sex work, increasing HIV or STI transmission risk. In their essay "Riding the Bull at Gilley's: Convicted Rapists Describe the Rewards of Rape," Diana Scully and Joseph Marolla[7] claim that some rapists consider sexual violence as a male entitlement: Men have the right to rape. A man should take it if a lady won't. No, women can't refuse. Women are meant for sex. This is their only skill. Some women would rather be beaten but always give in—it's their job."

In Feminism and the Power of Law, Carol Smart[8] claims that women's sexuality is often separated from their identities. The belief that women are responsible for something men value more than themselves and expected to enjoy sex without respect for their autonomy underpins this creation.

The rise of "stealthing," where men remove condoms without their partners' agreement, is also worrying. Studies show that some men consider stealthing as an "art" that enhances sexual pleasure, delivers a thrill of risk, and allows them to "give women what they deserve," related to a conviction in their right to "spread their seed". Contrary to these detrimental images of male entitlement over women's bodies, women often feel violated, confused about their sentiments towards their relationships, and struggle to reconcile rage with affection. One woman said, "He finished inside me. Despite my anger, I fought to reconcile my sentiments of violation with my love for him. I regret ignoring it at the time. I even attempted to be complimentary".[9]

Stealing is portrayed as sexually motivated violence and hegemonic male rule over women's sexuality and reproductive autonomy. However, relationship-related sexual assault demands careful evaluation. Legal institutions sometimes fail to address sexual intimacy. Relying on legal frameworks to settle human relationship complexity reinforces negative dualities like guilty/innocent or standard/deviant and the law's coercive and violent

tendencies. Michel Foucault's power relations and subjectivity theories can help address the concerns above, even though they don't match feminism. Foucault views power as complexly distributed across societal strata, not just in the state. Power is local and heterogeneous, interacting with other connections and allowing individuals to form and resist.[10]

In Discipline and Punish, Foucault[11] examines how modern disciplinary procedures like imprisonment affect individuality and the human sciences. He uses torture, punishment, and discipline to show how legal and social attitudes towards crime and punishment have changed and how they shape modern people. Foucault[12] believes that power-knowledge relations on the body shape individuality and self-understanding: "When thinking about power mechanisms, I am thinking about its capillary forms, the points where power reaches into the very grain of individuals, touches their bodies, and inserts itself into their actions, attitudes, discourses, learning processes, and daily lives." Forensic neuroscience may play a pivotal role to develop and refine etiological models of crime-related behaviours.[13]

Power-knowledge relations paradoxically manage people as objects and create specific types of subjectivity. While discipline shapes individuals, it also normalises them. A panoptic society achieves this through surveillance. The "judge of normality" is present in law, education, health, and social services, cautions Foucault. Foucault[14] examines how power-knowledge helps people view themselves as subjects in The History of Sexuality. However, he questions why sexuality is typically associated with secret truths about ourselves. Foucault's analysis shows how power mechanisms penetrate private and societal dynamics, questioning prevailing narratives about law, sexuality, and subjectivity.

3. Conclusion

Gender disparities and power dynamics in sexual relationships have a significant impact on sexual and reproductive health. Structured or relational power disparities restrict women's autonomy in negotiating safer sex practices like condom use. This imbalance threatens their physical and mental health. Stealthing illustrates power, gender inequality, and sexual violence. Changing condoms without consent violates bodily autonomy and encourages male domination over women's sexuality and reproductive decisions. Stealthing, like sexual abuse, causes humiliation, pain, and increased vulnerability to STIs and unplanned pregnancies. Stealing as sexual violence is not adequately addressed by law. Consent and sexual violence legislation offer a framework, but jurisdictional variations hinder their effectiveness. These theories can help solve stealthing, but permission and relational dynamics must be understood.

According to feminism and Foucault's power theories, sexual violence and gender-based inequality are profoundly ingrained in society and relationships. Foucault's view of power as widespread and constructive rather than oppressive illuminates how such interactions form subjectivities and sustain systemic inequality. Stealththing involves legal action and a societal movement towards recognising and abolishing sexual and reproductive power imbalances. Safer, consensual, and healthier sexual relationships require balanced power dynamics and women's autonomy in decision-making. To address sexual relationship inequalities, education, campaigning, legislative reform, and social change are needed.

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References:

1. Duby Z, Bergh K, Jonas K, Reddy T, Bunce B, Fowler C et al. "Men rule… this is the normal thing. We normalise it and it's wrong": Gendered power in decision-making around sex and condom use in heterosexual relationships amongst adolescents and young people in South Africa. AIDS and Behavior. 2023;27(6):2015-29.
2. Pulerwitz J, Amaro H, Jong WD, Gortmaker SL, Rudd R. Relationship power, condom use and HIV risk among women in the USA. AIDS care. 2002;14(6):789-800.
3. Alam N, Alldred P. Condoms, trust and stealthing: The meanings attributed to unprotected hetero-sex. Int J Environ Res Public Health. 2021 16;18(8):4257.
4. Latimer RL, Vodstrcil LA, Fairley CK, Cornelisse VJ, Chow EP, Read TR, et al. Non-consensual condom removal, reported by patients at a sexual health clinic in Melbourne, Australia. PloS one. 2018;13(12):e0209779.
5. Burgess AW, Holmstrom LL. Rape trauma syndrome. Am J Psychiatry. 1974;131(9):981-6.
6. Decker MR, Silverman JG, Raj A. Dating violence and sexually transmitted disease/HIV testing and diagnosis among adolescent females. Pediatrics. 2005;116(2):e272-6.
7. Scully D, Marolla J. "Riding the bull at Gilley's": Convicted rapists describe the rewards of rape. Social Problems. 1985;32(3):251-63.
8. Smart C. Feminism and the Power of Law. Sociology of Law and Crime. Routledge; 1989.

9. Ebrahim S. I'm not sure this is rape, but: An exposition of the stealthing trend. Sage Open. 2019;9(2):2158244019842201.
10. Phelan S. Foucault and Feminism. Am J Pol Sci 1990;34(2):421–40.
11. Foucault M. Discipline and Punish: The Birth of the Prison. In: Social Theory Re-Wired Routledge; 2023. p. 291– 9.
12. Foucault M. Power/Knowledge: Selected Interviews and Other Writings 1972 - 1977. (Gordon C. ed). Pantheon Books: New York; 1981.
13. Ravat PS, Deokar RB, Ravat SH. Future and Scope of Forensic Neurosciences in Criminal Investigation System towards Justice. J For Med Sci Law 2022;31(1):77-82.
14. Foucault M. The History of Sexuality. The History of Sexuality v. 1. Allen Lane; 1979.

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Short Communication

Executive Summary of the XXVI Annual State Conference of Medicolegal Association of Maharashtra (MLAM) - Forensicon 2023

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Forensic Horizons, Journey of Toxicology, Crime Scene Investigations, Law.

Abstract

The XXVI Annual State conference of Medicolegal Association of Maharashtra (MLAM) - FORENSICON 2023 was organized by the Department of Forensic Medicine & Toxicology, H.B.T Medical College & Dr. R.N. Cooper Municipal General Hospital, Mumbai on the 28th and 29th October 2023. The conference convened experts, practitioners, and researchers from various fields to explore the critical intersections between forensic medicine, toxicology, and investigative sciences. More than 300 delegates attended the conference, which included experts from the forensic medicine field as well as medical officers, lawyers and law enforcement who were inclined towards Forensic Medicine. The release of the souvenir & MLAM Official Journal- Journal of Forensic Medicine, Science & Law was done at the same time. The conference provided a comprehensive platform for discussing the latest advancements, methodologies, and challenges in forensic investigations related to medicine and toxicology.

1. Introduction

The "XXVI Annual State conference of Medicolegal Association of Maharashtra (**MLAM**) - 'FORENSICON 2023'" was organized by Department of Forensic Medicine & Toxicology, H.B.T Medical College & Dr. R.N. Cooper Municipal General Hospital, Mumbai on the 28th and 29th October 2023. The previous conference "25th (Silver Jubilee) Annual State Conference of Medicolegal Association of Maharashtra (MLAM) 'FORENSICON 2022', was held on 18th & 19th November 2022 hosted by the Department of Forensic Medicine & Toxicology, Dr. Vasantrao Pawar Medical College, Hospital & Research Centre, Nashik (Maharashtra) India.[1] The objectives of the conference were to serve as a significant platform for advancing the understanding and application of forensic medicine and toxicology. The conference was held at the newly inaugurated medical college building of H.B.T Medical College & Dr. R.N. Cooper Municipal General Hospital,

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Mumbai, India under the eminent leadership of Hon'ble Dean Dr. Shailesh Mohite. The conference was attended by almost 300 registered delegates and above, from various states. The Delegates were the Faculty, Medical Officers, post graduate students and researchers as well as lawyers and police officers from various parts of the country. The Organizing team was presided by Dr Shailesh Mohite (Organising President), Dean, and HBTMC and guided by Dr Rajesh Sukhdeve (Organising Chairman), Professor & Head of Department, FMT, HBTMC & Dr. Sachin S. Sonawane (Organising Secretary), Addl. Professor, FMT, HBTMC, Juhu, Mumbai (**Photograph 1**).

Photograph 1: Forensicon 2023 Organising committee.

The conference was conducted under the chief patronage of Dr Sudhakar Shinde, Hon. Addl. Municipal Commissioner, MCGM along with patronage of Mr Sanjay Kurhade, Hon Deputy Municipal commissioner, (PH) MCGM, Mumbai & Dr. Neelam Andrade, Director, ME & MH, BMC.

Photograph 2: Forensicon 2023 Lamp lighting ceremony.

The theme of the conference was **Forensic Horizons- Exploring the dimensions of Forensic Medicine & Toxicology**[2] as the name suggests aimed at broadening the scope of the knowledge of Forensic Medicine among the various delegates present and inspire the various post graduate students about the avenues in the field. The inauguration ceremony held at the auditorium at the newly constructed five storey college building. The eminent personalities like Dr Mohan Joshi Dean LTMMC, Dr. Suhas Warke, IG law and order of government of Maharashtra.

Photograph 3: Forensicon 2023- Organising President's address.

The inauguration was started with lamp lightening (**Photograph 2**) by the dignitaries Sarswati vandan

and then Organising president's address (**Photograph 3**) and MLAM Secretary's address (**Photograph 4**). This was followed by release of the MLAM official journal titled **Journal of Forensic Medicine, Science and Law** (Editor-in-chief- Dr Ravindra Deokar)[3] as well as souvenir of conference (**Photograph 5**).

Photograph 4: Forensicon 2023- MLAM Secretary's address.

Photograph 5: Forensicon 2023 – Journal of Forensic Medicine Science and Law current issue release.

2. Conference Proceedings

The first day of the conference, i.e.28th October 2024 commence with the **keynote address named after an eminent personality in Indian forensic milieu Dr. C.A. Franklin[4].** Dr. V.V. Pillay, Professor & Head, FMT, & Chief of Poison Control Centre, AIMS, Cochin, Kerala captivated the audience with the topic Journey of Toxicology in India: from Obscurity to Clarity.

The first of the scientific sessions titled Forensic Medicine featured three insightful lectures that explored the intersections of medicine, judiciary

and investigating authority. It also included other key areas related to forensic field i.e. law in forensic investigations and crime scene reconstruction. The first lecture was **Interdisciplinary Collaboration for Administration of Justice** delivered by Dr. Abhay Joglekar, Hon'ble Addl Sessions Judge, City Civil Court, Mumbai; **Crime Scene Reconstruction and Trace Evidence in Homicides** by Dr. Harish Pathak, Academic Dean & Prof & Head, FMT, GSMC, Mumbai and lastly **CBME curriculum of Forensic Medicine and its implications** by Dr. Sandeep Kadu, Controller of Examination, MUHS, Nashik. Each lecture provided delegates with deep dives into key aspects of forensic medicine, discussing new challenges, and case studies.

The next sessions were focused on **understanding the critical role that various stakeholders play in healthcare** and how healthcare professionals can navigate potential medicolegal challenges. Dr. Sharvari Mhapankar and Dr. Subita Patil provided an insightful discussion on **the importance of the Medical Certificate of Cause of Death (MCCD).** They emphasized its role in accurate documentation of death and its legal implications. The session also reviewed the MCCD forms, focusing on the proper completion of these forms to ensure accuracy and prevent legal challenges. This was followed by lectures on **Collection, Preservation, And Transportation of Biological Evidence in the Medicolegal cases** by Dr Sangeeta Ghumatkar, Director, Directorate of Forensic Science Laboratory, Govt. Of Maharashtra, Mumbai who discussed the critical procedures involved in handling biological evidence in forensic investigations; **Crime Scene Investigation Van** by Dr Sandeep Chetti, Deputy Director, Directorate of Forensic Science Laboratory, Govt. Of Maharashtra, Mumbai; **Role of Forensic Medicine in Emergency Medical Services** by Dr Manish Shrigiriwar Medical Superintendent, Prof. & Head FMT, AIIMS, Nagpur who discussed how forensic medicine integrates with emergency medical services; Dr. Shailesh C. Mohite, Dean of HBT Medical College, Mumbai, spoke on the crucial skill of giving evidence in a court of law in his talk on **Art of Giving Evidence in the Court of Law.** The session concluded with a lecture by Dr. Amit Patil, Professor & Head of Forensic Medicine & Toxicology at AIIMS Patna, on recent **amendments to the POCSO (Protection of Children from Sexual Offenses) and MTP (Medical Termination of Pregnancy) Acts**. He also covered the salient features of the Child Welfare Committee and Juvenile Justice Board, focusing on legal frameworks for child protection and juvenile justice, and the role of forensic professionals in cases involving minors.

The conference had also received about 75 abstracts. A total of 42 oral scientific presentations and 33 E-poster presentations were presented by various faculty, post graduate and undergraduate students over a period of the two days event. The presentations were appreciated by all the delegates. The Annual General body meeting (**Photograph 6**). of Medicolegal Association of Maharashtra was conducted from 05:15 pm on 28th October 2023. Various issues related to faculty of Medicolegal association of Maharashtra were discussed. This was followed by another much-awaited event, i.e., banquet to enable the delegates to interact with the eminent academicians and researchers. As guests enjoyed their meals, the highlight of the evening was the performance by a live orchestra. The combination of rich food, live music, and fine company created a memorable experience for all attendees.

Photograph 6: Forensicon 2023- MLAM Executive committee at Annual General Body Meeting.

Day 2 scientific sessions were started with a lecture series on Medical Jurisprudence. Dr. Ravindra Deokar, Professor of Forensic Medicine & Toxicology at Seth G. S. Medical College, Mumbai and Senate member, MUHS, Nashik, provided a detailed **overview of the legal and regulatory frameworks surrounding organ transplantation** in India[5], including the Human Organ Transplantation Act (HOTA), and the roles of various organizations like the National and Regional Organ & Tissue Transplantation Organizations (NOTTO, ROTTO, SOTTO), as well as State and District-level Transplantation Coordination Committees (ZTCC, NTORC).; **Recent Judgments in Relation to Medical Negligence** by Dr Mukesh Yadav Principal, Government Allopathic Medical College, Banda, Uttar

Pradesh, India discussed recent judicial decisions related to medical negligence, shedding light on how the courts have interpreted and applied legal principles to medical practice in India.; **Legal Challenges in Telemedicine and Digital Health**[6,7] by Adv. Mahendrakumar Bajpai, Advocate, Supreme Court of India, Hon. Director, Institute of Medicine & Law, Editor Emeritus, Medical Law Cases- For Doctors focused on the emerging legal complexities surrounding telemedicine and digital health platforms. He explored regulatory, privacy, and malpractice issues that healthcare providers face as telemedicine becomes more widespread in India and globally; Laws in Relation to Violence Against Doctors: **Patient Rights and Professional Safety** by Dr Rajesh Dere, Prof. & Head, Department of Forensic Medicine & Toxicology, LTMMC Sion, Mumbai In-charge Dean, BKC Jumbo Covid Center, Senate Member, MUHS, Nashik addressed the growing issue of violence against healthcare professionals.[8,9] He discussed the legal safeguards available for doctors' safety, patient rights, and the role of law enforcement and government in protecting medical practitioners from violence while ensuring quality patient care.

The session of the panel discussion on the **Upgradation of Medicolegal Services in the State** brought together a range of experts who discussed key initiatives and challenges in improving the quality and efficiency of medicolegal services in Maharashtra. The esteemed panellist included Dr. Abhinav Deshmukh (IPS) (Additional Commissioner of Police, South Zone, Mumbai), Dr. Sangeeta Ghumatkar (Director of the Directorate of Forensic Science Laboratory, Maharashtra), Dr. Mandar Karmarkar (Principal and Dean of Bharati Vidyapeeth Medical College, Pune), Dr. Ashok Nandapurkar (Deputy Director of Health Services, Konkan Division, Thane), Dr. Kapildeo Patil (Police Surgeon at Nagpada Police Hospital, Mumbai), Adv. Roopshree Kanojia (Public Prosecutor at Dindoshi Sessions Court, Mumbai), Mr. Santosh Shinde (Child Rights Activist, Mumbai). It was moderated by Dr Shashank Tyagi, Asst. Prof., FMT, MAMC, New Delhi. This session explored how diverse stakeholders, including police, healthcare professionals, legal experts, and activists, are working together to enhance medicolegal services in Maharashtra, aiming for a more integrated and effective system.

Photograph no.7: Forensicon 2023- Post-valedictory function memoria.

This was followed by lecture series on “Recent Advances & Disaster Management”. It included a wide range of lectures by esteemed speakers. Virtual autopsy Comparative Analysis: Traditional Autopsy vs. Virtual Autopsy, Its Advantages and Limitations by Dr Rajesh Bardale Prof. & Head, Department of Forensic, Medicine & Toxicology, Government Medical College Miraj discussed the emerging field of **virtual autopsy** (or "virtopsy"); Designing Modern Postmortem Complex

by Dr Shailendra Dhawane Professor, Department of Forensic Medicine & Toxicology, GMC, Nagpur poke about the design and infrastructure of modern **postmortem complexes,** emphasizing the need for well-equipped, hygienic, and efficient spaces for conducting postmortem examinations.; Artificial Intelligence and Biomedical Engineering in Medical Education and Healthcare Services by Dr Sachin Sarate, Assistant Professor & Campus Doctor, Dept of Biomedical Engineering, SSN Trust, Kalavakkam, Tamil Nadu explored the role of **artificial intelligence (AI)** and **biomedical engineering** in **medical education** and **healthcare services**. His demonstration enthralled the audience. Dr. Sachin S. Sonawane, Additional Professor in the Department of Forensic Medicine & Toxicology at HBT Medical College, Mumbai, addressed the importance of a well-structured **Hospital Disaster Management Plan** and concluded the conference.

Photograph no.8: Forensicon 2023- Organising team

The **Forensic Medicine Quiz for Undergraduate Students ForensiQUEST 2023** was an engaging and educational event designed to test the knowledge and understanding of medical students in the field of forensic medicine. The quiz format was both **interactive** and **stimulating**, encouraging students to think critically and apply their theoretical knowledge to hypothetical scenarios as well as seeing forensic medicine in pop culture. It was conducted in a friendly competitive spirit, allowing students to engage with each other, exchange ideas, and learn from the experience.

The **Valedictory Function** of the conference marked the conclusion of the event, bringing together key highlights from the sessions and expressing gratitude to all the speakers, participants, and organizers. Prize distribution to the various winners were also done in both oral and E-poster presentation for faculty and post graduate students. The function concluded with closing remarks that emphasized the importance of **knowledge-sharing, professional development**, and **continuous learning** in addressing the evolving challenges in the fields of **forensic science, medicolegal practice**, and **healthcare law.** Delegates were urged to apply the insights gained at the conference in their respective fields and to continue fostering collaboration between medicine, law, and technology. A vote of thanks was delivered, recognizing the valuable contributions of all involved in the event's planning and execution, and wishing everyone success in their future endeavors and the function ends with post-valedictory photo session (**Photograph 7 & 8**).

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References:

1. Varma NM, Pawar MN, Deokar RB. Executive Summary of the Forensicon 2022 - 25th Annual State Conference of Medicolegal Association of Maharashtra (MLAM). J Forensic Med Sci Law. 2023; 32(2):80-4.
2. Deokar RB, Patil SS. Avenues in Forensic Medicine. J Forensic Med Sci Law 2023; 32(2):1-3.
3. Deokar R, Bhise S, Patil S. J. of Forensic Medicine, Science & Law 2023; 32(1): 1-109
4. Dere RC, Kukde HG, Deokar RB, Patil SS, Kumar NB. Executive summary of the XXIV State Annual conference of Medicolegal Association of Maharashtra (MLAM): Forensicon 2021. J Forensic Med Sci Law 2022;31(1):84-8.
5. Deokar RB, Patil SS. Issues Related to Cadaver Organ Retrieval in Medicolegal Cases. J Forensic Med Sci Law 2022;31(2):1-3.
6. Singh SN, Singh D, Dev K, Mittal AK, Srivastava A. Anti-Forensics: Tool Against Cyber Forensic. J Forensic Med Sci Law 2023;32(1):68-73.
7. Amrita A, Deokar RB. Clinical Forensic Psychology: It's Emergence, Significance and Application in India. J Forensic Med Sci Law 2022;31(2):80-83.
8. Deokar RB, Patil SS. Violence against Doctors: Prevention, Administrative and Legal Recourse. J Forensic Med Sci Law 2023; 32(1):1-3.
9. Arthy A, Rathod SN, Goel R. Role of Checklists in Medicolegal Death Investigation. J Forensic Med Sci Law 2023;32(1):91-94.

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Short Communication

Legally Safe Medical Documentation: Ensuring Compliance and Patient Protection

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Abstract

In the domain of healthcare, sound and legally safe medical documentation is indispensable. It serves as a comprehensive record of patient care, facilitates communication among healthcare providers, and plays a crucial role in legal proceedings and regulatory compliance. Despite its importance, achieving legally sound medical documentation are associated with numerous challenges for healthcare providers and organizations. Common issues include illegible handwriting, inconsistent terminology, copy-and-paste errors, and failure to document essential clinical information in chronological order. By adhering to legal standards, maintaining accurate records, obtaining informed consent, ensuring data security, and investing in training and education, healthcare providers and organizations can to a great extent minimize legal risks, protect patient rights, and uphold the highest standards of care.

1. Introduction

The In the domain of healthcare, robust and legally safe medical documentation is indispensable. It is the cornerstone of healthcare delivery. It includes detailed record of a patient's medical history, examination findings, diagnoses, treatments, and outcomes. Despite its significance, medical documentation in many cases found to be incomplete, inconsistent, and many a times inaccurate, which can compromise patient safety and quality of care. Therefore, there is an urgent need for a collective effort to improve medical documentation practices in hospitals to ensure accuracy, efficiency, and patient-centric care. Comprehensive medical documentation plays a critical role in legal proceedings and regulatory compliance. However, achieving legally safe documentation requires adherence to stringent standards, meticulous attention to detail, and a commitment to ethical practice.

In this article, we will layout best practices for healthcare professionals to ensure legally safe medical documentation, thereby promoting

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patient safety, minimising legal risks, and endorse the integrity of the healthcare system.[1,2]

2. The Importance of Quality Medical Documentation

Medical documents provide a comprehensive account of a patient's medical history, enabling healthcare providers to make informed decisions about management of the patient. In addition, accurate documentation supports effective communication among interdisciplinary healthcare teams, ensuring that all healthcare members are adequately informed and coordinated in their efforts to deliver optimal care to the patients. In today's healthcare scenario, medical documentation plays a key role in legal matters ranging from malpractice claims to regulatory audits. Accurate and comprehensive documentation not only supports clinical decision-making and continuity of care but also serves as a legal record of healthcare services provided. Legally sound medical documentation will be of great help to healthcare providers in defence against malpractice allegations against them.[3,4] Inadequate or inconsistent medical documentation can expose healthcare providers to legal liabilities, compromise patient safety, and spoil professional reputation.[5,6]

3. Challenges in Medical Documentation

Despite its significance, medical documentation faces various challenges that can compromise its quality and integrity. Common issues are illegible handwriting, inconsistent terminology, absence of standardized templates and guidelines, copy-and-paste errors, failure to timely and chronologically record relevant clinical information about the patient. Apart from this, time constraints and competing priorities often lead to incomplete or hasty documentation, thus increasing the risk of errors and omissions. In addition, medical documentation serves as a legal and financial record, supporting billing, insurance claims, and compliance with regulatory requirements. Legally sound medical documentation can help healthcare providers defend against malpractice allegations, demonstrate compliance with regulatory standards, and ensure fair reimbursement for services rendered. On the other hand, inadequate or inconsistent documentation can expose healthcare providers to legal liabilities, jeopardize patient safety, and damage professional reputation. Transition from paper-based health records to electronic records has added new complexities, including concerns about data security, privacy breaches, and interoperability issues. These challenges not only compromise the quality of patient care but also contribute to physician burnout and dissatisfaction

4. Best Practices for Legally Safe Medical Documentation

Addressing the deficiencies in medical documentation requires a multifaceted approach involving technology, education, and workflow redesign. Healthcare institutions must invest in user-friendly EHR systems that prioritize interoperability and customization to meet the diverse needs of providers and specialties. Regular training programs should emphasize the importance of comprehensive documentation practices, including proper coding and documentation integrity.

Several strategies can be implemented to address the challenges associated with medical documentation and improve its quality, healthcare organizations and providers.

a. **Adherence to Legal and Regulatory Standards:** Healthcare providers must keep themselves updated on relevant laws, regulations, and industry standards governing medical documentation. Adhering to these standards ensures compliance with patient privacy, confidentiality, and data security requirements, laying the foundation for legally safe documentation practices.

b. **Comprehensive and accurate documentation:** It is paramount in legally safe medical practice. Documentation of informed consent is very important.[7] Healthcare providers should meticulously record all patient interactions, assessments, diagnoses, treatments, and outcomes in a chronological manner. Avoiding vague or ambiguous language, using standardized templates and terminology, and ensuring legibility contribute to a large extent to the clarity and reliability of medical records. Obtaining informed consent is not only an ethical imperative but also a legal requirement in medical practice. Healthcare providers should engage patients in meaningful discussions about proposed treatments, procedures, and potential risks associated with it, ensuring they understand their options and can make informed decisions about

their care.[8] Documenting these discussions, including patient questions, concerns, and preferences, helps establish evidence of informed consent and protects in future against allegations of negligence or lack of consent. Health care provide should give clear instructions for follow-up care, including medication instructions, referrals to specialists, and recommendations for ongoing monitoring or treatment. Any education provided to the patient or caregiver regarding their condition, treatment plan, self-care instructions, and potential complications should be comprehensively documented. If consultations or referrals are made to other healthcare providers, document the reason for the consultation or referral. If the patient is non-compliant with recommended treatment or follow-up, document efforts made to address non-compliance and the patient's understanding of the risks associated with non-compliance. With advancement of technology and innovations artificial intelligence based system may be used.[9]

c. **Utilization of Electronic Health Records (EHRs):** Transition from paper-based records to electronic health records (EHRs) to improve legibility, accessibility, and accuracy of medical documentation.[10] However, healthcare providers must exercise caution to ensure the legal integrity of electronic documentation. Implementing robust EHR systems with encryption, access controls, audit trails, and regular security audits, peer reviews and feedback mechanism helps safeguard patient information and maintain compliance with data protection laws. In addition to this, providing training to staff on proper use of EHRs and adherence to documentation protocols enhances the accuracy and legality of electronic medical records.

d. **Continuous Training and Quality Assurance:** Regular education and training are essential for promoting a culture of compliance and accountability in medical documentation. Healthcare organizations should organise regular training sessions and resources to healthcare providers and staff on best practices, legal requirements, and emerging issues in documentation.

e. **Conduct regular Audits and Reviews:** Implement quality assurance measures, including regular audits and reviews of medical documentation, to identify deficiencies, errors, and areas for improvement. Provide feedback to healthcare providers and offer training opportunities to enhance documentation practices and compliance with legal standards

5. Conclusion

Legally safe medical documentation is a cornerstone of ethical healthcare practice, patient safety, and legal risk management. By adhering to legal and regulatory standards, maintaining thorough and accurate documentation, obtaining informed consent, handling electronic health records responsibly, and investing in continuous training and quality assurance, healthcare professionals can uphold the highest standards of professionalism and integrity in documentation practices. In doing so, they not only protect themselves and their patients from legal liabilities but also contribute to the delivery of safe, high-quality healthcare services.

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References:

1. Shreekrishna HK, Mohan Kumar S. Legal aspect of medical records. Int J Preclin Clin res. 2022; 3(2): 66-8.
2. Thomas GG. Fundamentals of medical record documentation. Psychiatry. 2004;1(3): 26-8.
3. Pawar HJ, Pawar MN. A study of impact of medical records on healthcare management at tertiary care teaching hospital. J Forensic Med Sci Law. 2020;29(2):7-13.
4. Deokar RB, Patil SS. Bhise SS. Medicolegal Cases in Hospitals. J Forensic Med Sci Law 2018; 27(2):1-2.
5. David K, Huerta JM, Dobbs CA, Dukes DL, Kathy K. Medical Record documentation for patient safety and physician defensibility. MIEC 2008: 1-33.
6. Patil SS, Deokar RB, Dere RC. Euthanasia and Living Will - Right to Die with Dignity: A Literature Review. J Forensic Med Sci Law 2023;32(2):75-79.
7. Khairkar C B, Consent in Context to medical Practice J Forensic Med Sci Law 2018;27(2):15-18.
8. Amrita A, Deokar RB. Clinical Forensic Psychology: It's Emergence, Significance and Application in India. J Forensic Med Sci Law 2022;31(2):80-83.
9. Deokar RB, Patil SS. Artificial Intelligence in Healthcare and Biomedical Research - Ethical aspects. J Forensic Med Sci Law. 2024;33(1):1-4.
10. Kattamreddy AR, Ganja CD, Khan MT. A strong need for digitalization in medico-legal practice in India. J Forensic Med Sci Law. 2021;30(1):69-71.

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Case Report

Comparative Analysis of Post-mortem CT and Autopsy Findings in Abdominal Trauma- A Case Report

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Abstract

Introduction: Medico legal autopsy plays an important role in cases of unnatural death. The opinion framed after the autopsy helps the investigative agency to solve the crime. The value of detailed post-mortem examination findings is significant for the Indian Medico legal System. Maintaining the sensitivity and specificity of the examination methods is crucial. **Case report:** A 50-year-old male body was received for post-mortem examination with a history of assault. Before starting a conventional autopsy, PMCT was performed by the Faculty of Radiology. After the PMCT, we performed a conventional post-mortem examination. Here, we compared the findings of both PMCT and conventional autopsies. **Discussion:** Despite being the world's largest democracy, our country's healthcare sector remains inaccessible to the less affluent population. The government endeavours to extend its reach through limited resources. Ironically, some prominent institutions recommend that the central government mandate the establishment of PMCT facilities across the nation, even though they are not considered the optimal standard. Diagnostic services such as CT and MRI are unavailable for many people in India, so how can authorities establish PMCT facilities? **Conclusion:** Understanding the strengths and limitations of newer post-mortem techniques is important. We cannot discard any old methods and adopt a new technique only in the name of advancement.

1. Introduction

Cases involving traumatic deaths require a thorough examination to determine the cause and nature of the injuries.[1] This is important for both legal and medical purposes. Post-mortem imaging, such as computed tomography (CT), is becoming increasingly valuable in providing detailed insights into the extent and characteristics of traumatic injuries.[2] Accurate evaluation of chest and

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abdominal wounds is crucial for determining the cause and manner of death, particularly in forensic investigations.[3,4] While conventional autopsy is still considered the most reliable method for post-mortem examination, post-mortem computed tomography (PMCT) has shown significant potential in improving the visualisation of internal injuries and facilitating the forensic evaluation of trauma-related deaths.[5]

In India, providing basic healthcare support is a significant challenge for both central and state governments. The healthcare system is characterized by a mix of public and private providers, with the government playing a crucial role in service delivery. While forensic experts widely endorse virtual autopsy/PMCT, India's lack of infrastructure, financing, and a shortage of specialists and insurance coverage raise doubts about the feasibility of establishing PMCT facilities nationwide. Although the system faces several obstacles such as inadequate financing, inadequate infrastructure, shortage of healthcare specialists, and limited insurance coverage, the question of establishing a CT scan facility for post-mortem purposes arises.[6,7] In this case report, we aimed to compare the findings of post-mortem CT with those of conventional autopsy methods for assessing blunt trauma to the chest and abdomen. By conducting a comparative analysis of post-mortem CT and conventional autopsy findings, we sought to shed light on the potential benefits and limitations of post-mortem imaging in evaluating blunt-force injuries of the chest and abdomen. Understanding the strengths and weaknesses of these two approaches can ultimately contribute to improving the accuracy and reliability of forensic assessments in cases of traumatic deaths.

2. Case Report-

The deceased, a 50-year-old individual, was brought to the Forensic Medicine department by the police for post-mortem examination. According to previous reports, the individual sustained multiple injuries to the chest and abdomen due to assault using a wooden stick. Before the standard autopsy procedure, a non-contrast, thin, contagious helical MDCT scan of the chest and abdomen was performed using a GE Optima 128 slice CT scanner. The findings showed evidence of a fracture in the left 7th, 8th, and 9th ribs, accompanied by mild-to-moderate free fluid in the peritoneal cavity, particularly in the splenorenal area. In addition, the fracture caused splenic splitting (**Fig 1**).

Fig 1- Spleen splitting on PMCT.

Fig 2- Inverted Y-shaped incision.

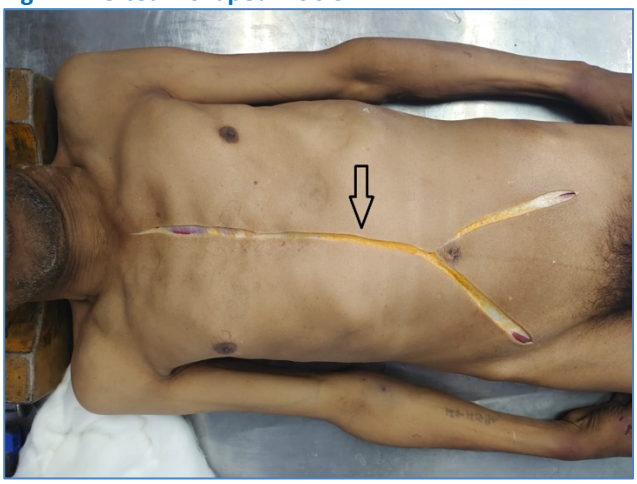
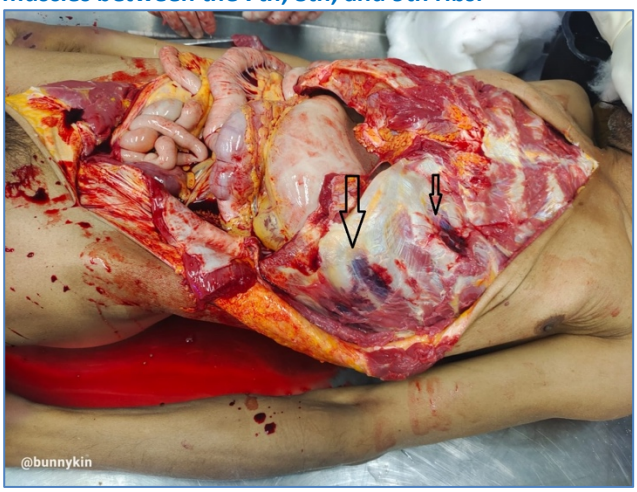


Fig 3- Blood extravasation surrounds the intercostal muscles between the 7th, 8th, and 9th ribs.



In the conventional autopsy, a 5 × 3 cm bruise was observed on the left lower lateral region of the chest, specifically at the 7th, 8th, and 9th ribs along the anterior axillary line. To enhance visualization of internal injuries in the lower chest and abdomen, an inverted "Y" shaped incision is made on the skin (**Fig 2**). An area of blood extravasation surrounding the

intercostal muscles between the 7th, 8th, and 9th ribs was observed, accompanied by fractures of the corresponding ribs along the anterior axillary line (**Fig 3**). Further investigation revealed a diaphragmatic laceration underneath the fracture site extending to the spleen (**Fig 4**). As a result of the laceration of the spleen, 1700 ml of blood was found in the peritoneal cavity (**Fig 5**).

Fig 4- Diaphragmatic laceration underneath the fracture site.

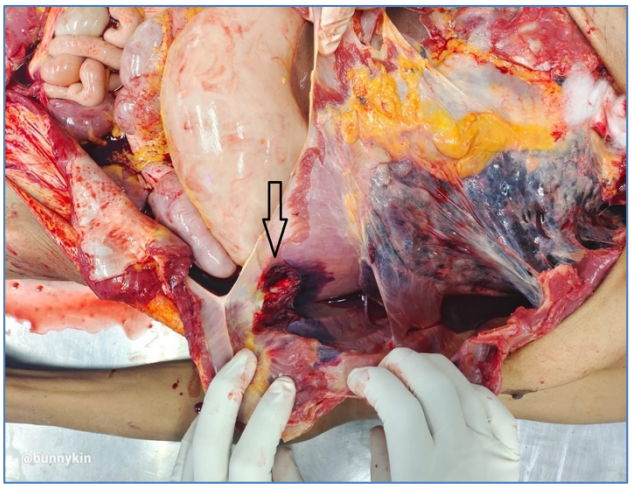
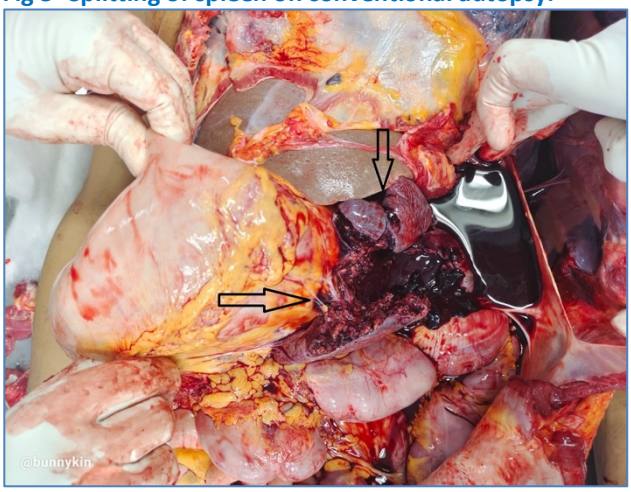


Fig 5- Splitting of spleen on conventional autopsy.



The final cause of death opined as 'Injury sustained to chest and abdomen as a result of blunt force impact leading to hypovolemic shock". PMCT was performed by Professor and Head of the Radiology Department, accompanied by a Senior Resident from the same department. In contrast, an Associate Professor and a final-year Resident of the Forensic Medicine department conducted Conventional Post-mortem examinations.

3. Discussion-

Interestingly, despite being the world's largest democracy, Indian states spend only about 1% of their net state domestic product on public healthcare, which is below the world average. This results in high out-of-pocket healthcare expenses and poor health outcomes. However, political competition in a democratic setup such as India is believed to drive governments to increase spending on public healthcare to win elections, as evidenced by empirical analysis.[6] Providing essential healthcare services in countries such as India is challenging for the central and State Governments. To overcome these challenges, Niti Ayog and the WHO developed policies for establishing a public-private partnership model to inculcate various diagnostic services, including CT scans, across India.[7] Conversely, several top institutions in India have advocated virtual autopsy/PMCT over conventional autopsy methods, and have suggested that all medical colleges and institutes nationwide adopt this approach. They also recommended that the Apex body, the National Medical Council (NMC), and other institutes of national importance should propose this as a compulsory curriculum, aiming to make it mandatory for all medical colleges.[9,10] Virtual autopsy, also known as PMCT, is increasingly being recognized as a valuable tool in forensic medicine. It is a non-invasive alternative to conventional autopsy, providing detailed insights into the cause of death through advanced imaging techniques. Studies have shown that PMCT can improve the diagnosis of the traumatic causes of death. Moreover, virtual autopsies can reveal findings such as air embolism and wound tracks, which might be challenging to visualize in a traditional autopsy.[11,12] However, a virtual autopsy may not always substitute a traditional autopsy because of its inability to perform histopathological and microbiological examinations, which are crucial for specific diagnoses.[13] There are various advanced techniques and innovations are important in future development of Forensic Medicine.[14-16]

The Effectiveness of PMCT varies depending on the nature of the case, such as being more consistent with traditional autopsies in traffic accidents but limited in cases of sudden cardiac death.[17,18] In the present case of a road traffic accident, even though PMCT was conducted by the senior faculty of the radiology department, it failed to detect laceration of the diaphragm and the presence of 1700 ml of blood in the peritoneal cavity.

4. Conclusion-

Virtual autopsies offer a promising alternative to traditional methods, although they

encounter financial and diagnostic challenges. They can be particularly useful as complementary tools or preliminary steps before conventional autopsies are conducted. To realize the full potential of virtual autopsies, it is essential to recognize their advantages and constraints and integrate them into a comprehensive diagnostic approach rather than treating them as an independent method.

Contributor ship of Author: All authors equally contributed.

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References:

1. Adams VI. Guidelines for reports by autopsy pathologists. Springer Science & Business Media; 2008 Dec 24.
2. Gascho D, Bolliger SA, Thali MJ, Tappero C. Postmortem computed tomography and magnetic resonance imaging of an abdominal gunshot wound. Am J Forensic Med Pathol. 2020 Jun 1; 41(2):119-23.
3. Spitz WU. Sharp Force Injury (From Medicolegal Investigation of Death: Guidelines for the Application of Pathology to Crime Investigation, P 532-606, 2006, Werner U. Spitz and Daniel J. Spitz, eds.--See NCJ-214126).
4. Ramteke BW, Karmakar SN, Tumram NK. Autopsy Based Study of Craniocerebral Injuries in Dependent Age Groups in Central Indian Population. J Forensic Med Sci Law. 2021; 30(1): 4-10.
5. Cha JG, Kim DH, Kim DH, Paik SH, Park JS, Park SJ et al. Utility of postmortem autopsy via whole-body imaging: initial observations comparing MDCT and 3.0 T MRI findings with autopsy findings. J Korean Radiol. 2010; 11(4):395-406.
6. Kumari R. Healthcare in India: Challenges and Innovative Solutions. In Global Issues and Innovative Solutions in Healthcare, Culture, and the Environment 2020 (pp. 195-205). IGI Global. Available from: https://www.igiglobal.com/gateway/chapter/254993
7. Datta S. Political competition and public healthcare expenditure: evidence from Indian states. Social Science & Medicine. 2020; 244:112429. [Cited on 12th Jan 2024]. Available from: https://www.sciencedirect.com/science/article/abs/pii/S027795361930423X
8. Government of India, New Delhi. Best Practices in the Performance of District Hospitals. Niti Aayog. Ministry of Health and Family Welfare; 2021.[Cited on 12th Jan 2024]. Available from: file:///C:/Users/srushti/OneDrive/Desktop/Annexure%20Arijit%20sir/srushti%20poster/DistrictHospital_Report_for_digital_publication.pdf%23_~_text=The%20Government%20of%20India%20is%20committed%20to,o.pdf
9. Yadukul S, Parmar P, Srirambhatla A, Arora AJ, Mada P, Reddy D. Virtual autopsy in India: The need of the hour. J Forensic Med Toxicol. 2022; 39(2):4-7.
10. Gupta S. Standard Guidelines for Dignified Autopsy in Covid-19 Deaths. All India Institute of Medical Sciences; Department of Forensic Medicine & Toxicology; New Delhi. [Cited on 12th Jan 2024]. Available from: https://www.aiims.edu/images/pdf/notice/COVID-19_Forensic_stamdard%20guidline_6-5_20.pdf
11. Sonnemans LJ, Kubat B, Prokop M, Klein WM. Can virtual autopsy with post-mortem CT improve clinical diagnosis of cause of death? A retrospective observational cohort study in a Dutch tertiary referral centre. BMJ open. 2018; 8(3): e018834.
12. Persson A, Lindblom M, Jackowski C. A state-of-the-art pipeline for post-mortem CT and MRI visualization: from data acquisition to interactive image interpretation at autopsy. Acta Radiologica. 2011; 52(5):522-36.
13. Rüegger CM, Bartsch C, Martinez RM, Ross S, Bolliger SA, Koller B, et al. Minimally invasive, imaging-guided virtual autopsy compared to conventional autopsy in foetal, newborn and infant cases: study protocol for the paediatric virtual autopsy trial. BMC Pediatrics. 2014; 14:1-5.
14. Deokar RB, Patil SS. Avenues in Forensic Medicine. J Forensic Med Sci Law 2023;32(2):1-3.
15. Patil SS, Deokar RB, Dere RC, Keoliya AN. Molecular Autopsy in Sudden Unexpected Death: A Review. J For Med Sci Law 2023;32(1):74-79.
16. Deokar RB, Patil SS. Artificial Intelligence in Healthcare and Biomedical Research - Ethical aspects. J Forensic Med Sci Law. 2024;33(1):1-4.
17. Salankar A, Ramteke R, Murkey PN, Shende S, Barmate N. Evaluation of Fatal Craniocerebral Injuries. J Forensic Med Sci Law 2023;32(1):20-24.
18. Ma L, Liang R, Liu Y, Shi Q, Xu X, Yang L, et al. Comparative analysis of CT virtual autopsy and traditional autopsy: a report of 3 cases. J Forensic Sci Med. 2020; 6(4):148-51.