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Editor

Dr. Manish Nigam

Professor & Head

Department of Forensic Medicine and Toxicology

Government Medical College, Vidisha, Madhya Pradesh

Email : editorjiafm2022@gmail.com



Joint Editor

Dr. Siddhartha Das

Professor

Department of Forensic Medicine and Toxicology

JIPMER, Puducherry

Email : jointeditor.jiafm2022@gmail.com

Appointed as Support System in Editorial Team



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Department of Forensic Medicine and Toxicology

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Department of Forensic Medicine and Toxicology

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Email : vivekchoukseymd@gmail.com

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Editorial Office

Dr. Manish Nigam

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

Mobile: +91-9826213412

E-mail: editorjiafm2022@gmail.com

Account details

Name : Indian Academy of Forensic Medicine

A/c. : 327101000763

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

Wish you all a very happy festive season which is around the corner waiting for colourful days to come!!

I am delighted at this moment because we are **halfway through** and have completed 6 issues of JIAFM out of a total 12 which were entrusted upon this editorial team in 3 years tenure and releasing the 7th one i.e. 3rd issue of volume 45. I as editor express my gratitude and happiness since we have gained as well as received confidence from our readers, authors, IAFM life members and my own editorial team and it's because of this that we are ready to take on more challenging tasks. We are continuously trying hard to do our best by putting in our continuous efforts, to upgrade at every step.

As informed a dedicated website for JIAFM '<https://jiafm.in>' has been set up and is fully functional. It has a submission portal, with authors getting regular updates on successful submission, acceptance, or review processes along with a payment gateway, through which manuscript handling charges can be paid. The best part of this new website is a section of archives, in which the articles have been uploaded separately in JATS (XML) format, where authors can retrieve their published articles free of cost. Search engines can display the article of relevance to the authors, based on keywords. The subscribers can place orders through this website.

Dr. Siddhartha Das as Joint Editor; **Dr. Mandar Sane**; **Dr. Narendra Patel** as Associate editors and **Dr. Vivek Chouksey** as Assistant editor; **Dr. Richa Nigam** as Research and Statistical Editor; and **Mr. Chain Singh Lodhi** as the technical editor, have been supporting me throughout the journey of bringing up JIAFM volume 45 (3).

We would like to inform all the readers that, we have also applied for **indexing JIAFM in DOAJ**, which is another step ahead as promised. It will take some time till then we will be providing all the documents to them as and when asked. This is entirely a new beginning and a new experience for us, and shortcomings are bound to come, which we all would be happy to receive from you through our official email ID (editorjiafm2022@gmail.com), or can call me directly, which we will try to resolve with time. The editorial board will be thankful to everyone for the suggestions, and guidance with a positive approach.

I honestly thank our **reviewers**, without whom we would not have come up with a quality issue as was desired. The names of reviewers who supported us have been added to the last page of the journal. They supported with sufficient reasons and detailed suggestions for the authors so that they could improvise, revise, or resubmit their work accordingly. I give my sincere thanks to all the **authors** who showed enough patience in the queue while waiting for their turn to undergo a lengthy review process before publication. I thank you all for your cooperation and continued support in the year 2023.

Best wishes!

Sincerely



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

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

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

EDITORIAL**Comprehensive review of 3 Indian Articles****Dr. Cuthbert Eng-Swee TEO**

Senior Consultant Pathologist & Gazetted Forensic Pathologist, Health Sciences Authority of Singapore

I have chosen to write on 3 topics based on recent papers by Indian authors which I read !!

Dental Autopsy :

In their article published on 22 April 2023, Kohli and Puri (Amity Institute of Forensic Sciences, Uttar Pradesh) stated that “dental autopsy” research or literature is lacking in India and still facing a challenge for human identification through dental evidence. The dental autopsy was reviewed by Roy et al (authors from National Forensic Sciences University and Pramukhswami Medical College, Gujarat). Kohli and Puri referred to a virtual dental autopsy as a more recent method of generating a post mortem dental profile. Since the advent of the virtual autopsy, the application of dentistry in the virtual autopsy has been of interest. For example, in 2016, Vadivel (Saveetha Dental College and Hospital, Chennai) mentioned the application of virtual autopsies in forensic odontology. In 2020, the medico-legal section of the University of Turin started a research project to study the feasibility of remote dental autopsy. Kohli and Puri emphasized that “a systematic and precise method must be adopted to facilitate the postmortem dental profile in India.”

Post Mortem Neck CT Scan :

In 2022, in a paper from the Department of Forensic Medicine and Toxicology, All India Institute of Medical Sciences, Uttarakhand), Chaudhary et al discussed their observations on post-mortem CT imaging in penetrating neck injuries. They conclude that PMCT can add value for detecting additional findings regarding the cause of death, but they are adamant that the conventional autopsy approach is still necessary for investigation, and that one must recognize the advantages and disadvantages of each approach. Post-mortem dissection of the common carotid arteries in the neck is a relative procedure. Post-mortem evaluation of the vertebral arteries is much more difficult. In a recent paper, Hulme et al describe the indications for the procedure, the method as completed in our institution (in Palmerston North, New Zealand), imaging findings and problem-solving. The method involves leaving the brain, cervical arteries, and the aortic arch in situ, while the rest of the autopsy is completed in a routine manner. Their institution rely on the availability of equipment and staffing in a general hospital, and they have an expectation of the release of the body within 24 hours. Their method is therefore designed to be time-efficient and suitable for staff who may not have much experience in post-mortem imaging.

Pesticide Poisoning and Deaths:

Pesticide (particularly organophosphates) related deaths, and particularly in suicides, remains a serious public health problem in India; and some pesticide bans appear to have decreased the rates of pesticide suicides. Deaths from organophosphate compounds are significantly higher compared to poisoning-

related deaths due to pyrethroids. In their paper in the March 2023 issue of the American Journal of Forensic and Pathology, the authors (from AIIMS, Bhubaneswar, Odisha) remind us that while pyrethroids are considered safer compared to organophosphates, deaths due to pyrethroids can occur. They describe a fatal case of poisoning by Lambda-cyhalothrin (LCH), due to neurotoxicity, in a farmer who was exposed after an accidental pipe burst in a sprayer. In children in India, pesticide poisoning includes organophosphates, paraquat, pyrethroids, and rodenticides. According to a study published a year ago in April 2022, the younger paediatric population in India are commonly poisoned by accidental ingestion, unintentional dermal or inhalational exposure, whereas adolescents are more severely poisoned if attempting self-harm through intentional ingestion. The authors of this study discuss the possible policy options to try to solve the pesticide poisoning among children in India: (1) Restrict pesticide availability, (2) Educate the pesticide user, (3) Establish more poison control centres.

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- Dr. Cuthbert Eng-Swee TEO
Senior Consultant Pathologist &
Gazetted Forensic Pathologist
Health Sciences Authority of Singapore

Introduction to author of this editorial :

Dr. Cuthbert Eng-Swee TEO is Senior Consultant Pathologist and Gazetted Forensic Pathologist with the Health Sciences Authority of Singapore. In the Forensic Medicine Division, he was formerly Head of Clinical Forensic Services, Head of Administrative Services, Branch Director of Operations, and Branch Director of Technical Services. He was also formerly Deputy Director of Clinical Standards and Technology Assessment, Ministry of Health (MOH) of Singapore. He is trained in Forensic pathology and Medicine in Singapore and UK, and in the field of Family Violence and Child Abuse & Neglect in California, USA. He is an Adjunct Associate Professor (Forensic Science) at the Department of Biological Sciences, Faculty of Science, National University of Singapore (NUS); and a Senior Lecture (Forensic Medicine) at the Yong Yoo Lin School of Medicine, NUS. In the medical field, he sits on various committees, including Singapore Medical Council (Complaints Committee, Panel of Medical Assessors), the Academy of Medicine of Singapore (AMS), and the Singapore Medical Association (SMA). In the AMS, he Chaired in Chapter of Pathologists. In the AMS, he has been involved in the teaching of Medical Ethics and Professionalism, and currently involved in the 'Medical Expert Witness' course (co-organised with the SMA, and supported by the QZ8501 crash (2015); the Pingat Pentadbiran Awam, Gangsa (Singapore national award, Public Administration Medal, Bronze) (2015).



ORIGINAL ARTICLE

Clinical Importance of Foramen Magnum Measurements for Determining Sex - CT Scan Based Study using Discriminant Function Analysis

Bhoi S,¹ Das S,² Subramania DB,³ Mishra A,⁴ Ganapathy S,⁴ Ravi K.⁵

1. MBBS student, JIPMER, Puducherry.

2,5. Department of Forensic Medicine & Toxicology, JIPMER, Puducherry.

3. Department of Radiodiagnosis, JIPMER, Puducherry.

4. Department of Biostatistics, JIPMER, Puducherry.

Abstract:

Identification of an individual is one of the important objectives of an autopsy. In forensic practice, partial identification from the bones in the form of sex is possible from the bones or any part of it. Foramen magnum (FM) measurements from skull or Computer Tomography (CT) scan images are useful for determining sex in different populations. The present study was undertaken with an objective to assess the clinical importance of FM measurements for determining sex from CT scan images in a south Indian population.

The parameters studied were the length and breadth of foramen magnum, foramen magnum index (FMI) and area of foramen magnum (AFM). The sample size was 384 consisting of 245 males and 139 females of south Indian origin. Independent student t-test showed that all the studied parameters except FMI was significantly different between the two sexes. Discriminant function analysis was used to differentiate sex from the measured parameters by using the split data method. Foramen magnum length (FML) was the best sex differentiating predictor with an accuracy of 70.9%. When all the parameters were taken together the accuracy increased marginally to 71.5%. FM measurements can be used to determine sex from CT scan measurements in a south Indian population but it is better to use it as an adjunct to other methods to increase the precision.

Keywords: Foramen magnum measurements; Computer tomography scan; South Indian population; Sex determination; Discriminant function analysis.

Introduction:

Sex determination is an essential criterion for establishing the partial identity of an individual. In many cases sexing of the deceased is done with the help of their skeleton. This situation may arise during mass disasters or homicide where only some body parts of the deceased are recovered. Accuracy of sex determination from analysis of long bones, skull, pelvis, pelvis and skull, entire skeleton was found to be 80%, 90%, 95%, 98% and 100% respectively.¹ The skull bone and its parts have a significant role in establishing the sex of an individual. The FM of skull remains well preserved and intact even during conditions of tremendous trauma or natural calamities owing to its compact anatomical structure and concealed location, especially due to the occipital condyles which encompasses it bilaterally. This significantly increases the utility of FM in sex determination.

Studies that have been done to evaluate the utility of FM measurements in determining the sex have utilised dry skulls mainly. In general, morphometric details of FM on dry skulls has been inspected by employing vernier callipers and calibrated paper strips. Gapert et al. evaluated 18th and 19th century British

dry skull specimens by manual craniometry. Their study consisted of 76 male skulls and 82 female skulls and they could establish sex from FM measurements with an overall accuracy of 68%.² One Brazilian study evaluated 211 skulls and estimated the accuracy of sexual dimorphism from FM measurements to be 66.5% by using discriminant function analysis.³ Researchers from Turkey studied the AFM in 219 skulls and found the correlation coefficient with sex to be 0.27.⁴ For calculating AFM, two formulae are available which are given by Radinsky and Teixeira.^{5,6} A study calculated AFM from dry skulls of an Indian population from the above two formulae and the accuracy was found to be 81.6% and 82.2% respectively from binary logistic regression (BLR) analysis.⁷ Lately, studies have taken FM measurements from CT scan images for determining the sex.⁸⁻¹¹ In medico-legal practice, at times soft tissues may be found adhered to the skull. In such a scenario it is desirable to go for a CT scan of the skull rather than wasting time for processing the skull for removal of the soft tissues and making it dry for use. The objective of this study was to assess the utility of FM measurements from CT scans for determining sex in a south Indian population.

Methods:

The study was conducted as a part of the ICMR-STs-2020 (Indian Council of Medical Research – Short Term Studentship-2020) project, in the Department of Forensic Medicine and Toxicology and Department of Radiology of our institute. The CT scan images of 384 South Indian adults were analysed, which comprised of 139 females and 245 males, who had undergone CT

Corresponding Author

Dr. Siddhartha Das (Professor)

Email : sendsids@gmail.com

Mobile No. : +91-9445803019

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scan of head and neck in our institute for various medical and surgical necessities.

Data collection: The CT scan images were accessed retrospectively after obtaining the approval of the Institute Ethics Committee. The scans were done by Siemens Somatom CT scanner, and were accessed via institute PACS (Picture Archiving and Communication System), using Siemens Healthineers Syngo Via 2.0 software. The images were visualized under VRT (Volume Rendering Technique) or cinematic VRT. VRT allowed 3D photorealistic visualization of CT scans, for better anatomical and diagnostic understanding of the structures. The image obtained in VRT was then rotated so as to view the FM at the base of skull. In majority of the cases the vertebrae and occipital condyles obscured the view of margins of FM and hence had to be removed using Punch tool.

In all the studies employing CT scan, the transverse diameter is measured in transverse section passed through the base of skull. But, the disparity in the measurement of antero-posterior diameter is noteworthy. It is either measured at mid-sagittal plane or the transverse plane passing below the base of skull. The two measurements taken were namely FML and foramen magnum breadth (FMB). They were measured using the inbuilt measuring scale present in the Syngo Via software. The adult south Indian patients for whom CT scans covering the FM region of the skull that were performed and the scan records available in the department of Radiodiagnosis of our institute were included in the study. Patients having congenital developmental deformities of the skull which affected the FM measurements and patients with fracture of the FM region of the skull bone were excluded from the study.

FML is the distance between basion and opisthion. FMB is the distance between the lateral margins of FM at point of greatest lateral curvature. Basion and opisthion are defined as the point where the anterior margin of FM is intersected by mid sagittal

Table 1. Descriptive statistics for individual measurements.

Parameters	Males (n = 245)			Females (n = 139)			t-statistic	P value
	Min.	Max.	Mean (SD)	Min.	Max.	Mean (SD)		
FML	2.87	4.15	3.49 (0.22)	2.22	3.68	3.27 (0.22)	9.35	<0.001
FMB	2.19	3.57	2.94 (0.23)	2.14	3.63	2.71 (0.21)	10.32	<0.001
FMI	63.48	117.05	84.47 (6.84)	63.97	122.97	83.08 (7.67)	1.82	0.069
AFM1	5.74	10.53	8.07 (0.93)	4.72	9.44	6.95 (0.78)	12.51	<0.001
AFM2	5.96	10.58	8.14 (0.93)	4.81	9.46	7.03 (0.79)	12.45	<0.001

Table 2. Correlations between FM measurements in males (upper right corner of the table) and females (lower left corner of the table).

Variables	FML	FMB	FMI	AFM1	AFM2
FML	1	.352**	-.455**	.784**	.820**
FMB	.251**	1	.670**	.856**	.824**
FMI	-.574**	.637**	1	.191**	.134*
AFM1	.755**	.823**	.092	1	.998**
AFM2	.794**	.786**	.035	.998**	1

*, ** Correlation is significant at 0.01 and 0.05 level of significance (2-tailed).

plane and the point where the mid sagittal plane intersects the posterior margin of FM respectively.

AFM: It is the area under the FM and estimated by two formulae namely Radinsky and Teixeira.

$$AFM1 \text{ (by Radinsky's formula)} = \frac{1}{4} \times \pi \times FML \times FMB$$

$$AFM2 \text{ (by Teixeira's formula)} = \pi \times \{(FML + FMB)/4\}^2$$

FMI is the the ratio of FMB and FML multiplied to 100.

$$FMI = (FMB/FML) \times 100.$$

Statistical analysis: All the continuous FM measurements like FML, FMB, FMI, AFM1 and AFM2 were reported for their mean, standard deviation, minimum and maximum. The significance for the mean difference of all the continuous measurements between male and female group was tested using Independent Student t test after checking for the normalcy assumption for both the groups by using Kolmogorov-Smirnov test. The Pearson correlation coefficient was calculated between all the above continuous measurements for both males and females. The entire dataset was split as training (80%) and testing (20%) dataset for internal validation. The discriminant function was built for each FM parameter and the combination of FM

Table 3. Discriminant function analysis and canonical discriminant coefficient for the variables.

Function	Variable Entered	Wilks' Lambda	Unstandardized Coefficient	Male and female centroids	Sectioning Point
Function 1	FML	0.842	4.387 Constant: -14.92	M: 0.325 F: -0.571	-0.246
Function 2	FMB	0.765	4.446 Constant: -12.755	M: 0.417 F: -0.732	-0.315
Function 3	FMI	0.978	0.130 Constant: -10.984	M: 0.113 F: -0.198	-0.085
Function 4	AFM1	0.717	1.137 Constant: -8.738	M: 0.472 F: -0.828	-0.356
Function 5	AFM2	0.723	1.137 Constant: -8.815	M: 0.465 F: -0.817	-0.361
Function 6	FML FMB FMI AFM1	0.715	-0.598 -2.901 0.048 1.806 Constant: -7.574	M: 0.474 F: -0.833	-0.359

Table 4. Percentage of correct group membership in training and testing dataset.

Function	Predicted group membership (%)	Correct classification (%)	
		Males	Females
Function 1	Training	68.8	62.2
	Testing	75.2	63.2
Function 2	Training	69.4	76.8
	Testing	71.3	64.9
Function 3	Training	59.0	61.0
	Testing	43.6	56.1
Function 4	Training	74.3	80.5
	Testing	67.3	70.2
Function 5	Training	73.6	79.3
	Testing	68.3	73.7
Function 6	Training	74.3	80.5
	Testing	70.3	73.7

parameters. The correct classification rate was estimated for training and testing dataset. The area under the curve (AUC) of receiver operating characteristic (ROC) was used as a measure of discrimination for all discriminant function built for the continuous measurements between males and females for each discriminant function. All the statistical analysis was carried at 5% level of significance and a P-value < 0.05 was considered to be statistically significant.

Results:

In our study cohort, we had a total of 245 (63.8%) males and 139 (36.2%) females.

Difference in FM measurements across gender: The descriptive measurements of the parameters were estimated for both males and females in the sample, as presented in Table 1. It was found that FML, FMB, AFM1 and AFM2 parameters differed significantly between the two genders as tested using Independent Student t-test. The mean values of all these parameters were significantly higher for males as compared to females (P value < 0.001). However, it was found that FMI did not

differ significantly between the groups (P value = 0.069).

Correlation between FM parameters: The correlation between FM parameters were estimated for both males and females using Pearson's correlation coefficient as presented in Table 2. The correlation coefficient between the FM parameters for males are given in the upper right corner of the table and for females in lower left corner of the table. It was found that FML, FMB, AFM1 and AFM2 were significantly and positively correlated to each other in both males and females.

Discriminant function: The entire dataset was split into training (80%) and testing (20%) dataset for the purpose of internal validation of the models. Binary linear discriminant functions were built for each of the FM parameter separately as a function along with the combination of them as given in Table 3 in the training dataset. We observed that amongst all the discriminant function that was built, function 6 gave us the least Wilk's lambda value ($\lambda = 0.715$) which indicated the best discriminatory ability of the model amongst others. Function 3 gave the maximum Wilk's lambda value suggesting it to be the worst amongst all the discriminant function for the discriminatory ability. Subsequently, the group centroids determined by the discriminant function was calculated which tells us about the mean of the function in each group. The sectioning points were determined which is the cut-off value categorizing the subjects into groups based on the discriminant function. In the case of the combination of FM parameters, AFM2 was not been considered in the discriminant function as it did not pass the tolerance criterion cut off of 0.001. Tolerance is the proportion of a variable's variance not accounted for by other independent variables in the equation.

Internal validation and discriminant accuracy: The internal validation of the discriminant functions was carried out using the split-data method. The proportion of correct classification for each function in males, females and overall were calculated in both training and testing dataset. We observed that Function 6 and Function 4 gave the best overall classification rate (76.5%) amongst the functions in training dataset. When the same function was allocated for testing dataset, Function 6 gave the best classification rate (71.5%) which was consistent (Table 4). Similarly, AUC from ROC curve was plotted for each of the discriminant function (Fig. 1). Function 6 had the best AUC (0.829; 95% CI = 0.774, 0.883) whereas Function 3 had the least AUC (0.618; 95% CI = 0.542, 0.695). We also observed that in spite of having the combination of four parameters in Function 6, the discriminant function with AFM1 and AFM2 gave us a good AUC of (0.827; 95% CI = 0.772, 0.882) and (0.824; 95% CI = 0.770, 0.879) respectively.

Discussion:

Of late, population specific research has gained momentum owing to the reasonable degree of variability in the craniometric parameters of the skull. The same is also applicable for FM measurements. Studies have been done on different populations for determining sex from FM measurements.^{2-4,7-11} Some of these researches have been done by using dry skull and some by CT scanning. India is a big country with lot of ethnic variation. Though research has been done to evaluate the sex from FM

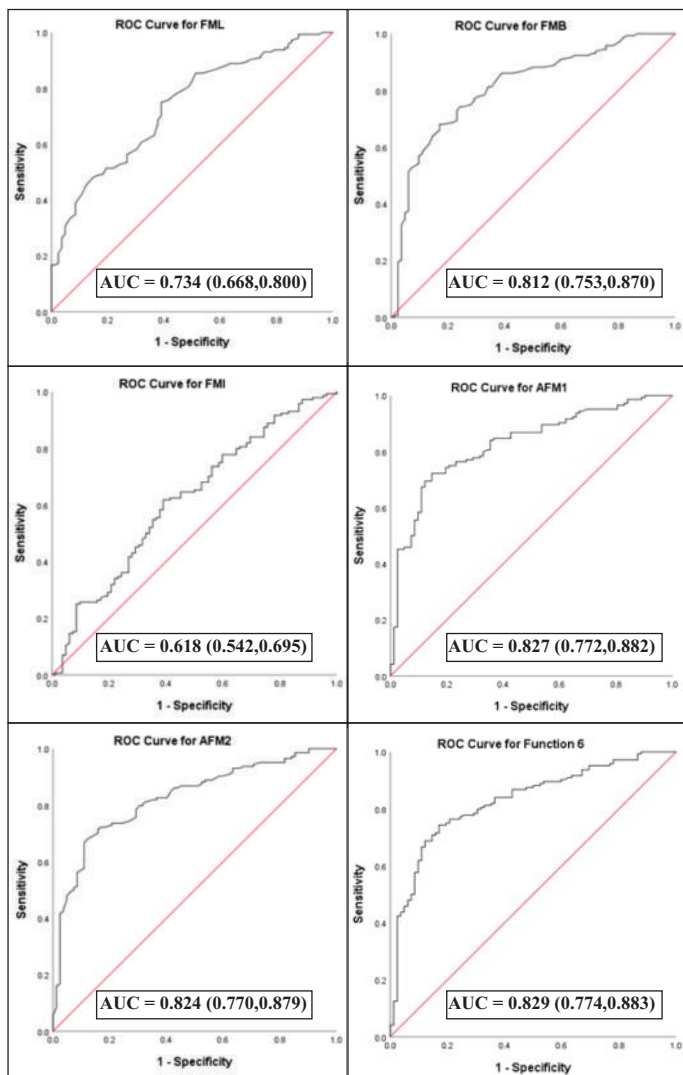


Figure 1. ROC curve of the different foramen magnum parameters.

measurements but our study confined it to a defined population only. Thus, this study was conducted to assess the sexual dimorphism of FM measurements using CT scan images of the south Indian population.

The FM parameters in our study was found to be greater in males when compared to females. Hence the parameters derived from them i.e., AFM1, AFM2 and FMI also show a similar trend. FMI was found to be insignificant in assessing sexual dimorphism, and same was reported in other studies also.^{10,11} The length and breadth of FM showed high degree of correlation with the AFM owing to the fact that AFM is derived from the FML and FMB itself. When individual parameters were analysed using discriminant function analysis, FML showed highest accuracy rate i.e., 70.9%. But when all the variables were used together namely, AFM1, FMI, FML and FMB, it resulted in an accuracy of 71.5%.

Researchers evaluated 18th and 19th century dry specimens (n= 158, male = 82 and female = 76), available at St. Bride Church, Fleet Street, London.² They took into consideration the parameters like maximum length of the foramen magnum, maximum width of the foramen magnum, circumference of the foramen magnum, AFM1 and AFM2. The overall accuracy for establishing sex was 68% in their study (univariate and multivariate functions had an accuracy of 65.8% and 70.3% respectively). Males were correctly classified at 70.7% and females at 69.7% using multivariate functions. 76% of the males and 70% of the females could be correctly predicted by using linear regression equations. Our study did not evaluate the circumference of the FM but instead used FMI which showed least significance. Babu et al. evaluated dry skulls of an Indian population for sexing, (n = 99, male = 50 and female = 40). They measured antero-posterior (FML) and transverse diameter (FMB) of the skull, and applied it to two available formulae, namely Radinsky and Teixeira. When individual parameters were analysed, AP diameter i.e., FML showed the highest accuracy of 86.5%, and when AFM was used it came out to be 81.6% and 82.2%, for Radinsky and Teixeira respectively using BLR analysis. When both antero-posterior and transverse diameter were used together for BLR analysis it resulted in an accuracy of 88%.⁷

In another Indian study using CT scan, the overall accuracy rate of all the FM parameters and AFM (Teixeira) was found to be 66.4%.⁹ In the same study the best parameter for sex determination was AFM. One Iraqi study did helical CT scanning of 88 patients which included 43 males and 45 females and concluded that FM circumference and area were the best parameters for sex determination with an accuracy of 67 and 69.3% respectively. Multivariate analysis could correctly determine sex from FM measurements of males and females in 90.7% and 73.3% respectively.⁸ Sexual dimorphism from FM of the Saudi population was studied retrospectively by analysing 200 CT scans. The study scrutinized seven measurements, oriented around the dimensions of occipital condyles. They are length of right occipital condyle (LROC), length of left occipital condyle (LLOC), width of right occipital condyle (WROC), width of left occipital condyle (WLOC), length of foramen

magnum (LFM), width of foramen magnum (WFM) and maximum bi condylar distance (MBD). Then the AFM was calculated. When individual parameters were employed, they showed an accuracy varying from 62.5% to 65.5%, with the highest being LROC and lowest being LFM. When LROC, LLROC, WROC, WLOC, and MBD were considered it gave an accuracy of 71%.¹⁰ We neither evaluated the length and width of the occipital condyles nor the bicondylar distance. One Bulgarian study evaluated the FML, FMB, AFM (digital, Radinsky and Teixeira), FM circumference and FMI from CT scans of 140 Bulgarian adults. Using discriminant function analysis and BLR, sexual dimorphism was noted in FM shape and size, but they concluded that FM does not offer enough accuracy for sex determination.¹¹

The objective of our study was to find out whether the FM measurements taken from the CT scans is able to predict the sex in a south Indian population. We conclude that the measurements of different FM parameters taken from CT scans is helpful in predicting sex in a south Indian population by discriminant function analysis. Though statistically significant differences were observed but alone they should not be used to differentiate sex. Hence it is advisable that the FM parameters should be used in conjunction with other available methods to precisely estimate the sex of unknown skeletons of a defined population.

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

Ethical approval: All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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ORIGINAL ARTICLE

A Prospective Study of Socioeconomic Status by Modified Kuppuswamy Scale in Cases of Suicidal Deaths: An Autopsy Based Analysis

Karmakar SN.

Professor and Head, Department of Forensic Medicine, Terna Medical College, Nerul, Navi Mumbai.

Abstract:

Out of the various determinants which leads a person to commit suicide the Socioeconomic status (SES) of a person is very important. The combined total of economic and sociological measure of a persons work experience and of an individual family's economic access to resources and social position in relation to others is termed as Socioeconomic status (SES). Several scales have been proposed and reported to evaluate the socioeconomic classes of families of which the modified Kuppuswamy scale is most commonly used. The present study aims to study in details the various components of Socioeconomic status (SES) in cases coming for autopsy of suicidal manner at a tertiary care centre. The cases of suicidal manners were studied prospectively for a period of eight months from July 2020 to February 2021. A total 53 cases of suicidal deaths were included and studied. Skilled Agricultural & Fishery Workers were the commonest occupational group in cases of suicidal deaths. Intermediate or post high school diploma educated, Middle school certificate educated and Graduates education group formed majority of suicidal cases. Most of the cases had monthly family income upto Rs 74,755. Almost all the suicidal cases were in middle Socioeconomic class and upper lower Socioeconomic class groups. A detailed analysis of various factors of Socioeconomic status of suicidal cases can help to target necessary interventions in such target groups so that such cases of suicide can be avoided.

Keywords: Forensic science; Suicide; Hanging; Socioeconomic status; Modified kuppuswamy scale.

Introduction:

Suicide is the act of intentionally causing one's own death.¹ Suicide is a personal catastrophe that untimely takes the life of an individual and considerably affects the lives of families, friends and communities. A total of 1,39,123 suicides were reported in India during 2019 showing an increase of 3.4% in comparison to 2018 and the rate of suicides has increased by 0.2% during 2019 over 2018.² Every year 7,03,000 people take their own life worldwide and there are many more people who attempt suicide. Suicide occurs throughout the life span and was the fourth leading cause of death among 15–29 year olds, globally in 2019.³ Out of the various determinants which leads a person to commit suicide the Socioeconomic status (SES) of a person is very important. The combined total of economic and sociological measure of a person's work experience and of an individual's or family's economic access to resources and social position in relation to others is termed as Socioeconomic status (SES).^{4,5} Research studies of cases of suicidal deaths in relation to Socioeconomic status of the deceased are rare.

Aims and objectives: The present study aims to study in details the various components of Socioeconomic status (SES) in suicidal deaths using Modified Kuppuswamy scale which is the most commonly used Socioeconomic status scales.

Corresponding Author

Dr. Shibanand Nepal Karmakar

Email : shivanandkarmakardr@gmail.com

Mobile No. : +91-9766159176

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Materials and methods:

The present study was conducted prospectively in the department of Forensic Medicine at our tertiary care centre for a period of eight months from July 2020 to February 2021. A total 53 cases of suicidal deaths were included and studied.

Out of the total autopsy cases inclusion criteria for the present study were as follows :-

- All cases of deaths due to suicidal manner.
- Suicidal death cases who were the family head.
- Suicidal death cases whose education and occupation was known at the time of conducting autopsy by asking to investigating agencies or relatives of the deceased.
- Suicidal death cases whose income per month of the family was known at the time of conducting autopsy by asking to investigating agencies or relatives of the deceased.

Exclusion criteria for the present study were as follows :-

- Suicidal death cases who were dependent and non-earning members of family were excluded from the present study. The rationale for excluding dependent and non-earning members of family was that education and occupation of head of family was difficult to obtain; as during medicolegal autopsy relatives were reluctant to provide such details of other members of family.
- Also cases with inadequate necessary information provided by relatives, inadequate history, doubtful findings and unknown bodies.
- All autopsy cases where manner of death is other than suicidal manner.

Table 1. Occupation of suicidal cases.

Occupation	No of Cases
Private Bussiness Work	04 (7.5 %)
Domestic Helper	03 (5.6 %)
Vegetable and fruits street vendor	02 (3.8 %)
Shopkeeper	04 (7.5 %)
Daily wage Labourer	07 (13.2 %)
Bricklayerer	03 (5.6 %)
Carpenter	02 (3.8 %)
Farmer	15 (28.3 %)
Technician	03 (5.6 %)
Teacher	01 (1.9 %)
Clerk	02 (3.8 %)
Retired Person	01 (1.9 %)
Gardener	01 (1.9 %)
Unemployed	05 (9.4 %)
Total	53

After the above mentioned inclusion and exclusion criteria a total 53 cases of suicidal deaths were included in the present study.

Necessary permission for the present study was obtained from institutional ethical committee. Consent is not required for conducting medicolegal autopsies in our country and hence consent to participate was not required.

Occupation of the cases was ascertained and was grouped as per Kuppuswamy socioeconomic scale. Education of cases and Monthly income of family of cases was also ascertained and was grouped as per Kuppuswamy socioeconomic scale. For monthly income of family; (February 2020 CPI) of Modified Kuppuswamy scale (update for February 2020) was used. Each case was then scored as per Kuppuswamy socioeconomic scale score and total score as per Kuppuswamy socioeconomic scale score was calculated and the cases were divided into different socioeconomic class as per Kuppuswamy socioeconomic scale.⁸

Results:

3.1. Occupation of suicidal cases.

Out of the total 53 cases of suicidal deaths; 15 (28.3 %) cases were farmers, 07 (13.2 %) cases were daily wage labourers, 05 (9.4 %) cases were unemployed or were not working at the time of death, 04 (7.5 %) cases had private bussiness work and also 04 (7.5 %) cases were shopkeepers.

There were 03 (5.6 %) cases each of Bricklayerer, domestic helper and technician. There were 02 (3.8 %) cases each of Vegetable and fruits street vendor, carpenter and clerk. Also there was 01 (1.9 %) cases of teacher, gardener and a retired Person. (Table no 1)

3.2. Occupation of cases of death due to suicide as per Kuppuswamy socioeconomic scale.

Out of the total 53 cases of suicidal deaths; 15 (28.3 %) cases were skilled agricultural & fishery workers having Kuppuswamy socioeconomic scale score 5, 12 (29.8 %) cases were in elementary occupation having Kuppuswamy socioeconomic scale Score 2, 08 (15.1 %) cases were skilled workers and shop &

Table 2. Occupation of suicidal cases as per Kuppuswamy socioeconomic scale.

Occupation as per Kuppuswamy socioeconomic scale	Kuppuswamy socio-economic scale Score	No of Cases
Legislators, Senior Officials & Managers	10	0
Professional	9	02 (3.8 %)
Technicians and Associate Professionals	8	03 (5.6 %)
Clerks	7	
Skilled Workers and Shop & Market Sales Workers	6	08 (15.1 %)
Skilled Agricultural & Fishery Workers	5	15 (28.3 %)
Craft & Related Trade Workers	4	05 (9.4 %)
Plant & Machine Operators & Assemblers	3	01 (1.9 %)
Elementary Occupation	2	12 (29.8 %)
Unemployed	1	05 (9.4 %)

market sales workers having Kuppuswamy socioeconomic scale Score 6.

There were 05 (9.4 %) cases each of craft & related trade workers having Kuppuswamy socioeconomic scale Score 4 and of unemployed workers having Kuppuswamy socioeconomic scale Score 1. 03 (5.6 %) cases were technicians and associate professionals workers having Kuppuswamy socioeconomic scale Score 8.

There were 02 (3.8 %) cases each of professionals having Kuppuswamy socioeconomic scale score 9 and of clerks having Kuppuswamy socioeconomic scale Score 7.

There was a single case of plant & machine operators and assemblers having Kuppuswamy socioeconomic scale Score 3. There was no case of legislators, senior officials & managers having Kuppuswamy socioeconomic scale Score 10. (Table no 2)

3.3. Education of cases of suicidal deaths as per Kuppuswamy socioeconomic scale.

In our current study of the total 53 cases of suicidal deaths; 15 (28.3 %) cases were intermediate or post high school diploma educated having Kuppuswamy socioeconomic scale Score 5, 13 (24.5 %) cases were middle school certificate educated having Kuppuswamy socioeconomic scale Score 3, 11 (20.7 %) cases were graduate having Kuppuswamy socioeconomic scale score 6, 06 (4.3 %) cases were primary school certificate educated having Kuppuswamy socioeconomic scale Score 2, 04 (7.5 %) cases were high school certificate educated having Kuppuswamy socioeconomic scale Score 4.

There were 02 (3.8 %) cases each of profession or honours educated having Kuppuswamy socioeconomic scale Score 7 and of Illiterates having Kuppuswamy socioeconomic scale Score 1. (Table no 3)

3.4. Monthly income of family of deaths due to suicide as per Kuppuswamy socioeconomic scale.

Out of the total 53 cases of suicidal deaths; 19 (35.8 %) cases had monthly family income of 10,002–29,972 having Kuppuswamy socioeconomic scale score 2, 15 (28.3 %) cases had monthly family income of 29,973– 49,961 having Kuppuswamy socioeconomic scale score 3.

There were 06 (11.3 %) cases had monthly family income of 49,962–74,755 having Kuppuswamy socioeconomic scale score

Table 3. Education of cases of suicidal deaths as per kuppuswamy socioeconomic scale.

Education as per Kuppuswamy socioeconomic scale	Kuppuswamy socioeconomic scale Score	No of Cases
Profession or Honours	7	02 (3.8 %)
Graduate	6	11 (20.7 %)
Intermediate or post high school diploma	5	15 (28.3 %)
High school certificate	4	04 (7.5 %)
Middle school certificate	3	13 (24.5 %)
Primary school certificate	2	06 (4.3 %)
Illiterate	1	02 (3.8 %)

Table 4. Monthly income of family of deaths due to suicide as per kuppuswamy socioeconomic scale.

Monthly income of family as per Kuppuswamy socioeconomic scale 2020 (February 2020 CPI)	Kuppuswamy socioeconomic scale Score	No of Cases
≥ 199,862	12	02 (3.8 %)
99,931–199,861	10	04 (7.5 %)
74,755 –99,930	6	01 (1.9 %)
49,962–74,755	4	06 (11.3 %)
29,973– 49,961	3	15 (28.3 %)
10,002–29,972	2	19 (35.8 %)
≤ 10,001	1	06 (11.3 %)

4 also 06 (11.3 %) cases had monthly family income of ≤ 10,001 having Kuppuswamy socioeconomic scale score 1.

04 (7.5 %) cases had monthly family income of 99,931–199,861 having Kuppuswamy socioeconomic scale score 10. 02 (3.8 %) cases had monthly family income of ≥ 199,862 having Kuppuswamy socioeconomic scale score 12. Only a single case (1.9 %) had monthly family income of 74,755 –99,930 having Kuppuswamy socioeconomic scale score 6. (Table no 4)

3.5. Socioeconomic class of suicidal death cases as per Kuppuswamy socioeconomic scale.

In the present study 21 (39.6 %) cases were in upper lower socioeconomic class having total score 05-10 as per Kuppuswamy socioeconomic scale score, 17 (32.1 %) cases were in lower middle socioeconomic class having total score 11-15 as per Kuppuswamy socioeconomic scale Score, 12 (22.6 %) cases were in upper middle socioeconomic class having total score 16-25 as per Kuppuswamy socioeconomic scale score.

There were only 02 (3.8 %) cases in lower socioeconomic class having total score 01-04 as per Kuppuswamy socioeconomic scale score and only a single case (1.9 %) in Upper socioeconomic class having total score 26-29 as per Kuppuswamy socioeconomic scale score. (Table no 5)

Discussion:

Suicide is a tragedy and it affects families, society, countries and the whole world. It also has long-lasting effects on the people left behind who are associated with them. Worldwide every year 7,03,000 people take their own life.³ There are much more people who attempt suicide. Suicide occurs throughout the lifespan and was the fourth leading cause of death among 15–29-year-olds globally in 2019.³ Suicide is a global phenomenon and is seen in all regions of the world. In the year 2019 over 77% of global suicide cases were seen in low- and middle income countries.³

Table 5. Socioeconomic class of suicidal death cases as per kuppuswamy socioeconomic scale.

Socioeconomic class as per Kuppuswamy socioeconomic scale		Total score as per Kuppuswamy socioeconomic scale Score	No of Cases
I	Upper	26-29	01 (1.9 %)
II	Upper middle	16-25	12 (22.6 %)
III	Lower middle	11-15	17 (32.1 %)
IV	Upper lower	05-10	21 (39.6 %)
V	Lower	01-04	02 (3.8 %)

Suicide is an important public health problem. The availability, accessibility and usage of the health facilities and other service facilities by an individual depends on his/her socioeconomic status. Various variables such as income, education, occupation, family effluence, physical assets, social position, social participation, caste, political influence and muscle power determine the economic and social position. Wealth can be influenced by intergenerational transitions as well as accumulation of income, savings, and immovable property.⁶ Several scales have been proposed and reported to evaluate the socioeconomic classes of families in specific circumstances, such as in urban or rural setting: Rahudkar scale 1960, Jalota scale 1970, Udai Pareekh scale 1964, Kuppuswamy scale 1976, Shrivastava scale 1978, Kulshrestha scale 1972, and Bharadwaj scale 2001.⁷ The modified Kuppuswamy scale is the most commonly used of all scales and includes the education and occupation of the family head along with income per month of the family, which yields a score of 3–29. This scale classifies the study populations into five SES. Often, occupation and education of head of the family are not changeable with time. However, the income categories in the scale lose their scoring following the change in the value of the rupee. Therefore, there is a need to update the scale as per the changes in consumer price index (CPI), thus making the socioeconomic scale applicable to the study populations.⁷

For the year 2020 Kuppuswamy socioeconomic scale details were used as reference for the present study as published by Sheikh Mohd Saleem.⁸

4.1. Occupation of suicidal cases.

In the present study (28.3 %) cases were farmers and (13.2 %) cases were daily wage labourers, In study by Zandre Smith⁹ (56.6%) cases were unemployed. D. W. Knipe et al.¹⁰ in their study found; out of total 129 cases of suicides individual occupation were 43 farmer, 17 daily wage labourer, 14 salaried employee, 12 unemployed/retired, 12 house-worker/other, 10 students, 8 self-employed, 7 security forces, 5 Businessmen and 1 non-graduate foreign employed. Elfawal et al.¹¹ reported that most of the victims of suicidal hanging were laborers and domestic workers. Nattapong Tulapunt et al.¹² found that of the 244 victims of hanging cases, most (63.1%) were in the service industry, followed by merchants/managers (12%) and government service (5%) while the lowest number of cases was farmers (1 case).

4.2. Occupation of cases of death due to suicide as per Kuppuswamy socioeconomic scale.

In the present study (28.3 %) cases were skilled agricultural & fishery workers; (29.8 %) cases were in elementary occupation; (15.1 %) cases were skilled workers and shop & market sales workers; (9.4 %) cases each of craft & related trade workers and of unemployed.

Professionals and semi-professionals are the groups which are skilled and hence are ambitious but are subjected to ever increasing competitions in almost all fields of life. Failure to meet the expectations in life with possessing the skills results in anxiety, stress, strain, and this could be the reason for them committing suicide. While unskilled workers don't possess the skills but hardships in workplace with resulting very less financial gains from such hardships may be the reason for their subjected poverty and alcohol addiction probably making them more vulnerable to commit suicide.

4.3. Education of cases of suicidal deaths as per Kuppuswamy socioeconomic scale.

In the present study (28.3 %) cases were intermediate or post high school diploma educated, (24.5 %) cases were middle school certificate educated, (20.7 %) cases were graduate, (4.3 %) cases were primary school certificate, (7.5 %) cases were high school certificate educated.

In study by Zandre Smith⁹ (36.3%) cases had completed their high school education. D. W. Knipe et al.¹⁰ in their study found that out of total 129 cases of suicides 81 cases had O-level education, 33 cases had primary education, 10 cases had university/A-level education and 5 cases were illiterate. Sachidananda Mohanty et al.¹³ found usually the suicidal victims were less educated or illiterates. Gopal B K et al.¹⁴ in their study found that 10.78% cases had educational qualification of masters degree; 24.08% cases had basic degree; 25.8% cases had educational qualification up to preuniversity; 24.85% cases had educational qualification up to higher primary while educational qualification was unknown in 14.45% cases. Ali E et al.¹⁵ in their study found that more than a half cases of hanging (51.8%) were illiterate followed by 23.1% cases passed primary education level, 20.1% cases passed S.S.C education level and 1.8% cases passed H.S.C level education.

4.4. Monthly income of family of deaths due to suicide as per Kuppuswamy socioeconomic scale.

In the present study (35.8 %) cases had monthly family income of 10,002–29,972; (28.3 %) cases had monthly family income of 29,973–49,961; (11.3 %) cases had monthly family income of 49,962–74,755; (11.3 %) cases had monthly family income of ≤ 10,001. Ali E et al.¹⁵ in their study found that (78.1%) cases of hanging deaths were from middle income group, (16.5%) cases were from lower income group and (2.1%) cases were from higher income group while socio-economic class was not known in 11 (3.3%) cases. T. Saisudheer and T.V. Nagaraja¹⁶ in their study found that 78% of the victims belonged to the middle income group. Thomas Zachariah and Joseph T John¹⁷ found that 48% cases were of lower middle class (Rs.501-1000); 18% cases were of lowest income group (Rs.0-300); 16% cases were of lower classes (Rs.301-500); 16 cases were of high income group

(Rs.1000 & above) and 2% cases unknown income group.

4.5. Socioeconomic class of suicidal death cases as per Kuppuswamy socioeconomic scale.

In the present study (39.6 %) cases were in upper lower socioeconomic class; (32.1 %) cases were in lower middle socioeconomic class; (22.6 %) cases were in upper middle socioeconomic class. There were only (3.8 %) cases in lower socioeconomic class and only a single case (1.9 %) in upper socioeconomic class. D. W. Knipe et al.¹⁰ in their study found that out of total 129 cases of suicides; 70 cases were of high asset score, 48 cases were of middle asset score, 11 cases were of low asset score. Elfawal et al.¹¹ reported that most of the victims of suicidal hanging were from low socioeconomic class. Sachidananda Mohanty et al.¹³ found (48%) cases of suicidal victims were from low socioeconomic status. Gopal B K et al.¹⁴ in their study found that (58.38%) cases were of lower socioeconomic status; (32.26%) cases were of middle socioeconomic status and (9.2%) cases were of upper socioeconomic status. Tirpude B.H et al.¹⁸ in their study found that (83.87%) cases were of low socioeconomic status, (9.67%) cases were of middle socioeconomic status and (6.45%) cases were of high socioeconomic status. Dinesh Rao¹⁹ found majority (59.09%) cases of the victims belonged to the low socioeconomic group. Jagannatha S R et al.²⁰ found majority of the victims (58.38%) belonged to lower socioeconomic strata.

Conclusion:

The present study aims to study in details the various components of socioeconomic status (SES) using Modified Kuppuswamy scale which is the most commonly used socioeconomic status scales. Skilled agricultural & fishery workers were the commonest occupational group in cases of suicidal deaths. Intermediate or post high school diploma educated, middle school certificate educated and graduates education group formed majority of suicidal cases. Most of the cases had monthly family income upto 74,755 Rs. Almost all the suicidal cases were in middle socioeconomic class and upper lower Socioeconomic class groups.

A detailed analysis of various factors of socioeconomic status of suicidal cases helps to target necessary interventions in such target groups so that such cases of suicide can be avoided.

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ORIGINAL ARTICLE

Forensic Age Estimation by Ossification of Medial Clavicular Epiphysis using Kellinghaus et al. Classification in an Indian Population

Maled V,¹ Patil PB,² Kiran R.³

Professor,^{1,2} Senior Resident.³

1. Dept of Forensic Medicine, SDM College of Medical Sciences & Hospital, Shri Dharmasthala Manjunatheshwar University, Dharwad.

2. Dept of Radio Diagnosis & Imaging, SDM College of Medical Sciences & Hospital, Shri Dharmasthala Manjunatheshwar University, Dharwad.

3. Dept of Radio Diagnosis & Imaging, ESIC Medical College & Hospital, Bangalore.

Abstract:

Present study aimed to determine the chronology of medial clavicular union for an Indian population. A retrospective study was conducted by evaluating 556 (227 females and 329 males) Computed Tomographic (CT) images of chest and neck region. The evaluation was carried out based on five stages of maturation described by Schmeling et al. [2004] and sub-stages of stages 2 and 3 by Kellinghaus [2010]. In the results the range, mean age, median, upper quartile, lower quartile, standard deviation and student t test are presented for each stage of ossification. Comparison between males and females revealed statistically significant differences in mean age at maturation stage 1, 3b and 5 which was absent in remaining stages. Maturation stage 3a was first presented at 16 year of age for both sex, stage 3b was first presented at age 18 year in females and 16 year in males and stage 3c was first presented at 21 years for both sex. To conclude the likelihood of whether an Indian individual is at least 16, 18 and 21 years or not can be determined. It is a reliable indicator of chronological age and somatic maturity.

Keywords: Age estimation; Clavicle; Ossification; Skeletal age; Computed tomography; Identification.

Introduction:

Estimation of age is of prime importance in routine practice of law enforcement in case of identification, searching for unknown victims, estimating the age at death, classification of cluster victims in mass disaster, to know the age for availing social benefits and also aid in immigration services in processing of illegal immigrants.¹

In majority of countries, the age limits of criminal responsibility lie between 14 to 21 year of life.^{2,3} European nations like United Kingdom, Switzerland, Sweden, Norway, Italy use age 18 and 21 years as a threshold for assessment of an individual as juvenile or adult. If you look at the Indian subcontinent, criminal responsibility lies at 16, 18 and 21 years for both sexes. Indian judicial system will decide a male or a female as juvenile or an adult at 16 and 18 year respectively in heinous crimes.

Continuous research is going on worldwide to improve the accuracy of Forensic age estimation (FAE) to help in the administration of justice. Different population groups have variations in the attainment of the maturity indicator like eruption of teeth, ossification of bones based on the geographical, environmental and nutritional factors. Dentition and skeletal maturation are used either individually or in combination to estimate the age of an individual.⁴ Ossification of the carpal bones

and wrist is one of the easily available reliable methods of age estimation in children.⁵ By 18 years of age majority of the skeleton will complete ossification except few centers like sacrum and clavicle among them clavicle is notable. Therefore many countries are using the clavicle as a gold standard in determining the age of an individual above 16 years.⁴ If you look at the guidelines issued by the Study group on Forensic Age Diagnostics [Arbeitsgemeinschaft für forensische Altersdiagnostik (AGFAD)] from the German Association of Legal Medicine, X-ray/CT examination of the clavicle is mandatory to confirm the age over 18 and 21 years.⁶ The study group further recommended that it should be followed by worldwide for better forensic age diagnostics.⁷⁻⁹

Development of the clavicle starts in the fetal life. The ossification begins from a primary center for central zone along with coalescent ossification centers appearing at both ends. The second phase of ossification begins in the adolescent age group. Secondary epiphyseal center for the medial end which is also called as medial clavicular epiphysis (MCE) fuses with the primary center.¹⁰ Beginning of fusion of MCE (stage 3a) signifies > 16 years.¹¹ Complete ossification of MCE (stage 4) confirms age >21 years.¹¹⁻¹³

Correlation with the chronological age of an individual with the maturation of clavicle has been studied in dry bones which revealed positive correlation but the age estimation was in wide range.¹⁴ Recent research revealed the possibility of using imaging techniques in the field of age estimation. A study conducted in an European continent revealed the positive correlation between chronological age and age estimated at death of an individual based on the maturation of cranial sutures using CT scan.¹⁵ The

Corresponding Author

Dr. Venkatesh Maled

Email : drmaled_fm@yahoo.co.in

Mobile No. : 9880385800

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most common techniques used are X-Ray, ultrasound, CT, and magnetic resonance imaging (MRI).¹⁶⁻¹⁸ When you compare them, CT has many advantages over other techniques. The notable ones are high image resolution, increased accuracy in detecting ossification centers, absence of overlapping soft tissue images.^{2,11,19-22}

If you look further into CT, a revolution in the multi detector CT scanners give you very thin slice equal to 0.6 mm. This high resolution enables clear vision of the ossification centers which are beginning as well as the thin growing epiphyseal growth plates. Therefore, presently CT imaging has been considered as a gold standard in assessing the ossification of MCE.^{2,23}

Kreitner et al. introduced the use of CT in assessment of MCE ossification.¹⁰ Later, Schmeling et al. designed the common staging system which divide the ossification of MCE into 5 stages.²⁴ Kellinghaus et al. brought forward sub-stage system which decrease the interval of assessed age thus enhancing estimation of accuracy in the chronological age of an individual.²⁵ That will help a forensic expert in FAE of an individual in turn helping the law enforcement authorities to enforce the law more accurately.

Table 1. Stage of maturation of the medial epiphysis of clavicle described by Schmeling et al. and the sub-stages of stage 2 and 3 by Kellinghaus et al.

Stage	Diagram	Description
1		Non-ossified epiphysis
2a		Ossified epiphysis, growth plate not fused. Ossified epiphysis is 1/3rd or less compared to the width of metaphysis
2b		Ossified epiphysis, growth plate not fused. Ossified epiphysis is over 1/3rd until 2/3rd compared to the width of metaphysis
2c		Ossified epiphysis, growth plate not fused. Ossified epiphysis is more than 2/3rd compared to the width of metaphysis
3a		Growth plate is partially fused. The epiphysis and metaphysis complete the fusion up to 1/3rd width
3b		Growth plate is partially fused. The epiphysis and metaphysis complete the fusion over 1/3rd until 2/3rd width
3c		Growth plate is partially fused. The epiphysis and metaphysis complete the fusion over 2/3rd width
4		Growth plate complete the union of epiphysis with metaphysis. Visible physal scar
5		Complete union of the epiphysis and metaphysis. Invisible physal scar

Presently most of the studies conducted on maturation of MCE with the help of CT were reported in European and Australian continents.^{10,11,19,20,26,27} Although few studies were reported on Indian population which is based on either post-mortem examination of the clavicle or radiographic examination.⁶ Authors reported similar study using CT scan over the Indian population with Schmeling et al. six stage classification of MCE union. The results revealed that the maturation of MCE stage 2 attained at 13 year, stage 3 at 16 year, stage 4 at 22 year and stage 5 at 25 year.²² It help in estimation of age in wide range, which is less accurate.²² If the Kellinghaus et al. sub stage classification is used, there may be a possibility of increased accuracy in age estimation because the ossification stage 2 and 3 are sub classified as 2a, 2b, 2c, 3a, 3b, 3c, which are attained at a very short interval of time. That will help us to assess the chronological age more accurately. There is paucity of such research in Asian continent using CT. It may be because of the unavailability of CT in the underdeveloped south Asian countries. Present study is aimed to assess the correlation between the ossification of the MCE and chronological age in an Indian individual using CT, to know whether the standard staging procedure of MCE ossification is applicable or not to the study demographic.

Materials and methods:

It is a retrospective study conducted in the Department of Radiology after approval from the institutional ethical committee. We collected the CT scans of the neck and chest of patients aged from 10 to 30 years taken between 2010 and 2016 for the period of six years. The age and place of birth of an individual were confirmed by the government issued

Table 2. Age by sex distribution of patients.

Age (Y)	Gender		Total
	Female	Male	
10	6	2	8
11	4	4	8
12	6	6	12
13	4	12	16
14	6	4	10
15	10	14	24
16	6	16	22
17	16	18	34
18	28	20	48
19	23	17	40
20	18	16	34
21	20	20	40
22	14	28	42
23	8	8	16
24	4	24	28
25	18	38	56
26	8	24	32
27	6	18	24
28	8	26	34
29	2	4	6
30	12	10	22
Total	227	329	556

Table 3. Descriptive statistics for age by sex and ossification stage expressed in years.

Stage	Gender	N	Age range (Min-Max)	Lower quartile	Median	Upper quartile	Mean (SD)	p-value
1	Female	24	10-15	10.75	12	13.25	12.08 (1.792)	0.009*
	Male	36	10-16	12	13	15	13.39 (1.886)	
2	Female	71	13-23	17	18	19	17.68 (2.020)	0.49
	Male	79	13-21	17	18	19	17.91 (2.039)	
2a	Female	21	15-19	16	17	18	17.19 (1.436)	0.608
	Male	31	13-20	17	18	19	17.45 (1.981)	
2b	Female	26	13-19	15	17	18	16.46 (1.860)	0.423
	Male	24	15-18	15.75	17.5	18	16.83 (1.308)	
2c	Female	24	18-23	18.75	19	20	19.42 (1.349)	0.719
	Male	24	15-21	19	20	21	19.58 (1.692)	
3	Female	86	16-26	19	21	22	20.93 (2.419)	0.009*
	Male	92	16-27	21	22	24	21.98 (2.855)	
3a	Female	34	16-22	18	20	21	19.41 (1.743)	0.796
	Male	22	16-22	17	20	21.75	19.27 (2.272)	
3b	Female	26	18-22	19	21	21	20.23 (1.451)	0.009*
	Male	36	16-24	21	22	23	21.61 (2.296)	
3c	Female	26	21-26	22	23	25	23.62 (1.627)	0.298
	Male	34	21-27	22	25	25	24.12 (1.966)	
4	Female	20	24-27	25	25	26	25.30 (0.801)	0.557
	Male	84	22-29	24	25	27	25.55 (1.852)	
5	Female	26	27-30	28	29	30	28.85 (1.190)	0.01*
	Male	38	25-30	27	28	29.75	27.84 (1.653)	

* Significance was set at P-value < 0.05

identification document. The date of performing the CT scan, date of birth and any medical illness were reviewed from the medical records section. Patients who are not of Indian origin and Indian nationals, patients treated with chemotherapeutic drugs, steroids, immunosuppressant drugs and patients suffering from chronic diseases which affect the bone development were excluded from the study. Data regarding the socioeconomic status and nutrition was unavailable.

All the axial and coronal CT images of 1 mm slice thickness were used in assessment. High resolution thin-slice imaging was obtained using 128 row multi detector scanner. Scan images were assessed on a standard picture archiving and communication system (PACS). The standard viewing tools were used. The thin-slice-axial images helped us in reconstructing superior quality images on coronal, sagittal, and oblique planes. If the staging remained doubtful on axial and coronal views, the multiplanar images in the long axis of clavicle were used.

The medial clavicular ossification was scored by two independent radiologists with more than 8 years of experience separately at two different time intervals to see any inter-observer variability. Both radiologists routinely assess skeletal ossification using clavicles and other bones on CT as a part of evaluation for head and neck as well as chest wall. The assessment of stages and scoring was done as described by Schmeling et al.²⁴ and sub-stages of stages 2 and 3 by Kellinghaus et al.²⁵ (Table 1).

The right and left clavicles were assessed separately as given in table 1. The images were scored by consensus. Both radiologists

Table 4. Comparison of study results conducted on different population using maturation of medial clavicular epiphysis.

	Kellinghaus et al. ¹⁹	Kellinghaus et al. ¹⁷	Wittschieber et al. ⁷	Pattamapaspong N et al. ²⁰	Present study
Study characteristics					
n	502	185	493	409	556
Age	10-35	13-26	10-40	11-29	10-30
Slice thickness (mm)	0.6-1.5	0.6-1.5	0.6	0.6-1	1
Minimum-maximum age by maturation stages (years)					
1	10-15	-	10-15	11-16	10-16
2	13-20	-	14-20	12-21	13-23
2a	-	13-20	14-18	12-20	13-20
2b	-	15-20	14-20	13-19	13-19
2c	-	15-20	17-20	15-21	15-23
3	16-26	-	15-36	15-27	16-27
3a	-	16-22	15-23	15-24	16-22
3b	-	17-25	16-36	15-24	16-24
3c	-	19-26	19-30	17-27	21-27
4	21-35	-	21-40	18-29	22-29
5	26-35	-	26-40	20-29	25-30

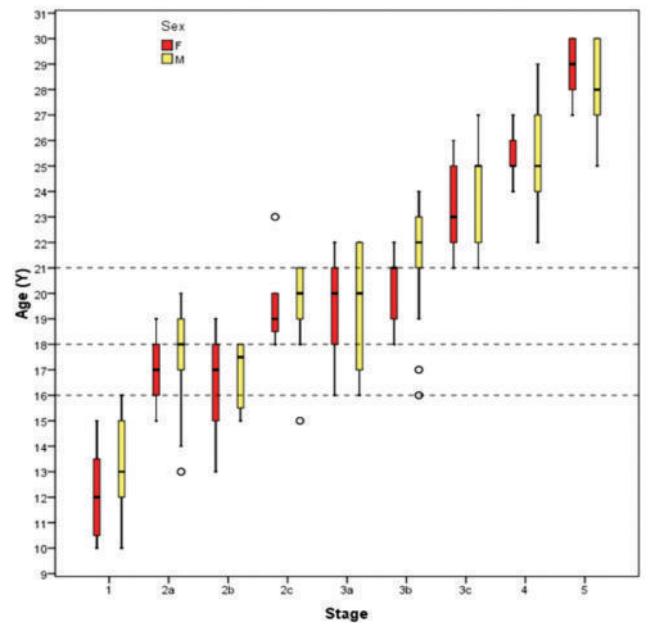


Figure 1. Box plots of the correlation between chronological age and stages for maturation of the medial epiphysis of clavicle with reference line at 16,18 & 21 years and outlier marked (O) (statistically).

were blinded for patient's age. In cases where a different maturation stage appeared between right and left clavicle, the more advanced (stage) side was used for analysis.

The data was analyzed using SPSS software. Results are expressed as age range, mean, median and standard deviation for each stage. The differences of every maturation stage between both sexes were analyzed by using the two-sample t-test. The statistical significance was set at P < 0.05. The box-and-whiskers plot was drawn to explain the degree of maturation of MCE with chronological age and sex.

Results:

The selection of 556 CT scans were done according to inclusion and exclusion criteria. Scans with blurred/unclear/invisible image quality and unclassifiable clavicle union were excluded. The medial clavicle union was assessed and scored in 556 (227 females and 329 males) scans. The difference in the maturation of right and left clavicle was observed in 76 scans [total 13.6%, 32/227 females (14%) and 44/329 males (13%)]. The inter-observer variability was negligible [Kappa value of 0.851]. It reflect that there is good strength of agreement between two observers.

Table 2 describes the age and sex distribution of patients. Table 3 gives the descriptive statistics for age by sex which are divided into maturation stages. Comparison between males and females revealed statistically significant differences in mean age at maturation stage 1, 3b and 5. The maturation at stage 1 attained 16 months earlier in females (mean age 12.08 vs. 13.39 years), at stage 3b 17 months earlier in females (mean age 20.23 vs. 21.61 years) compared to their male counterparts whereas at stage 5, 12 months earlier in males (mean age 27.84 vs. 28.85 years) compared to females. The remaining maturation stages (2a, 2b, 2c, 3a, 3c and 4) did not show statistically significant difference between males and females at mean age of maturation. Figure 1 describe the box-and-whisker plot expressing the degree of maturation of MCE with chronological age and sex at various stages.

Table 3 describe the maturation stage 3a was first noted at 16 year of age for both sexes with mean age at 19.4 and 19.2 for females and males respectively. Maturation stage 3b was first noted at the age of 18 year in females and 16 years in males with mean age at 20.2 and 21.6 respectively. Maturation stage 3c was first noted at 21 years for both sexes with a mean age at 23.6 and 24.1 for females and males respectively.

Discussion:

As per the review of literature the maturation of clavicle in the form of MCE ossification stages were used in young adults of various populations to assess the chronological age which aid in the administration of justice. If you look at table 1, Schmeling A et al. described clavicular ossification into five stages, in which stage 2 and 3 are further sub-classified by Kellinghaus et al.^{11,25,27,28}

The active phase of maturation (stage 2) started at <14 years in Indians which is similar to European and Thai populations.^{25,27,28} Whereas study on German population by Wittschieber D et al. revealed it at 14 years¹¹ (Table 4).

The first appearance of MCE in the present study was noted at 13 years, a year earlier than German population. It may be due to an outlier in the statistical analysis or due to data collection process where completed age in years is considered. Similar finding of early stage 2 maturation in females was observed in another study conducted on Caucasians.²¹

Many European studies revealed maturation stage 3a represent 16 years or older for FAE.^{25,27} This criteria was derived from European studies where maturation stage 3a did not occur before 16 years. Whereas few studies conducted on the same population

revealed that stage 3a represented 15 years or older.¹¹ However, in the present study we found stage 3a at the age of 16 years. That is a significant benchmark in the Indian judicial system to classify an Indian male as juvenile or adult in heinous crimes.

Maturation stage 3b represents 17 years or older in the present study but when you look at the box plot, stage 3b represents 18 years or older except few outliers (Fig.1), while studies conducted on European continent represented 16 and 17 years.^{11,24} Another study conducted on Thai population revealed stage 3b at the age of 15 year.²⁸

Present study revealed maturation stage 3c was attained at the age of 21 years or older, while studies on Thai and European populations represented at 17 and 19 years or older respectively.^{11,25,28} It highlights the fact that maturation of the MCE occurs at dissimilar age in different populations.

Therefore for the purpose of FAE in an Indian individual, the maturation stage 3a, 3b and 3c will represent the chronological age ≥ 16 , ≥ 18 and ≥ 21 years respectively. This alteration is vital for Indian judiciary because the age thresholds for criminal responsibility of an Indian individual lies at 16, 18 and 21 years.

To increase the precision of sub-stage classification it is necessary to assess the CT scan images in multiple planes. If the assessment of particular stage is doubtful with axial plane, we discovered that images reformatted in multiplanes perpendicular to the growth plate have resolved the problem. There are numerous possible difficulties in exact staging of the epiphysis, notable once are variants of epiphysis, overlooking epiphyseal scars and misinterpretation within stage 1 and 4. Inappropriate grading of maturation is possible due to various forms of epiphyseal configuration.²⁹ If these variants are present it is better to avoid the staging as per the opinion of Wittschieber et al.³⁰ Stage 1 and 4 may counterfeit each other because both do not show separate epiphyseal centers. Such difficulty can be easily overcome by substitution of hand radiographs as well as dental radiographs. Stage 4 of maturation will be seen at 18 years or above which will be confirmed by skeletal maturation of hand radiographs or dental radiographs with the evidence of third molar.^{31,32}

Radiological examination is widely available method worldwide including the suburban and remote rural areas. It is safe, inexpensive and easy to use without much expertise. But the assessment of ossification of MCE is difficult due to superimposed image of bones (rib and vertebrae) and mediastinal structures.³³ Other available imaging tools in living objects are ultrasonography and MRI, both of which have a great advantage of non-ionizing rays.³⁴ Ultrasonography is widely available compared to MRI. However its accuracy is limited because of limited viewing angle leading to incomplete visualization of the ossification. MRI is available in bigger centers and tertiary care centers which show the clear growth plate. But its reliability in age determination need to be established when compared to CT scan. When it comes to the CT, of course it is a better tool when compared to any other method described above in age determination of individuals. But a long standing debate is going on in India as well as in other parts of the world regarding the

ethical issues in using the CT scan for criminal investigation because of its ionizing nature.^{35,36}

Present study has several limitations. CT scans used for the analysis of study group were collected from the pool of hospital case records. In such records/scans artifacts are very common. The frequently encountered artifacts are contrast dyes and intubation tubes etc, which produced various artifacts overlapping the sternal end of the clavicle comparable to the growth plate. The considerable experience of the radiologist in differentiation of the artifacts from the ossifying epiphysis helped to score the stages accurately by excluding such cases. Linear streak artifacts usually appear dark compared to the growing end of the clavicle and also extend beyond the range of clavicle. Various techniques are used while exposing the patient to CT scan for example variable patient position, variable arm, neck and head position, variable radiation dose etc, which may affect the sharpness of images. By the observations of the present study, the sharpness of image did not affect interpretation because of thin slice of the images.

Conclusion:

The study found that the accuracy of age estimation can be improved in stage 3 with the help of Kellinghaus et al. sub-stage classification. Which represent stage 3a for age ≥ 16 years, stage 3b for age ≥ 18 years and stage 3c for age ≥ 21 years. CT scan is a helpful tool for FAE. We recommend to extend the study to larger set of population to create a reference data for study population.

List of abbreviations:

CT: Computed Tomography.

FAE: Forensic Age Estimation.

AGFAD: Arbeitsgemeinschaft für forensische Altersdiagnostik. (Study group on Forensic Age Diagnostics from the German Association of Legal Medicine).

MCE: Medial Clavicular Epiphysis.

MRI: Magnetic Resonance Imaging.

PACS: Picture Archiving and Communication System.

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ORIGINAL ARTICLE

A Study to Find the Encounter and Awareness of Cybercrimes among People During Lockdown in Gurgaon Region of Haryana

Kumari R,¹ Narwal S.²

Research Scholar,¹ Student.²

1,2. GD Goenka University, Gurugram.

Abstract:

With the COVID-19 and subsequent lockdowns, the dependency of people on the internet increased a lot for all needs. The cyber criminals perceived this opportunity to benefit themselves. People during lockdown came across the cyber-attacks in the form of phishing, cyberbullying, email frauds, fake medicine or related websites, zoom bombing, fake information etc. This survey was conducted in the regions of Gurgaon, Haryana to find the awareness of people and the encounter of cyber activities during the lockdown. It was found that people did come across cyber activities and some became victims too. Though most people do have some awareness of cyber-crimes but still most of them have incomplete awareness or unaware of the same. Most people did not report cyber-crimes to the police. It is important that the government must take steps to find the vulnerability of cybercrimes among people and spread relevant awareness among them.

Keywords: Cybercrime; COVID-19; Lockdown; Awareness; Phishing; Frauds.

Introduction:

From 24 March, 2020, the govt. of India announced a complete lockdown throughout the country in order to contain the spread of Coronavirus in the country. Only the essential services were allowed to operate, causing other activities to a standstill, which hardly affected the nation's economy. In India, the areas in a district were divided into various zones of red, orange and green depending upon the cases and hence the restrictions decreasing respectively. The lockdown forced people to be contained inside their houses and people got more engaged with mobile and internet for each and every utility. This long period of lockdown had though might have reduced the number of street crimes but had paved the way to increased various other crimes like domestic violence and threat to cyber-crimes. The motivation of crime depends upon the benefits and costs of committing¹ and the imposition of lockdown has impacted the motivation of criminals leading to change in the course of crime type and commission. The cyber space in such a period became one of the easiest platforms for the criminals to explore various forms of crimes online. It is important to understand the nature of crime and its location while analyzing the implications of lockdown on crime.² The lockdown had increased the opportunities for cyber criminals to exploit the fear and anxiety of people to make money using various cyber- attacks such as malware, spyware, ransomware, counterfeited medical equipment and drugs sponsored through emails, fake crowd funding mails and even fake investments opportunities. The concern of pornography, drug trafficking etc. are also important to vulnerable group like

children/students who were shifted to internet for online education, games etc.³ Hence, the majority of cyber-crimes has been classified as-fake agencies/websites for supplying medicinal equipment like PPE kits, face masks, medicine, oxygen cylinders etc., Phishing (getting hold of the account details), creating fake social accounts or influential people, pornography etc. Cyber-crime does not spare influential people also. As per The Indian Express, a merchant navy officer of Indore received a mail regarding refund of his custody duty but he was asked to pay 62 lakhs rupees as the processing fee. He paid the sum also but did not get the refund. Such financial frauds became common during lockdown. Various officers from Bihar had reported the case to police. It has been reported that the use of e-wallets for various digital transactions increased by 44% and hence the cyber-attacks increased by 86% between March and April, 2020.⁴ The increased dependency of internet during lockdown for each and every need from purchase to education to entertainment had paved the way for various cyber-crime activities like the use of spyware and ransomware by the crime opportunist to steal and take control of the vital information of the people.⁵ Figure 1 shows increase in cyber-attack during 2019-2020 period. Almost everything went online i.e. even the court, govt. offices, medical consultations, United Nations meetings etc. The immediate shift to digital platforms had paved a difficult way to people who were unaware of these technologies and this could also cause vulnerability for these people to get into the cyber trap. Also, due to lack of awareness among people about cyber- crime, how to deal with these crimes, data theft, misuse of digital platforms etc. the cyber-crime boomed during lockdown. Various common types of cyber-crimes encountered during lockdown are phishing, zoom bombing or online abuse, ransomware etc. In a phishing cyber-attack, the attacker contacts a person through a mail, mobile or SMS posing itself as a legitimate source and thereby takes away sensitive and private data from the victim. As per K7 computing's report, Kerala posed the highest number of phishing attacks during the pandemic

Corresponding Author

Dr. Ruby Kumari

Email- rubyraut18@gmail.com

Mobile No.: +91 8447824956

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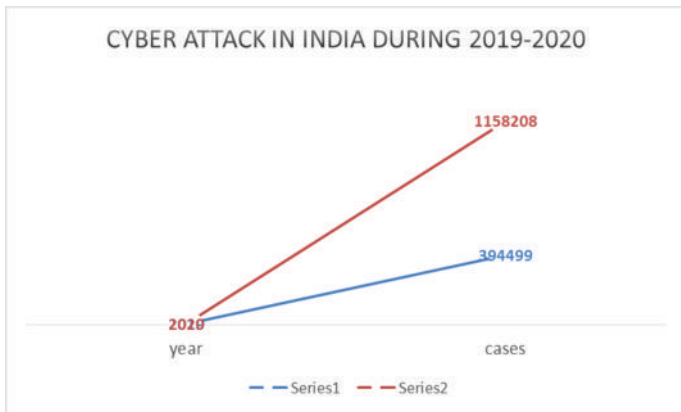


Figure 1. Increase in Cyber-attacks in India during 2019-20.
Source : Ubaid. S, 2020, Cybercrime in India: A Review.

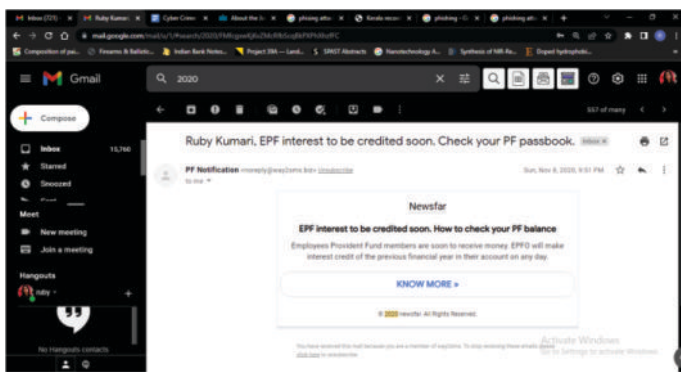


Figure 2. EPF (Employee Provident Fund) mail luring the person to get into a phishing attack.

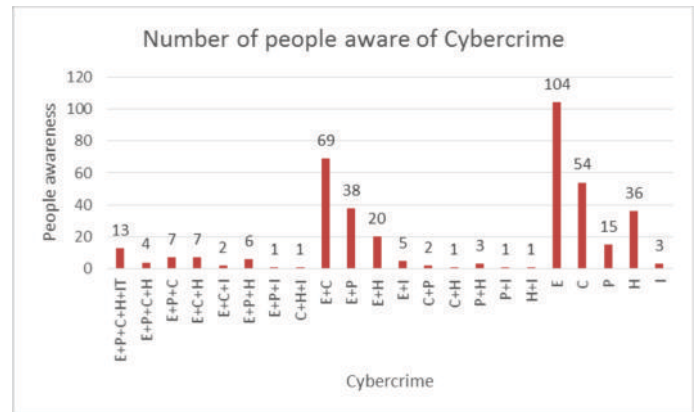


Figure 5. Showing awareness of various types of cybercrimes among people.

E+P+C+H+IT	Email fraud+Phishing+cyberbullying+hacking+Identity theft
E+P+C+H	Email fraud+Phishing+cyberbullying+hacking
E+P+C	Email fraud+Phishing+cyberbullying
E+C+H	Email fraud+Cyberbullying+hacking
E+C+I	Email fraud+cyberbullying+Identity theft
E+P+H	Email fraud+Phishing+hacking
E+P+I	Email fraud+Phishing+Identity theft
C+H+I	Cyberbullying+Hacking+Identity theft
E+C	Email Frauds+Cyberbullying
E+P	Email Frauds+Phishing
E+H	Email Frauds+Hacking
E+I	Email Frauds+Identity Theft
C+P	Cyberbullying+Phishing
C+H	Cyberbullying+Hacking
P+H	Phishing+Hacking
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C	Cyberbullying
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H	Hacking
I	Identity Theft

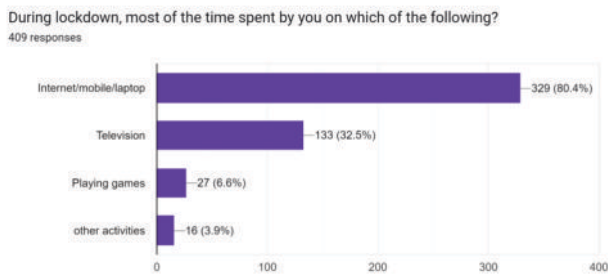


Figure 3. Time spent by people in various activities during lockdown.

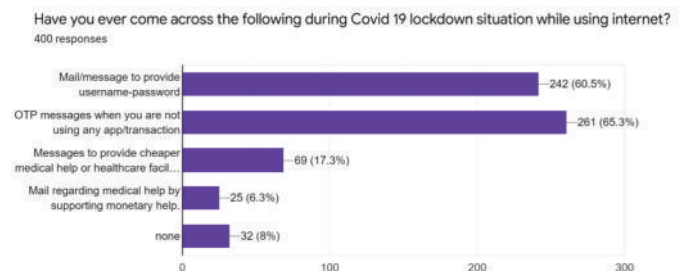


Figure 6. Cyber activities faced by people during lockdown.

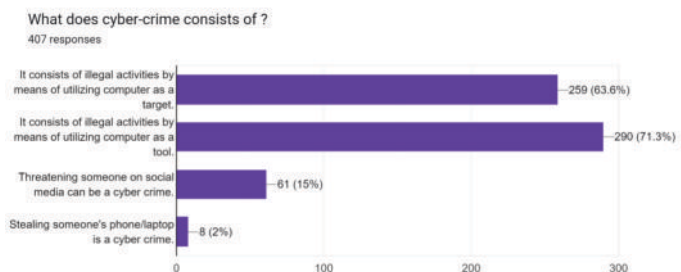


Figure 4. Understanding of people about the definition of cybercrime.

period from Feb-April 2020 followed by Punjab and Tamil Nadu with 207 and 184 cases respectively.⁶ During this period, these attacks were in the guise of famous organizations such as the

World Health Organization, Center of Disease Control & Prevention etc. Figure 2 shows a screenshot of the author's Gmail. Mail seems to be from a legitimate source EPF and given the link to know more. It might be possible such links can get away useful information from the user if one clicks it. Another important surge was in zoom bombing/online abuse. There has been incidents of zoom bombing during pandemic where the cyber attackers entered the online classrooms/meeting and disturbed/abuse people in the form of verbal abuse or display/acting of indecent images/acts.^{7,8} There was a case of the same by the CEO of 'The Information' Jessica Lessin who shared the zoom bombing experience, which is shown depicted in the picture taken from

twitter, which shows how someone intruded into a video call and started sharing objectionable content like pornography.⁹ Ransomware is a malicious software, which takes the control of a computer system/server denying the access to the user and demanding ransom in place of the restoration of data. IT companies like Cognizant got infected by Maze ransomware. Some firms had to pay huge ransom for clicking some malicious link, which could download the ransomware. World Health Organization even gave warning to stay away from the fraudsters imitating their employees to prevent such cyber-attacks.¹⁰ The pandemic/lockdown has also affected the susceptibility of cyberbullying.¹¹ The case of Bois Locker room in Gurugram where a 17-year-old boy committed suicide because of the allegations by a girl after sharing the images of Instagram group of Bois Locker room.¹² Apart from these cyber activities, fraud portals related to COVID 19 related information were launched by the cyber attackers. For example, websites related to the PM CARES fund. Around 4000 fraud portals were created by cybercriminals. In context to the increasing rise of cyber-crimes during COVID-19 lockdown, this paper elaborates the result of a survey conducted from the people of Gurgaon, Haryana in order to understand whether the people became victims of any cyber activities/crime, awareness about the same and any legal conscience related to cyber-crime. This study would help to understand the people's awareness about cybercrime as everything shifts towards online/digital platforms. Because it is very important to be aware of the cons of using the internet or one must be careful enough to safely use the internet. If people are not well aware about the cyber-crime, then the government/various organizations must step up to arrange the awareness camp or introduce compulsory academic courses for the students because nowadays every person from a small labor to high profile is a click away from being the victim of cyber-crimes.

Material and methods:

This study is a survey-based analysis of encounter/information of cyber-crimes faced by people during the pandemic period. For this study, the Gurgaon (India) city was selected to collect the responses. The participants belonged to the age of 18 years or above. For the survey, questionnaire was prepared on certain parameters related to cyber-crimes and pandemic using Google Forms and was circulated among the people. Around 410 responses were collected. After assessing the responses, the result was presented through charts and graphs.

Results:

The aim of this study was to understand the vulnerability of cyber-crimes during lockdown in Gurgaon region as well as the awareness of the cyber-crimes in people if they are caught with any type of cyber-crimes. From the survey responses, it was observed that most of the participants were from the age group of 18 to 39 years. As explained earlier that during the lockdown period, people were spending much of their time online in different activities. It was observed from the survey that most of the people, around 80% of the responses were involved in internet related activities followed by watching television and other activities as shown in figure 3. Although, most of the people were aware of the cyber-crime but, as per responses none of them were

entirely aware of the same. Though, most of the people know that it consists of illegal activities by means of utilizing computers as target as well as computer as tool but rarely they know that stealing someone's phone/laptop or threatening someone on social media are also under the purview of cyber-crimes as shown in figure 4. Figure 5 shows various types of cyber-crimes and their awareness in people. People are mostly aware of Email frauds. It was observed that people also faced cyber activities during lockdown. The activities where people were communicated through mail to provide username or password and OTP verification were very common as shown in figure 6. One important thing observed was that most of the people did not report any type of cyber-crime to the police. In context to safe browsing of the internet, people were mostly neutral about the safety issues.

Discussion:

The majority of the people were young in the survey, which indicates the relevance of this study as most of the people in this age group use various digital platforms for their use. The increase in the online activities during the lockdown period were also due to the shift towards digital lifestyle such as work from home and online classes for the working and students respectively combined with the social media activities, the result also affirms the same. IT Act 2000 encompasses various provisions for such offenses and their penalties too. During COVID period around 39% of the participants became the victim of cybercrime. Some people are not aware if they faced the cyber-crime or not. People not reporting the incident of cyber-crime to the police may be due to lack of awareness about the legal aspects of cyber-crime among people. People were also not much worried about the safe browsing of internet, which might be due to unawareness of the nuances of cyber threats while using the internet. Hence, it is important that people should be provided awareness about the crimes and their cyber modifications for the safe and fear free use of the internet.

Conclusion and Limitations: Cybercrime is one of the most dynamic crimes, which are beyond any physical boundaries or any circumference. Mere computer/mobile, target, internet and intention are the prerequisites for commission of crime. People during the lockdown were scared, nervous and totally became dependent on the internet for all sorts of requirements from entertainment to business and transactions. These opportunities were completely utilized by cyber criminals to deceive and earn money or other kinds of satisfaction. Such crimes are initially difficult to understand and victims rarely know that it could be reported to law enforcement agencies regarding the crime. People did come across various cyber activities and various reports show they became victims of the cyber-crime. Hence, it is important that basic understanding or awareness of such crimes must be taught to people. The government must step up in this regard and the academic institutions must introduce basic courses of cyber-crime or security to the curriculum. This survey though has some limitations as the number of respondents could be increased and some more aspects of cybercrimes, their legal implications, measures etc. could be extended in the questionnaire. Such surveys could also be focused on a particular cohorts like doctors,

teachers, and businessmen etc. to understand more vulnerabilities of cyber-crime.

Ethical Clearance: NA (No Human samples were involved)

Conflict of Interest: None

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ORIGINAL ARTICLE

Effect of COVID 19 on Mental Health Status of Health Care Providers Working in a District Medical College Hospital of West Bengal - A Questionnaire-Based Study

Biswas S,¹ Das A.²

Associate Professor.^{1,2}

1. Dept of Forensic Medicine & Toxicology, Rampurhat Govt. Medical College, Birbhum.

2. Dept of Forensic Medicine & Toxicology, Calcutta Medical College, Kolkata.

Abstract:

COVID-19 has become a threat to human civilization since its outbreak. Doctors, nurses, and other health care workers (HCWs) have been detected COVID-19 positive across the country and many of them have lost their lives too. Not only them but also their family members and close ones are susceptible to the infection. Fear of getting infected, losing near and dear ones, and social ostracization have led to unprecedented psychological stress among health care workers. The objective of this study is to know about the prevalence of depression, anxiety, and stress among the said population and their attitude and knowledge about COVID-19 and to establish any correlation between these parameters. It was a cross-sectional study done at Rampurhat Govt. Medical College, West Bengal, India over a period of 2 months on 150 subjects. DASS 21 scale was used for scoring depression, anxiety, and stress level. Prevalence of depression, anxiety, and stress was studied and their correlation with knowledge, attitude, and demographic factors were studied. The prevalence of depression, anxiety, and stress noted in this study is 34.7%, 50.7% and 34.7% respectively. Statistically significant correlations between depression and age, anxiety and occupation-gender, stress, and COVID positive family history were established. COVID-19 is an important factor for mental health among the health care providers which in turn is affected by other demographic factors. This must be dealt accordingly to ensure maximum service from the health care workers for the society.

Keywords: Depression, Anxiety, Stress, DASS 21, COVID-19.

Introduction:

Presently entire civilization is going through a tough time due to the emergence of a novel Severe Acute Respiratory Syndrome Coronavirus (SARS-Cov-2).^{1,2} Starting from the Wuhan city of China 16 months COVID-19 D 19 is the most dangerous threat to the mankind now.³ It was declared a pandemic on 11th February 2020 by WHO after being declared as sixth Public Health Emergency under International Health Regulation.⁴ In spite of having good health infrastructure, USA, UK and other many European countries have witnessed a sharp peak of the pandemic very soon after its outbreak.⁵ Starting late, India has suffered from the outbreak fast due to the large population. To date, nearly 10.8 million people have got infected and more than 150000 people died.⁶ This pandemic is affecting mental health severely.^{1,7} Studies have revealed that a significant number of doctors and health care workers (HCWs) are vulnerable to suffering from depression and anxiety.⁸ It has also been associated with significant anxiety and stress among HCWs experiencing work-related exhaustion, difficult triage decisions, separation from families, fear of being infected, fear of infecting close ones, and pain of losing patients and colleagues.⁹ A preventive measure can be taken by setting up multidisciplinary mental health teams at

regional and national levels to deal with mental health issues and providing psychological support.¹⁰ Research studies have been conducted in nine countries in Eastern Mediterranean Region (EMR) countries, United Arab Emirates (UAE), Saudi Arab, Egypt, Italy, Jordan and Singapore for the prevalence of depression, anxiety, and stress among doctors and other HCWs as an effect of COVID 19 but study on Indian population is scarce.^{1,11-16} Our aim in this study is to find out the prevalence of depression, anxiety, and stress among the doctors and other HCWs along with search for any correlation with their demographic parameters between the mental health status of health care workers in the Indian population, especially in a District Medical College & Hospital in West Bengal, an eastern state of India.

Materials and methods:

Sampling - This was a cross-sectional study conducted among doctors, nurses and other HCWs in a district-level tertiary care medical centre of Eastern Indian state of West Bengal. This questionnaire-based study was conducted over a period of two months (1st November 2020 to 31st December 2020). Ethical clearance was obtained from the Institutional Ethics Committee. Sample size was calculated using the formula $4pq/l^2$ where p = Prevalence=0.39,¹⁷ q =(1-p), l = allowable error=10%. The sample size was found to be 95.16≈96. Questionnaires were distributed to 182 healthcare workers including all doctors, nurses, and other healthcare workers of the hospital via e-mail after obtaining informed consent from them with an assurance not to disclose the personal information of any participant. 150 of them responded

Corresponding Author

Dr. Abhishek Das

Email : abhishek.das.forensic@gmail.com

Mobile No. : +91-8902640596

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finally (response rate=82.4%) including 81 doctors, 40 nurses and 29 other health care providers.

The questionnaire – Each questionnaire contained three parts. Part 1 was about demographic aspects like age, gender, type of family, marital status, occupation, area of residence (rural or urban), duration of work in health care service, presence of any comorbidity, and training on COVID-19. Part 2 included knowledge, attitude, and practice like area of work in the hospital, precautionary measures are taken, hand washing, sanitization, COVID test status of participants and their family members, and hours of daily work. Part 3 was about the scoring of depression, anxiety, and stress levels with already validated questions from the DASS 21 scale.¹⁸ Questions of part 1 and part 2 were pre-

Meaning	Depression	Anxiety	Stress
Normal	0 - 9	0 - 7	0 - 14
Mild	10 -13	8 - 9	15 - 18
Moderate	14 - 20	10 - 14	19 - 25
Severe	21 - 27	15 - 19	26 - 33
Extremely Severe	28+	20+	34+

validated by experts. Scoring of each item was done using a self-rated Likert scale from 0 (didn't apply to me) to 3 (mostly applied to me). Each score was multiplied by 2 to obtain the final score. Interpretation of scoring was done as follows-¹⁹

Assessment tools – Data was entered in Microsoft Excel Office 365. SPSS Version 21 was used for statistical analysis. Numerical data were expressed by mean value and categorical data as percentage or frequency. A comparison study for continuous data was done by t-test and for categorical data by Chi-square test. Any P value < 0.05 was considered statistically significant

Results:

The study was conducted on 150 health care workers among which female participants (n=76, 50.6%) were more than male participants (n=74, 49.4%) and all of them were aged 20 years and above. Male population were seen to be highest in the 31 to 40 years age group (22.7%) while the female and total population were highest in the 21 to 30 (33.3%) years age group. The least were in more the age group than 50 years [Table-1].

This study was conducted among different healthcare workers including doctors, nurses and others among which doctors were highest in numbers followed by nurses and others. More than 2/3rd of the study participants came from rural populations and nuclear families while the rest were from urban setups and joint families. Most of the participants (58.7%) had less than 10 years in their field of professional work. More than half of the participants did not receive the COVID training at or before the time of conduction of the study. Comorbidity was not present in more than 2/3rd of the study population. Among different comorbidities disclosed by the participants, hypertension was most frequent

Table 1. Sex Distribution of study participants in different age groups.

Age (years)	Male (n)	Male (%)	Female (n)	Female (%)	Total (n)	Total (%)
21 to 30	12	8	50	33.3	62	41.3
31 to 40	34	22.7	13	8.7	47	31.4
41 to 50	19	12.7	10	6.6	29	19.3
more than 50	9	6	3	2	12	8
Total	74	49.4	76	50.6	150	100

Table 2. Frequency distribution of demographic factors among health care providers.

Attribute (n)	Frequency	Percentage
Profession (n=150)		
Doctor	81	54
Nurse	40	26.7
Other	29	19.3
Home (n=150)		
Rural	102	68
Urban	48	32
Family type (n=150)		
Nuclear	102	68
Joint	48	32
Duration of service (n=50)		
<10 years	88	58.7
10-20 years	43	28.7
20-30 years	16	10.6
>30 years	03	02
COVID training (n=150)		
Received	64	42.7
Not received	86	57.3
Comorbidity (n=150)		
Present	43	28.7
Not present	106	70.7
No comment	01	0.6
Types of comorbidities (n=43)		
Hypertension	20	46.5
Asthma	8	18.6
Dyslipidaemia	7	16.3
Hypothyroidism	6	14
Diabetes mellitus	3	07
Hyperuricemia	3	07
COPD	2	4.7
Gastric ulcer	1	2.3

Table 3. Frequency distribution of attitude and practice (daily working hours, hand washing, sanitization, covid test).

Attribute (n)	Frequency	Percentage
Daily working hours (n=150)		
<6 hours	15	10
6 to 12 hours	14	9.3
>12 hours	121	80.7
Frequent hand washing (n=150)		
Yes	144	96
No	06	4
Frequent sanitization (n=150)		
Yes	143	95.3
No	07	4.7
COVID test done (n=150)		
Yes	37	24.7
No	113	75.3
COVID test status (n=37)		
Positive	02	5.4
Negative	35	94.6
COVID +ve family member (n=150)		
Present	17	11.3
Absent	133	88.7
Isolation by society (n=150)		
Yes	22	14.7
No	128	85.3
Proud as Healthcare worker (n=150)		
Yes	139	92.7
No	11	7.3

Table 4. Depression, anxiety and stress among study participants.

	Absent	Mild	Moderate	Severe	Extremely severe
Depression	98(65.3%)		23(15.3%)	5(3.3%)	0
Anxiety	74(49.3%)		33(22%)	12(8%)	18(12%)
Stress	98(65.3%)	23(15.3%)	23(15.3%)	6(4)	0

Table 6. Comparison of prevalence of depression, anxiety and stress during COVID 19 among different worldwide studies with the present study.

Study area	Sample size	Male: Female	Depression	Anxiety	Stress
Nine Eastern Mediterranean Region (EMR) countries ¹	1448	51.2: 48.8	57.5%	59.1%	42%
United Arab Emirates ¹¹	400	15.5: 84.5	76.5%	78.8%	63.5%
Egypt ¹³	270	43: 57	92.9%	--	--
Italy ¹⁴	214	84: 130	28.5% in frontline & 16.4% in second line workers	21.4 in frontline & 14.5% in second line workers	33.4% in frontline & 14.5% in second line workers
Jordan ¹⁵	365	44.4 : 55.6	40% extremely severe	60% extremely severe	35% extremely severe
Saudi Arab ¹²	283	--	17%	32%	17%
Turkey ²¹	442	43.2 : 56.8	64.7%	51.6%	41.2%
India ²⁰	254	66.1 : 33.9	60.2%	50.4%	13%
Present study	150	49.4 : 50.6	34.7%	50.7%	34.7%

Table 5. Frequency distribution of depression, anxiety and stress among based on different parameters.

	No depression (n/%)	De-pression (n/%)	No anxiety (n/%)	Anxiety (n/%)	No stress (n/%)	Stress (n/%)
Gender (n=150)						
Male	51 (68.9)	23 (31.1)	43 (58.1)	31 (41.9)	52 (70.3)	22 (29.7)
Female	47 (61.8)	29 (38.2)	31 (40.8)	43 (59.2)	46 (60.5)	28 (39.5)
Age in years (n=150)						
21 to 30	33 (53.2)	29 (46.8)	24 (38.7)	38 (61.3)	37 (59.7)	25 (40.3)
31 to 40	31 (66)	16 (34)	26 (55.3)	21 (44.7)	30 (63.8)	17 (36.2)
41 to 50	24 (82.8)	05 (17.2)	18 (62)	11 (38)	20 (69)	09 (31)
more than 50	10 (83.3)	02 (16.7)	06 (50)	06 (50)	11 (91.6)	01 (8.4)
Profession (n=150)						
Doctor	57 (70.4)	24 (29.6)	50 (61.7)	31 (38.3)	53 (65.4)	28 (34.6)
Nurse	24 (60)	16 (40)	17 (42.5)	23 (57.5)	26 (65)	14 (35)
Other	17 (58.6)	12 (41.4)	07 (24.1)	22 (75.9)	19 (65.5)	10 (34.5)
Comorbidity (n=149)						
Present	30 (69.8)	13 (30.2)	24 (45.3)	19 (54.7)	31 (72)	12 (28)
Not present	68 (64.2)	38 (35.8)	50 (47.2)	56 (52.8)	67 (63.2)	39 (36.8)
COVID training (n=150)						
Received	42 (65.6)	22 (34.4)	31 (48.4)	33 (51.6)	45 (70.3)	19 (29.7)
Not received	56 (65.1)	30 (34.9)	43 (50)	43 (50)	53 (61.6)	33 (38.4)
COVID test done (n=150)						
Yes	26 (70.3)	11 (29.7)	17 (46)	20 (54)	23 (62.2)	14 (37.8)
No	72 (63.7)	41 (36.3)	57 (50.4)	56 (49.6)	76 (67.3)	37 (32.7)
COVID +ve family member (n=150)						
Present	14 (82.4)	03 (17.6)	06 (35.3)	11 (64.7)	07 (41.2)	10 (58.8)
Absent	84 (63.2)	49 (36.8)	68 (51.1)	65 (48.9)	90 (67.7)	43 (32.3)
Daily working hours (n=150)						
<6 hours	09 (60)	06 (40)	11 (73.3)	04 (26.7)	11 (73.3)	04 (26.7)
6 to 12 hours	80 (66.1)	41 (33.9)	56 (46.3)	65 (53.7)	78 (64.5)	43 (35.5)
>12 hours	09 (64.3)	05 (35.7)	07 (50)	07 (50)	09 (64.5)	05 (35.7)

followed by asthma, dyslipidemia, hypothyroidism, diabetes mellitus, hyperuricemia, COPD, and gastric ulcer [Table-2].

As a precautionary measure, study participants were mostly habituated to using the N95 mask (n=122), followed by PPE (n=84), surgical mask (n=33) and triple-layer mask (n=6). Area of work in the health care setup varied from fever clinic (n=69) to ICU (n=21), through isolation ward (n=32), COVID ward (n=24), and surgical ward (n=22). More than 3/4th of participants (80.7%) used to work for more than 12 hours in the healthcare setup. Almost all the participants practiced frequent hand washing (96%) and frequent sanitization (95.3%). COVID test was done in 24.7% among which most of them (94.6%) were COVID negative. COVID positive family members were present in 11.3% of participants. Most of the participants felt proud (92.7%) of being healthcare worker and were not isolated (85.3%) from society [Table-3].

After assessing the participants through the DASS 21 questionnaire, various degrees of depression, anxiety, and stress

were noted in 34.6%, 50.7%, and 34.6% of the participants respectively [Table-4].

The frequency of presence of depression, anxiety, and stress among different demographic groups and COVID issues have been expressed in Table- 5.

The proportion of study participants having depression differs significantly in statistics by age (p=.022).

The proportion of study participants suffering from anxiety disorder did differ significantly in statistics by occupation (p=.000998) and gender (p=.034).

The proportion of study participants under some degree of stress did differ significantly in statistics by presence of COVID positive family members (p=.03).

Discussion :

All the healthcare workers are serving their duties in this COVID pandemic period. In a peripheral district medical college, they are fighting the situation by staying away from home for a long time. This may be a key factor in the psychological impairment of health care providers and has been reflected in our study. The prevalence of depression, anxiety, and stress noted in this study is 34.7%, 50.7%, and 34.7% respectively. Though the prevalence of stress and depression are more or less similar to previous studies, that of anxiety has significantly increased.⁶ In terms of the prevalence of stress, our result is much lower than the study conducted in China where stress was noticed in 69% of participants.²⁰ This study has similar findings as that conducted on HCWs of nine EMR countries, Turkey and India while in UAE, Egypt, and Jordan there was a higher prevalence of depression, anxiety, and stress.^{1,11,13,15,21,22} In comparison, Saudi Arabian and Italian study populations showed much less affection for mental health due to COVID-19^{12,14} [Table-6]. Lockdown, restricted outdoor activities, altered sleep patterns, and high workload may be precipitating factors for a marked

increase in anxiety.²³ According to our study, the degree of depression and stress due to COVID-19 is 8% and 26% higher than those due to MERS.⁸ In a Saudi Arabia-based study, it was suggested that 41% of health care workers were more worried about COVID-19 than MERS COV endemic which supports our result.²⁴

Our study revealed nurses and other health care workers are suffering from depression and anxiety more than doctors whereas the prevalence of stress is almost similar for all professions. Females are more depressed, anxious, and stressed than males according to our study. All three parameters are significantly higher in the younger age group (20 to 30 years). Hypertension is the most noticed comorbidity among study participants. Levels of depression and stress are more among those who have some comorbidity. Those who have some friends or family members positive for COVID-19 are more stressed than others which is supported by another Saudi Arabia-based study.²⁴ Our study revealed that increased daily working hours is responsible for an increased degree of anxiety and stress. The present study also revealed a statistically significant correlation between depression and age, anxiety, and occupation - gender, stress, and COVID positive family history.

The present study has a limitation as a more extensive study with even a larger sample size comprising of an equal population of doctors, nurses, and other health care workers would have yielded a more generalizable result.

Conclusion :

To conclude, the present study highlights the fact of emerging concern of mental health challenges among doctors, nurses and other health care providers supporting the view of other authors.²⁵ Inadequate supply of PPE and other infrastructures may also have aggravated the situation like in other countries.²⁶

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ORIGINAL ARTICLE

Pattern of Injuries in Deaths by Electrocution: An Autopsy StudyKiran JVK,¹ Jemila S,² Aruna MV.³Associate Professor,¹ Assistant Professor,² Junior Resident.³

1. Forensic Medicine Dept., Mamata Academy of Medical Sciences, Bachupally.

2. St. Paul's hospital & Millennium Medical College, Addis Ababa, Ethiopia.

3. MNR Dental College, Sangareddy.

Abstract:

Electrical injuries are complex and associated with high morbidity and mortality. Low voltage injuries cause less severe injuries but are highly fatal whereas high voltage injuries cause more severe skin injuries. In this study we tried to analyse the pattern of injuries from electrocution in relation to the voltage the victim was exposed to. We categorized the exposure according to the voltage and place of exposure into household setup, exposure at construction site and exposure to electric utility poles and exposure to transformers. The maximum number of cases were in the category of electric utility pole exposure. The cases which occurred in a span of about one year were considered and were few in number. The findings that we got in this study were in agreement with some of the previous studies by other observers but due to low sample size further studies would help in reaching more definitive conclusions.

Keywords: Electrocution, Voltage, Household, Construction site, Utility pole, Transformer.

Introduction:

“Electrocution” refers only to a person who is killed as a result of exposure to electricity.¹ Electrical injuries are a complex form of trauma that is often associated with high morbidity and mortality. The majority of deaths occurred in the 21-30 year age group.⁴

The severity of the injuries depends upon the type of current, the voltage, and the resistance. Tissues with the highest resistance tend to suffer the greatest level of damage as a result of an electrical injury. If skin resistance is high, more electrical energy may be dissipated at the skin, resulting in large skin burns but less internal damage. If skin resistance is low, skin burns are less extensive or absent, and more electrical energy is transmitted to internal structures. Thus, the absence of external burns does not predict the absence of electrical injury, and the severity of external burns does not predict the severity of electrical injury. Other determinants of electrical injury throughout the body are the source (i.e., entry point) and ground (i.e., exit point) of the current.³

Home accidents were responsible for 56 cases deaths (45.5%).⁵ At least half of all electrocutions encountered in an occupational setting occur as a result of contact with power lines, and about a quarter as a result of electrical machines or tools.⁶

Low-frequency alternating current (AC) causes more extensive injury to tissues than does high-frequency AC or direct current (DC).¹ Low-frequency AC can often be more hazardous than high-frequency AC. In general, AC is also approximately three to

five times more damaging than DC of equal voltage and current. In addition, DC only causes a single convulsion or contraction, usually propelling the person away from the electrical source. The higher the current and voltage associated with AC or DC, the greater the electrical damage will be. High-voltage current (greater than 500 V to 1000 V) typically will result in deep burns, while low-voltage current (110 V to 120 V) is more likely to result in tetany. Muscle tetany typically occurs in response to electrical stimulation at a frequency of 40 Hz to 110 Hz, a range in which most household currents exist.⁶

The size of burns seen on scene by the medicolegal death investigator can also vary greatly depending on the voltage. If the death involved a low voltage source, there are likely to be a small or multiple small burns where the decedent's body comes in contact with the source. The same would be true for the exit burns. However, with a higher voltage source the external burns could be very severe and cover a large area.²

Materials and methods:

The institutional Review Board (IRB) of St. Paul's hospital Millennium Medical College (SPHMMC), Addis Ababa, Ethiopia, has given ethical clearance for research on the title.

Analytic Prospective cross-sectional study was conducted on 49 electrocution cases which arrived at the mortuary, Forensic medicine dept. in the year 2020, have been selected for this study for studying the pattern of injuries especially in relation to the Voltage the deceased was exposed. Thorough autopsy was done on these cases and Photographs were taken in all cases.

Inclusion criteria: All electrocution cases with proper history or with definitive electrical injuries.

Exclusion criteria: Cases with doubtful history and doubtful electrical injuries.

Corresponding Author

Dr. J.V. Kiran Kumar

Email : nsvlskumar@gmail.com;

Mobile No. : +91 9652862996

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Figure 1. Household electrocution entry.



Figure 4. Electric pole electrocution - arcing.



Figure 2. Household electrocution contact burns.



Figure 5. Electric pole electrocution - entry in sole.



Figure 3. Entry on sole in construction site electrocution.



Figure 6. Transformer electrocution.

Results:

Total number of deaths from electrocution which arrived at the mortuary of St. Paul's hospital & Millennium Medical College, Ethiopia in the year 2020 were 49. Out of 49 cases 44 cases i.e. 89.7% were males and 5 were females i.e. 10.2% (Table 1).

Most people out of these 49 cases fell in the 21-30 year age group (48.9%). The maximum number of cases were in the category of electric utility pole exposure. The cases in this study were divided according to the Source of electricity that the person was exposed to. This tries to correlate the Voltage of the source to the severity of injury sustained by the person.

In this study there were 12 cases of electrocution who sustained

injury in a household setup i.e. 220V in Ethiopia. The injuries at the site of entry or exit caused by this voltage have been observed to be less severe (involving the superficial layers of skin) and typical (Picture 1), in 10 out of 12 cases (83.3%), than those caused by voltages greater than 380V. In one case out of these 10 cases, one female sustained well-defined widespread contact burns (Picture 2), which were due to fall of the victim on the electric stove on which she was cooking rather than by the primary electric shock.

Out of the 2 electrocuted cases in household setup in which there were apparently more severe or atypical injuries, one case showed electric injury involving the skin of arm which was burnt, black, and hardened. In the other case, there was exit wound, and

Table 1. Age group vs gender distribution of deaths from electrocution.

Age group in years	Number of deaths				Total	Percentage
	Male	Percentage	Female	Percentage		
0-10	2	1	1	20	3	6.1
11-20	12	27.2	1	20	13	26.5
21-30	50.0	50.0	40	40	31-40	31-40
31-40	5	11.3	1	20	6	12.2
41-50	1	2.2	0	0	1	2.0
51-60	4.5	4.5	0	0	2	4.0
Total	44	89.7	5	10.2	49	100

Table 2. Number of cases according to source to which person exposed.

Source of electrocution	Number
Household	12
At site of construction	4
Utility electric pole wire	
• Intact wire on electric pole	15
• Fallen electric pole wire	12
Transformer/Factory	6
Total	49

Table 3. Findings in electrocution deaths exposed to electric utility pole.

Features	Number
Entry wound only and less deep injuries	4
Both Entry and Exit wounds	4
Entry wound more severe than in household setup cases	10
Entry wound in sole	4
Multiple electrical injuries	3
Arcing	6

was the only case out of the 12 cases with exit wound, involving the sole which was deeper and extended beyond the superficial layers. There were 4 cases of electrocution in which the victims were exposed while they were working at construction sites. Out of these 4 cases, 2 cases were exposed to a voltage greater than 380 V and the other 2 cases exposed to 220V. In those cases exposed to more than 380V, the injuries were more deeper and in both the cases the deep injuries involved the soles. In 1 out of these 2 cases, in which the injury involved the sole, the wound was an entry wound (Picture 3) and there was associated localized burning of skin of foot which is evidence of arcing.

27 cases of electrocution were seen in this study who sustained electric shock from electric utility pole wire, either while the victims were working on the electric pole or they accidentally came in contact with the pole wires while working adjacent to the wires (15 out of 27 cases in both these categories) or they came in contact with fallen electric utility pole wires (12 out of 27) (Table 2).

In 18 out of 27 cases (66.6%) the injuries were found to be more severe deeper injuries, cases associated with arcing (picture 4) that are evident as localized or whole body burns, multiple electrical injuries which are reddish brown, hardened areas of skin] than the injuries seen in household setup. In 4 cases out of the 12 fallen electric utility pole wire exposure, the entry was in the sole (Picture 5). The injury is appreciated as entry wound based upon history and inward indentation or absence of outprojection of skin at the margins in contrast to exit wound which may have outprojecting skin margins. Also, in 11 out of 27 cases (40.7%) it was observed that the injuries involving palms or

soles were more severe than the injuries on other parts of the skin.

4 cases in this study were of electrocution in which the victims were exposed to transformers. In 2 out of these 4 cases, the victims touched the transformer with a wet stick. In 1 out of the 2 cases there was evidence of arcing (Picture 6) and in another case the injuries were superficial. In the other 2 of the total 4 cases, the injuries were multiple but were apparently less severe.

Electrical injury may present as Atypical electrical injury in some cases as an abrasion which is reddish brown and hardened.

Victims of electrocution fell from height sustaining fatal head injuries in 6 cases and all of these cases belonged to the category of exposure to a Utility pole. But in all these cases the victims were working at a height and there was no history that they were thrown away to a distance from the site of sustaining electric exposure.

Discussion:

In Ethiopia, the voltage in household setup is 220 V. During work of construction the voltage used is 380 – 400 V. The Voltage at electric utility pole is 380 V and the voltage at transformer is 15000V.

This study was mainly focused to see the pattern of electrical injuries particularly in relation to the voltage the victims were exposed to.

The majority of deaths occurred in the 21-30 year age group in a study conducted by Shaha, Joe which is in line with the result in our study (48.9%).

Home accidents were responsible for 56 cases deaths (45.5%) in the study conducted by Tirasci, Goren, Subasi et al. in contrast to our study in which the number of household exposure was 12 out of 49 (24.4%). In the household setup where the voltage was 220V the injuries on the skin were not severe in 83% cases. Whereas those victims exposed to electricity at construction site and those exposed to electric utility pole wires suffered severe injuries (66.6%). This finding is consistent with the study conducted by Zemaitis, Foris, Lopez, et al and the study by Lunn and Runde who concluded in their study that the higher the current and voltage associated with AC or DC, the greater will be the electrical damage. However, in our study we found that Voltage greater than 380V caused deeper burns or injuries than voltage less than 220V. The victims exposed to lesser voltage and sustaining less severe injuries on the skin does not in anyway indicate the potential fatality caused to the person as low voltage is more likely to cause tetany and death of the person and hence more dangerous. Hence, in contrast to the study by Bounds, Khan, Kok it was seen in this study that low voltage injuries cause less tissue damage but the lesser tissue damage does not indicate fatality.

In 40.7% cases it was observed that the injuries involving palms or soles were more severe, as these parts are thicker and offer greater resistance, than the injuries on other parts of the skin. This finding is again consistent with the findings in study by Zemaitis, Foris, Lopez, et al. which says that the tissues with the highest resistance tend to suffer the greatest level of damage as a result of an electrical injury.

The maximum number of cases were in the category of electric utility pole exposure (27 out of 49, i.e. (55.1%). This is in line with the finding in the study conducted by study by Zemaitis, Foris, Lopez, et al.

From our study, we can consider a voltage greater than 350 V as High voltage.

In cases of deaths from electrocution the scene of crime should be visited to understand the circumstances causing the electrical injury to prevent future accidents and also analyse the factors responsible for the production of severe or less severe injuries like presence of water at the site and whether the person was thrown to a distance by the exposure.

A bigger sample size in each category is required for better understanding of the pattern of injuries and for epidemiological purposes.

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

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ORIGINAL ARTICLE

Distribution of Fingerprint in Relation with Blood Group and Gender: A Cross-Sectional Study

Talukdar J,¹ Karmakar JK,² Ghosh A,³ Saikia NJ.⁴

Assistant Professor,^{1,2} Final year student,³ Tutor.⁴

1. Department of Forensic Medicine & Toxicology, North Eastern Institute of Ayurveda and Homoeopathy, Shillong.

2. Department of Forensic Medicine & Toxicology, Tomo Riba Institute of Health and Medical Sciences, Naharlagun.

3. North Eastern Institute of Ayurveda and Homoeopathy, Shillong.

4. Department of Community Medicine, Tomo Riba Institute of Health and Medical Sciences, Naharlagun.

Abstract:

Fingerprints are the most widely accepted method of determining the identity of a person in the court of law. The association of blood grouping is also another important tool in identification and the association between the two may in some way aid in Forensic analysis also similar studies lack in our area. The cross-sectional study was done by direct personal investigation and chi square test used for assessing statistical significance. The present study shows most common blood group as a whole is A which (33.60%) followed by B (29.50%), least common is AB (11.47%). Gender wise A is the most common blood group. The common finger print is loop which is 62.7%, followed by whorl (32.7%) and least common is Arch (4.6%). The most common Rh factor in Loop (58.7%- Rh positive), Whorl (29.3% Rh positive), and Arch (4.5% Rh positive).

Keywords: Fingerprints, Blood group; ABO and Rh system; Forensic analysis.

Introduction:

Dactylography is unique character mainly used in personal identification. Fingerprints are composed of various fine ridges which are mainly distributed in the palmer region of hands.¹ Mainly four types of fingerprints are observed in fingers i.e. loop, whorl, arches and composite or mixed variety.² Fingerprints pattern has loops which are commonly found (65%),³ whorl pattern accounts for 30%⁴ of total. Arches are rare and comprises of 5% cases.⁵ Blood grouping was discovered by Karl Landsteiner in 1901. Till date more than 20 different types of blood groups were identified,⁶ which vary in distribution pattern in different human races. This blood grouping system is further classified into ABO and RH system; which play an important role in several biological purposes. ABO system is further classified into A, B, AB and O in presence of corresponding antigens in blood cells,⁷ while antigen D forms the basis of classification of RH system into RH⁺ or RH⁻.

Although there are a number of research works done in the aforesaid context, this study is an attempt to analyze the association of different fingerprints with ABO, RH typing, gender; and also to identify the association between gender and blood groups.

Material and methods:

The present study was a cross section study, carried out among all medical students of North Eastern Institute of Ayurveda and Homoeopathy, Shillong, Meghalaya between March 2021 to February 2022. A total of 122 students were included in this study. The data of this study were collected from the individuals by

direct personal investigation.

Fingerprints were recorded from ten (10) fingers on a white paper by black ink and smudging avoided and later observed with magnifying lens and classified according to Henry system of classification. For determining blood groups samples were collected after cleansing the finger with spirit and pricking with lancet, a blood drop was taken from each individual and mixed with anti-serum A, B and D on a tile. The presence or absence of agglutination leads to the diagnosis of blood group.

The collected data were presented in different tables and diagram. Chi-square test was used for assessing statistical significance. Data were analyzed using SPSS 16.0. Necessary permission from institutional ethical committee (IEC) was taken for the study.

Results:

In the present study 122 medical students participated, out of which 57(46.7%) were males and females were 65 (53.2%).

Table-1 is showing the most common blood group as a whole is A (33.60%) followed by B (29.50%), least common is AB (11.47%). Gender wise A is the most common blood group. It is observed, in boys A blood group is followed by O (13.9%) whereas in girls it is B (17.21%) which is the second most common type. However, there is no significant association between gender and blood groups ($p > .05$).

Table-2 Showing the most common finger print is loop which is 62.7%, followed by whorl (32.7%) and least common is Arch (4.6%). Same pattern is observed in both sexes. After testing association we conclude that finger print is associated with gender ($p \leq .05$).

Table-3 showing that in people with A blood group Loop is more common finger print pattern. People with arch the blood group A

Corresponding Author

Dr. Jeneth Karmakar

Email : jenethkdr@gmail.com.

Mobile No.: 09854141317

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Table 1. Distribution of blood groups according to gender.

Blood group → Gender ↓	A	B	AB	O	Total
Male (N-57)	19 (15.5%)	15 (12.2%)	6 (4.9%)	17 (13.9%)	57 (46.72%)
Female (N-65)	22 (18.03%)	21 (17.21%)	8 (6.55%)	14 (11.47%)	65 (53.27%)
Total	41 (33.60%)	36 (29.50%)	14 (11.47%)	31 (25.40%)	122 (100%)
Chi square	1.276448				
P value	0.73				

Table 2. Distribution of finger prints in relation to Gender.

Blood group → Gender ↓	Loop	Whorl	Arch	Total
Male	369 (30.24%)	185 (15.16%)	16 (1.3%)	570 (46.72%)
Female	396 (32.46%)	214 (17.54%)	40 (3.27%)	650 (53.28%)
Total	765 (62.7%)	399 (32.7%)	56 (4.6%)	1220 (100%)
Chi square	8.135			
P value	0.017			

Table 3. Table showing variation of finger print pattern according to blood group.

Blood groups → Finger print ↓	A	B	O	AB	Total
Loop	259 (21.23%)	215 (17.62%)	205 (16.80%)	86 (7.05%)	765 (62.7%)
Whorl	121 (9.92%)	134 (10.98%)	98 (8.03%)	46 (3.77%)	399 (32.7%)
Arch	30 (2.46%)	11 (0.9%)	7 (0.5%)	8 (0.7%)	56 (4.59%)
Total	410 (33.6%)	360 (29.5%)	310 (25.4%)	140 (11.48%)	1220 (100%)
Chi square	17.33				
P value	12.59				

Table 4. Table showing Variation of finger print pattern with Rh factor.

Rh factor → Finger print ↓	Rh +ve	Rh-ve	Total
Loop	717 (58.77%)	48 (3.93%)	765 (62.7%)
Whorl	358 (29.34%)	41 (3.36%)	399 (32.7%)
Arch	55 (4.5%)	1 (0.08%)	56 (4.59%)
Total	1130 (92.62%)	90 (7.38%)	1220 (100%)
Chi square	8.83		
P value	5.99		

are more common. B blood group have marginally higher Whorl pattern. However statistically there is no significant association between blood group and pattern of finger print ($p > .05$).

Fig -1 is showing the most common Rh factor in Loop (58.7%- Rh positive, 3.93% Rh negative), followed by Whorl (29.3% Rh positive, 3.3% Rh negative), Arch (4.5% Rh positive, Rh negative 0.08%). After testing Chi-square test for independence of attributes it can be inferred that there does not exist any association between finger print and Rh factor ($p > .05$) (Table 4).

Discussion:

The present study indicates presence of a possible relationship between blood group and fingerprints. Gender wise A is the most common blood group among boys and girls. However in boys A blood group is followed by O (13.9%) whereas in girls it is B (17.21%) which is the second most common consistent with Patil et al (2021).⁸ In case of distribution of finger prints in relation to gender it is seen that the most common finger print is loop which

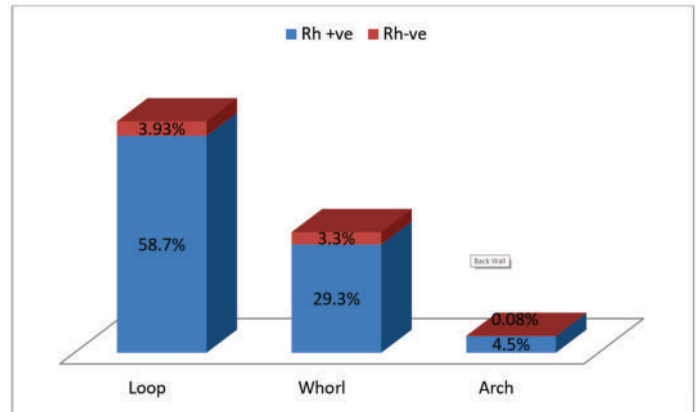


Figure 1. Variation of finger print with Rh factor.

is 62.7%, followed by whorl (32.7%) and least common is Arch (4.6%, $p < 0.017$) similar with Sahu et al.⁵

In variation of finger print pattern according to blood group the present study shows that in people with a blood group Loop and Arch is more common finger print pattern not consistent with Sahu et al.⁵ Variation of finger print pattern with Rh factor, the most common Rh factor in Loop (58.7%- Rh positive) followed by Whorl (29.3% Rh positive), Arch (4.5% Rh positive) consistent with Sahu (2016) and Smaio (2019).^{5,9}

Conclusion:

The present study is a humble effort to relate the association of blood group of individuals with fingerprints as no such studies was done earlier in our area; moreover this study may also aid in some way in forensic analysis. The above study shows blood group A is common in males whereas loop and arch are common in blood group A. Rh positivity dominates the presence in all fingerprints.

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ORIGINAL ARTICLE

The Changing Profile of Suicidal deaths in COVID-19 Pandemic in Haryana: A Retrospective Study

Chhikara P,¹ Dhatarwal SK,² Kumar S,³ Jindal M.⁴

Associate Professor,¹ Sr. Prof. & HOD,² Resident.^{3,4}

1-4. Department of Forensic Medicine, PGIMS, Rohtak.

Abstract:

Life is precious in all forms and stakes rise when it concerns the most advance species on our planet i.e humans. COVID-19 pandemic has been the most challenging time for human civilization in 21st century. Billions infected, millions dying, reeling health infrastructure, economic meltdown pushed people to their wits end, traumatising them physically, crippling them economically and psychologically. Physical and economic damage may be adjudged by morbidity, mortality figures and GDP but psychological derangements are very difficult to assess as their effect can be long lasting and far reaching. An attempt was made in this study to assess this by studying the most severely affected individuals who resorted to ending their lives. A retrospective study was conducted to study & statistically compare the profile parameters of suicide deaths during the two peak of COVID-19 pandemic (2020 & 2021) and years preceding it (2017 & 2018) brought for autopsy at an apex tertiary care centre in Haryana. It was found that there was an increase in number of suicide cases per year as the pandemic progressed along with rise in ratio of male to female cases and change in distribution of cases in different age groups with preponderance of younger age groups.

Keywords: Suicide; Pandemic; Change.

Introduction:

Life is precious in all forms and stakes rise when it concerns the most advance species on our planet i.e humans. COVID-19 pandemic has been the most challenging time for human civilization in 21st century. Billions infected, millions dying, reeling health infrastructure, induced a substantial fear and concern leading to stress and anxiety which was further worsened by lockdown restrictions, financial meltdown, lack of physical contact with acquaintances and friends pushing people to their wits end, traumatising them physically, psychologically and crippling them economically. COVID-19 not only caused physical health concerns but also resulted in a number of psychological disorders.¹ First case of COVID-19 was reported in India in January 2020 and first death in March 2020.²

Physical and economic damaged may be adjudged by morbidity, mortality figures and GDP but psychological derangements are very difficult to assess as their effect can be long lasting and far reaching. An attempt was made in this study to assess this by studying the most severely affected individuals who resorted to ending their lives by suicide. The operational criterion for determination of suicide defines it as "A death arising from an act inflicted upon oneself with the intent to kill oneself".³

Although, homicide appears to be the most gruesome face of death, it is usually for a sinister purpose whereas, suicide is a

purposeless loss of life due to mental inability to face situations and challenges of life. Such loss is unacceptable and preventable with timely and often low-cost interventions. Therefore, all recourses possible must be undertaken to prevent it. In order to devise these measures of prevention we need to understand the change in scenario like subjects at risk, high risk time zones.

This study was planned for studying and comparing the profile of suicidal deaths during the peak years of COVID-19 pandemic with those in preceding two years free from pandemic, so that a clear and scientific comparison can be made between the two phases.

Material and methods:

A retrospective study was planned and rolled out by authors from Department of Forensic Medicine, PGIMS, Rohtak. Post-mortem records of suicidal deaths whose postmortem was done at mortuary of PGIMS, Rohtak, over a period of four years, were thoroughly reviewed. The data was collected from post-mortem record register of mortuary for eligible cases of suicidal deaths brought to mortuary of PGIMS, Rohtak, over a period of four years. A total of 967 cases fulfilled the eligibility criteria. The data was collected for a period spreading over four years, including two peak years of COVID-19 pandemic (2020 & 2021) and two years preceding it (2017 & 2018) on a structured proforma designed to capture relevant details. Data obtained regarding various parameters like age, gender, time of year, district of origin, method of suicide was tabulated and statistically analyzed.

Inclusion criteria: All confirmed cases of suicidal deaths whose post mortem was done at mortuary of PGIMS, Rohtak during the study period.

Exclusion criteria: 1. All cases where manner of death is not

Corresponding Author

Dr. Pankaj Chhikara

Email : drchhikara@gmail.com

Mobile No.: 8607702777

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Table 1. Shows the year wise distribution of cases in Pre-COVID and COVID phase.

	Year	Suicidal Deaths
Pre-covid Years	2017	219
	2018	214
Covid-19 Pandemic Years	2020	252
	2021	265

Table 2. Gender wise distribution of cases in Pre-COVID and COVID phase.

Gender	Pre-Covid Phase	Covid Phase	Total	Test of significance
Male	226	347	613	X ² =4.355, df=1, p= 0.0369
Female	170	167	337	
Total	436	514	950	

Table 3. Age wise distribution of cases in Pre-COVID and COVID phase.

Age Group	Pre-covid Phase	Covid Phase
0 to 10	0	0
11 to 20	73	94
21 to 30	131	132
31 to 40	94	105
41 to 50	87	97
51 to 60	37	54
61 to 70	10	28
71 to 80	1	7

Table 4. Quarter-wise distribution of cases in Pre-COVID and COVID phase.

	Pre-Covid Phase	Covid Phase	Test of significance
First Quarter (Jan-Mar)	83	97	X ² =4.328, df=1, p= 0.228
Second Quarter (Apr-Jun)	131	138	
Third Quarter (July-Sept)	114	167	
Fourth Quarter (Oct- Dec)	105	115	

Table 5. Case distribution based on method of suicide in Pre-COVID and COVID phase.

Method of suicide	Pre-covid phase	Covid phase
Poisoning	416	490
Hanging	14	21
Drowning	3	2
Firearm	0	3
Jumping in Front of Train	0	1

suicidal. 2. All cases where no definitive manner and cause of death could be established.

Data analysis: Collected data were entered in the MS Excel spreadsheet, coded appropriately and later cleaned for any possible errors. The statistical analysis was carried out using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp. Armonk, NY, USA). Chi-square test was applied to compare profile parameters of suicidal deaths in PRE-COVID years (2017 & 2018) and COVID-19 pandemic years (2020 & 2021) to evaluate whether the changes found in various parameters were statistically significant or not. All tests were performed at a 5% level of significance; thus, an association was significant if the p value was less than 0.05.

Results:

Among the total 967 cases studied 17 cases were excluded due to indeterminate or non-suicidal manner of death. Amongst the remaining 950 cases included in the study the year wise distribution of cases was as shown in table 1. It is clear from the data that there was an increase in number of suicide cases per year as the pandemic progressed.

The study cases were predominantly males with 613 subjects

Chart 1. Shows the year wise distribution of cases in Pre-COVID and COVID phase.

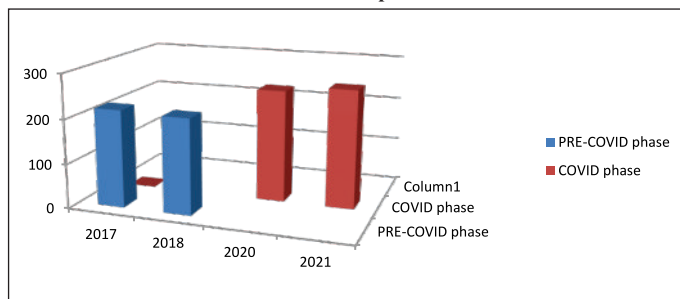


Chart 2. Gender wise distribution of cases in Pre-COVID and COVID phase.

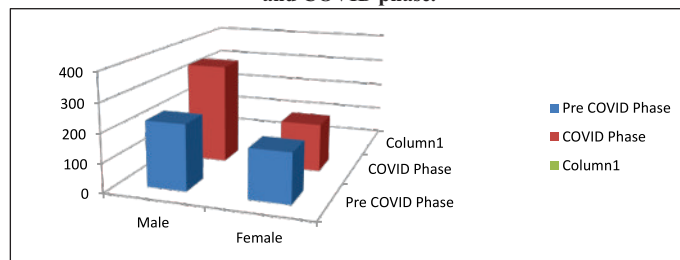


Chart 3. Age wise distribution of cases in Pre-COVID and COVID phase.

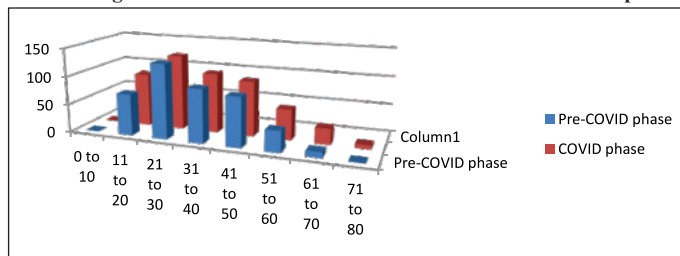


Chart 4. Quarter-wise distribution of cases in Pre-COVID and COVID phase.

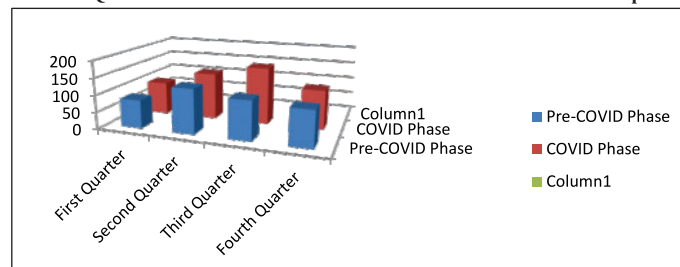
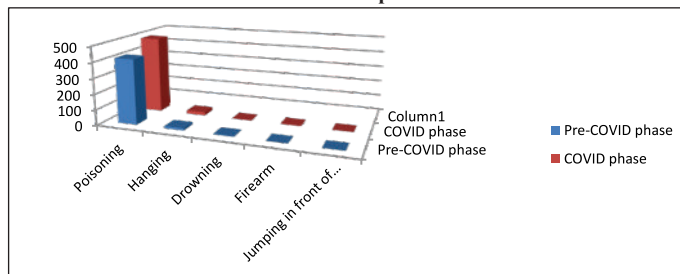


Chart 5. Case distribution based on method of suicide in Pre-COVID and COVID phase.



(64.5%) whereas females were about one-third of the total at 337 cases (35.5%). However, the ratio of male to female cases increased more during the COVID phase as compared to pre-COVID phase with number of male suicides increasing from 266

to 347 in COVID phase. On statistical analysis this increase was found significant as shown in Table 2.

The cases belonged to all age groups ranging from second decade to eighth decade. The age wise distribution of cases was as shown in table 3. Although there was a clear predominance of younger age groups in the suicides, the age distribution remained similar with no statistically significant change in age-wise distribution of case during pre-COVID phase as compared to COVID phase.

The cases were not distributed evenly all around the year with rise in number of cases in certain quarters in COVID phase corresponding to peak of COVID-19 wave. The quarter-wise distribution of cases around the year was as shown in table 4. There was a distinct rise in suicidal deaths in the third quarter of the COVID phase (167), corresponding to the post-peak of COVID-19 wave in second quarter as compared to similar quarter in pre-COVID phase (114). On statistical analysis the difference in suicidal deaths in third quarter of COVID phase and pre-COVID phase was found to be statistically insignificant.

The various methods used for suicide also studied and number of each was as shown in table 5. The data shows that poisoning was the predominant method of suicide in Haryana both during pre-COVID and COVID phase. Suicide by firearm injury and jumping in front of train was seen only during COVID phase. Deaths due to hanging also increased during COVID phase however, the increase was not found to be statistically significant on analysis.

Discussion:

WHO had predicted the rise in the number of mental health problems due to the global pandemic and had addressed this issue through various messages and publications related to mental health awareness and prevention.⁴ The study of profile of suicidal deaths can help the policy makers to identify the high risk population group and expected catastrophic time zones so as to devise strategies to save maximum number of lives with available resources.

In the present study it was found that number of cases of suicidal deaths increased during the COVID phase, similar to findings of Acharya et al.,⁵ Pathirathna et al.⁶ and Choudhury et al.⁷ probably due to the uncertainty induced fear and concern leading to stress and anxiety especially in developing countries where health services were limited and overwhelmed by huge population load. However, in study by Pirkis et al.⁸ in developed countries suicide rates either remained stable or decreased during early phase of pandemic.

The present study found males were more as compared to females, further the ratio of male to female cases increased during the COVID phase which could be attributed to stress of loss of employment and income as males are usually the sole bread-earners of family in India. Similar observations were made by Mamun et al.⁹ in his study in neighbouring country.

There was a clear predominance of younger age groups in the suicides in the present study and similar findings were observed by Acharya et al.⁵ and Choudhury et al.,⁷ which can be attributed to the fact that younger generations are actively involved in social

and economic activities and thus were worst affected.

In the present study it was observed that there was a distinct rise in suicidal deaths in the third quarter of the year in COVID phase (167), corresponding to the post-peak of COVID-19 wave in second quarter as compared to similar quarter in pre-COVID phase (114). This rise in number of cases corresponding to waves of COVID-19 peaks and economic lockdown have been documented by John et al.,¹⁰ Shrestha et al.¹¹ and many others.

Conclusion:

We humans cannot control nature and its wraths like the COVID-19 pandemic however, no stone should be left unturned in saving human lives whenever possible. The health care sector needs to strengthen its suicide screening services like the community based gatekeeper training programme, for early identification of high risk cases and timely intervention for individuals with suicidal behavior. All the stakeholders, including policymakers, psychiatrists, psychologists, and other healthcare professionals should collaborate to raise awareness to screen, detect and timely intervene the needy patients. The challenge of the COVID-19 crisis can be turned into an opportunity to advance the suicide prevention strategies and save precious lives not only today but even in future.

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ORIGINAL ARTICLE

Study of Changing Mortality Patterns of Medico Legal Cases in relation to Covid Pandemic

Kumar MU,¹ Kumar SK,¹ Kiran PP,² Rao PUM,³ Niha C.⁴

Assistant Professor,¹ Associate Professor,² Professor & Head,³ Post Graduate.⁴

1-4. Department of Forensic Medicine & Toxicology, Rangaraya Medical College, Kakinada.

Abstract:

This century's most dreadful disease COVID-19 has created significant knock, effecting day to day life - economically, socially & psychologically all over the world. This pandemic has affected not only thousands of people in terms of morbidity and mortality due to spread of this disease, also made the medical world most affected. Nearly half of the world's 3.3 billion global workforce had lost their livelihoods in the pandemic period. Without the means to earn an income during lockdowns, many are unable to feed themselves and their families. As bread winners lose jobs, fall ill and die, millions of dependents under the threat of livelihood and prosperity in all aspects. The no. of road traffic accidents has decreased during 1st wave period and 2nd wave period. There are varied patterns among all the sectors of occupation with significant and surprising changes among private sector and business. The number of suicidal deaths shows an increase during the 1st wave period and decrease in 2nd wave period.

Keywords: COVID-19; Mortality; Pandemic; 1st Wave; 2nd Wave.

Introduction:

The first human case of COVID-19 caused by the novel coronavirus (named SARS-CoV-2) was reported in Wuhan City, China, in December 2019. On 30 January 2020, the WHO declared that the outbreak of COVID-19 constituted a public health emergency of international concern.¹ Based on the high level of global spread and the severity of COVID-19, on 11 March 2020, the Director General of the WHO declared the COVID-19 outbreak a pandemic.² In India, the disease was first detected on 30 January 2020 in the state of Kerala, in a student who returned from Wuhan.³ The number of cases of COVID-19 continues to rise around the world. Maximum share of cases came from low and middle income countries in Asia, Africa and the America.⁴ Even though India is 3rd highest in deaths due to COVID-19 but reported COVID-19 deaths are widely believed to be under reported because of incomplete certification of COVID-19 deaths; misattribution to chronic diseases and also most deaths occur in rural areas often without medical attention.⁵ The present study aims to analyse the mortality pattern during COVID pandemic in medico-legal cases.

Materials and methods:

It was a retrospective, analytical, observational and comparative study done on the cases that were brought for post mortem examination to the Mortuary, Department of Forensic Medicine & Toxicology, Rangaraya Medical College, Kakinada, Andhra

Pradesh. We have taken the periods of study as follows that were compared with corresponding durations of pre COVID year i.e. 2019.

1. 1st Wave period - July 2020 to November 2020.
2. 2nd Wave period - May 2021 to July 2021.

Ethical clearance (IEC/RMC/2022/772) was obtained from the institutional ethics committee of Rangaraya medical college, Kakinada, Andhra Pradesh.

The acquired data was statistically analysed using SPSS software version 21.

Results:

During the study period of July to November 2019 a total number of 481 deaths were recorded. Out of which 409 (85.03%) were male, 71 (14.76%) were female and 1 (00.21%) was a transgender. During the study period of July to November 2020 a total number of 412 deaths were recorded. Out of which 329 (79.85%) were male and 83 (20.15%) were female.

During the study period of May to July 2019 a total number of 298 deaths were recorded. Out of which 239 (80.20%) were male and 59 (19.80%) were female. During the study period of May to July 2021 a total number of 261 deaths were recorded. Out of which 206 (78.93%) were male, 54 (20.69%) were female and 1 (00.38) was transgender [Table 1].

The data when statistically analysed and segregated for age wise distribution of the COVID cases [Table 2].

It was found that deaths in the people in age groups 11-20 years, 21-30 years and 51-60 years percentage of deaths have increased in both 1st wave and 2nd wave periods when compared to the corresponding pre-COVID period. In age groups <10 years, >60 years the percentage of deaths have increased in 1st wave period

Corresponding Author

Dr. P. Phani Kiran

Email : phanikiran.mbbs@gmail.com

Mobile No. : +91 98853 66222

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and decreased in 2nd wave period when compared to the corresponding pre-COVID period.

In age groups 31-40 years and 41-50 years the percentage of deaths have decreased in 1st wave period and increased in 2nd wave period when compared to the corresponding pre-COVID period.

The medico legal cases under section 174 Cr.P.C., during the study period of July to November were decreased in 2020 when compared to 2019, and during the study period of May to July they were decreased in 2021 when compared to 2019. There was no major difference in the pattern of deaths under section 302 I.P.C. during the above mentioned study periods. There were no significant number of deaths under remaining other sections, occurred during the above mentioned study periods [Table 3].

During the study period of July to November the number of deaths among the occupation of government sector, housewives and students were increased in 2020 when compared to 2019; whereas they were decreased in the occupation of private sector, daily labour, business, and unemployed. During the study period of May to July the number of deaths among the occupation of government sector, housewife, student, and unemployed were increased in 2020 when compared to 2019; whereas they were decreased in the occupation of private sector, daily labour, and business [Table 4].

Regarding the manner of death there was an increase in deaths due to suicide during the study period from July to November in 2020 (38.11%) when compared to 2019 (29.11%); whereas there was an minimal decrease in number of suicides during the study

period from May to July in 2021 (26.05%) when compared to 2019 (27.85). There was decrease in the number of deaths due to homicides and accidents, during all the study periods. Regarding deaths due to natural causes, there was no difference during the study period from July to November in 2019 and 2020; and from May to July in 2021 when compared to 2019 [Table 5].

During the study period of July to November, Regarding the motive for suicide there was an increase in deaths due to marital disputes, petty issues, and property issues in 2020 when compared to 2019; whereas there was decrease in suicides due to financial causes, mental stress, extra marital affairs, and ill health. During the study period of May to July, regarding the motive for suicide there was an increase in deaths due to ill health in 2021 (27.94%) when compared to 2019 (18.07%); whereas there was decrease in suicides due to financial causes, mental stress, and petty issues during the study period of May to July, and there was no significant change in the pattern of suicides due to marital disputes, extra marital affairs, and property issues during the above mentioned study period [Table 6].

Discussion:

In both the 1st wave and 2nd wave periods, percentage of deaths is decreased in males whereas increased in females when compared to the study period in the pre-COVID year [Table 1]. The findings are contradictory to the studies conducted in lockdown period by

Table 1. Gender wise distribution of deaths.

Gender	July - November		May - July	
	2019	2020	2019	2021
Male	409 [85.03%]	329 [79.85%]	239 [80.20%]	206 [78.93%]
Female	71 [14.76%]	83 [20.15%]	59 [19.80%]	54 [20.69%]
Transgender	1 [0.21%]	0 [0.0%]	0 [0.0%]	1 [0.38%]
Total	481	412	298	261

Table 2. Age wise distribution of deaths.

Age in years	July - November		May - July	
	2019	2020	2019	2021
<10	7 [1.45%]	9 [2.18%]	7 [2.35%]	6 [2.30%]
11-20	34 [7.07%]	43 [10.44%]	18 [6.04%]	22 [8.43%]
21-30	99 [20.58%]	94 [22.81%]	72 [24.16%]	66 [25.29%]
31-40	116 [24.12%]	80 [19.42%]	63 [21.14%]	57 [21.84%]
41-50	95 [19.75%]	55 [13.35%]	51 [17.11%]	36 [13.79%]
51-60	74 [15.39%]	64 [15.53%]	49 [16.44%]	47 [18.00%]
>60	56 [11.64%]	67 [16.26%]	38 [12.75%]	27 [10.34%]
Total	481	412	298	261

Table 3. MLC deaths under various sections.

Section	July - November		May - July	
	2019	2020	2019	2021
174 Cr.P.C	307 [63.83 %]	277 [67.23%]	192 [64.43%]	175 [67.05%]
304-A IPC	154 [32.02%]	120 [29.13%]	93 [31.21%]	72 [27.59%]
304-B IPC	1 [0.21%]	0 [0%]	0 [0%]	0 [0%]
302 IPC	9 [1.87%]	7 [1.7%]	8 [2.68%]	8 [3.07%]
306 IPC	2 [0.42%]	7 [1.7%]	2 [0.67%]	3 [1.15%]
309 IPC	2 [0.42%]	1 [0.24%]	1 [0.34%]	2 [0.77%]
498 - A IPC	3 [0.62%]	0 [0%]	1 [0.34%]	1 [0.38%]
176 Cr.P.C	3 [0.62%]	0 [0%]	1 [0.34%]	0 [0%]
Total	481	412	298	261

Table 4. Occupation of the deceased.

Occupation	July - November		May - July	
	2019	2020	2019	2021
Government Sector	4 [0.83%]	6 [1.46%]	2 [0.67%]	16 [6.13%]
Private Sector	58 [12.06%]	11 [2.67%]	50 [16.78%]	14 [5.36%]
Daily labour	308 [64.03%]	281 [68.2%]	166 [55.7%]	152 [58.24%]
Business	12 [2.49%]	9 [2.18%]	16 [5.37%]	1 [0.38%]
House wife	45 [9.36%]	58 [14.08%]	27 [9.06%]	30 [11.49%]
Student	20 [4.16%]	27 [6.55%]	7 [2.35%]	15 [5.75%]
Unemployed	27 [5.61%]	16 [3.88%]	12 [4.03%]	26 [9.96%]
Un mentioned	7 [1.46%]	4 [0.97%]	18 [6.04%]	7 [2.68%]
Total	481	412	298	261

Table 5. Comparison of manner of death.

Manner of Death	July - November		May - July	
	2019	2020	2019	2021
Suicide	140 [29.11%]	157 [38.11%]	83 [27.85%]	68 [26.05%]
Homicide	11 [2.29%]	7 [1.7%]	9 [3.02%]	7 [2.68%]
Accident	289 [60.08%]	207 [50.24%]	187 [62.75%]	167 [63.98%]
Natural	41 [8.52%]	41 [9.95%]	19 [6.38%]	19 [7.28%]
Total	481	412	298	261

Table 6. Motive for suicide among suicidal deaths.

Motive for Suicide	July - November		May - July	
	2019	2020	2019	2021
Financial	24 [17.14%]	18 [11.46%]	17 [20.48%]	12 [17.65%]
Mental stress	47 [33.57%]	45 [28.66%]	11 [13.25%]	8 [11.76%]
Marital disputes	24 [17.14%]	40 [25.48%]	21 [25.3%]	21 [30.88%]
Extra marital affairs	4 [2.86%]	3 [1.91%]	0 [0%]	0 [0%]
Petty issues	15 [10.71%]	25 [15.92%]	14 [16.87%]	6 [8.82%]
Property issues	2 [1.43%]	3 [1.91%]	2 [2.41%]	2 [2.94%]
Ill health	21 [15%]	19 [12.1%]	15 [18.07%]	19 [27.94%]
others	3 [2.14%]	4 [2.55%]	3 [3.61%]	0 [0%]
Total	140	157	83	68

Patel Ankur P et al.,⁶ Vijay arora et al.,⁷ and Shinto Devassy et al.,⁸ because of ethnic variations and lockdown regulations. The age wise distribution of deaths due to COVID-19 did not reveal any pattern [Table 2].

The number of road traffic accidents has decreased during both the 1st wave period and 2nd wave period [Table 3]. This could be due to the restrictions imposed by the government in view of COVID-19 and the fear among the people to go outside unless it is necessary.

There are varied patterns among all the sectors of occupation with significant and surprising changes among private sector and business [Table 4]. Decreased transport, work from home, psychological and physical stress, relief of staying home with the family could have resulted in such surprising results, but, in the contrary women staying at home have to go through lots of physical and psychological stress with all the family members staying home and also in homes where the bread winners are lost leaving the dependent wives and children devastated resulted in the rise of cases.

The number of suicidal deaths shows an increase during the 1st wave period [Table 5]. The financial uncertainty and anxiety caused by the pandemic led to the increase in suicides but by the 2nd wave time situations have become better resulting in the decrease of cases. The decrease in number deaths due to accidents corresponds with the decrease in number of road traffic accidents due to lock down and transport restrictions.

Though the unexpected and unwelcomed mental stress and financial crisis caused by the pandemic which was faced 1st time in the present generation led to the rise of suicidal cases during the initial stages [Table 6]. The change in perspective of public towards the crisis and methods to face it resulted in the decrease of cases during 2nd wave period. The psychological and physical stress increased due to staying home together with all family members might have led to increased marital disputes and petty issues resulting in the rise of cases.

Conclusion:

The financial crisis, psychological effects and lock down restrictions during the pandemic has led to significant change in the mortality patterns among the Medico legal cases. COVID-19 has affected all over the world and impacted people lives and

economy. Our study highlights the effect of the pandemic on the mortality pattern in a developing country of India where people live on daily wages and the sudden change in the perception of life due to lockdown and restriction of movement. As World Health Organisation Director General gave an alert that world must be ready to respond to the next pandemic, governments should have an eye on psychological impact of policies taken during the times of pandemic on the public.

Conflict of interest: None

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ORIGINAL ARTICLE

Challenges in Estimation of Post Mortem Interval from Vitreous Potassium Concentration in Global Perspective: A Systematic Review

Chowdhuri S,¹ Mridha W,² Ghosal S,³ Mishra V.⁴

Assistant Professor,¹ MBBS student,² PhD research scholar,³ Scientist.⁴

1,3. Department of Forensic and State Medicine, Calcutta National Medical College, Kolkata.

2. Calcutta National Medical College, Kolkata.

4. Toxicology Division, Central Forensic Science Laboratory, Kolkata.

Abstract:

Postmortem interval as an essential component of death investigation needs to be precisely estimated scientifically as far as practicable. In decomposed bodies, vitreous humour potassium concentration holds scientific merit as they resist early bacterial putrefaction. However, the quantitative estimation of ion depends on several factors, such as climatic, seasonal, storage conditions apart from biological age and hidden pathological condition of the deceased concerned. Thus equations formulated in a particular climatic condition may not be validated with other. Some of the studies generated regression equations based on their regional climatic considerations, but they highly vary with other studies performed across the geographic barrier. Global studies suggested immediate freezing of samples below -20°C to maintain its quality for forensic analysis. Samples should not be exposed to light and temperature. The immediate challenges in the field are explored and outlined comprehensively and possible solutions to the feasible context are recommended.

Keywords: Forensic science; Forensic pathology; Postmortem changes; Potassium.

Introduction:

Post mortem interval (PMI) is referred as time passed from death to the discovery of the cadaver and is an important part of medico-legal investigation.^{1,2} After death, bodies are subjected to various decomposition changes both physically and chemically. To be more precise with diagnosing time of death and for scientific interest chemical changes in electrolyte composition of biological fluids have been the focus of investigation in forensic medicine.¹ Compared to physical changes, time dependent quantitative chemical changes in biological fluid serve as an important tool in estimation of PMI.¹ Some studies have shown the chemical importance of vitreous humor in estimation of post mortem interval.^{3,4} Vitreous humor is a colloidal substance, made up of gel like fibrils of collagen and fluid, well compartmentalized between posterior retina and lens anteriorly, protected by surrounding bony architecture and tight junctional complex vitreous-blood barrier. Therefore, it is less vulnerable to external contamination and putrefaction.^{3,5} Key electrolyte components of vitreous biomatrix are potassium, sodium, chloride, calcium, phosphate apart from other biomolecules.^{3,5} Several studies have reported post-mortem time dependent relation with electrolytes under various condition.^{2,6,7} The aim of the review is to outline the comprehensive existing knowledge on use of vitreous potassium concentration as a forensic tool, with its challenges, methodological gap analysis for PMI estimation in global context.

Corresponding Author

Dr. Soumeek Chowdhuri

Email : smk.kgp@gmail.com

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Methods:

Electronic database i.e. Google Scholar were searched with related keywords- “post mortem interval”, “vitreous humor”, “potassium” using connectivity AND. The custom ranges for search were 2017-2022. 198 articles were primarily screened. Removal of duplication search, and relevance to the study objectives, 23 articles (3 abstracts and 20 full text papers) were selected, critically reviewed, analyzed with comprehensive knowledge and presented in this article. Figure 1 shows the flowchart of literature search.

Results:

Indian perspective: In a recent study conducted by Singh et al. (N=140) concluded statistical linear correlation between vitreous potassium and post mortem interval.⁸ In a recent study conducted by Paul et al. (N=75) revealed the linear increment in vitreous potassium with PMI.⁹ The calculated average rate of increase was 0.931 mmol/L/hour. The 95% confidence limit of the study was over ± 20 hours. Among the samples, the mean vitreous potassium range was 5.4-36 mmol/L. The equation which was generated $\text{PMI} = 1.075 \times (\text{K}^+ \text{ in mmol/L}) - 2.53$ with the coefficient of correlation between post mortem interval and vitreous humor potassium 0.997.⁹ In another study done by Angayarkanni (N=100) showed positive correlation between PMI and vitreous potassium.¹⁰ Pearson coefficient value for right and left vitreous potassium were 0.580 and 0.536 with respect to the samples aspirated from the cadavers as soon as they were received at mortuary and that of for right and left vitreous potassium were 0.611 and 0.581 with respect to the samples at the time of post mortem examination implied the significant relation with PMI. No significant difference was noted between right and left vitreous potassium values (P-value >0.05). ANOVA study

Table1. Summary of Literature review in Indian perspective.

Sl. No.	Name of the author	Sample size (N)	Sampling technique	Storage condition	Method applied	Equation generated	Outcome
01	Tatiya et al.2017 (Western India)	67	Not applied	Not applied	Not applied	Not applied	No significant difference in electrolytes in both eyes
02	Taware et al.2017 (Western India)	207	Aspirated from posterior chamber of eyes by using 10 mL sterile syringe and 21 gauze needle through a puncture 5-6 mm away from eye limbus near outer canthus. Samples contaminated with particulate matter, blood, cloudy and discoloured excluded.	Not applied	Flame photometry	$y=0.2115x + 8.9122$	Elevation in K ⁺ up to 46 hours PMI
03	Nasim, 2017 (Southern India)	100	Aspirated by using 10 mL sterile syringe and 20 gauze needle through a puncture 5-6 mm away from eye limbus. Crystal clear samples included and visibly discoloured samples discarded.	Not applied	Ion selective electrode	Not applied	No significant K ⁺ elevation after 48 hours PMI
04	Shrivastava et al. 2018 (Western India)	200	Aspirated from posterior chamber of both eye by using 10 mL sterile syringe and 20 gauze needle through a puncture 5-6 mm away from the eye limbus. Spoiled samples and extracted amount < 0.5 mL discarded.	Not applied	Electrolyte analyzer	PMI = $16.22 + 3.75 \times K^+$	Linear rise in K ⁺ up to 57 hours PMI
05	Rama, 2018 (Southern India)	100	Aspirated from posterior chamber of eye by using 10 mL sterile syringe and 20 gauze needle through a puncture 5-6 mm away from eye limbus. Only clear samples included.	Not applied	Ion selective electrode	Not applied	No significant correlation between K ⁺ and PMI
06	Nasim and Selvaraj, 2019 (Southern India)	100	Aspirated by using 10 mL sterile syringe and 20 gauze needle through a puncture 5-6 mm away from eye limbus	Not applied	Ion selective electrode	Not applied	Linear correlation between K ⁺ and PMI
07	Murthy et al. 2019 (Southern India)	100	1.5-2 mL aspirated by using 20 gauze hypodermic needle from outer palpebral fissure lateral to eye limbus. Samples aspirated from left and right eyes before and after exposure to cold chamber respectively.	Cold chamber 2oC-4oC	Ion selective electrode	Not applied	Cold chamber affected K ⁺ concentration
08	Ruia & Viswakanth, 2019 (Southern India)	200	Not applied	Not applied	Not applied	Not applied	Linear rise in K ⁺ up to 57 hours PMI
09	Dhuvarkesh, 2020 (Southern India)	100	Aspirated by using 10 mL sterile syringe and 20 gauze needle through a puncture 5-6 mm away from eye limbus in the peri limbal region. Turbid samples excluded and clear samples included.	Not applied	Ion selective electrode	PMI = $0.2038 \times (\text{Postmortem } K^+ \text{ Concentration}) - 16.7348$	Positive correlation between K ⁺ and PMI
10	Angayarkan ni, 2021 (Southern India)	100	Aspirated from posterior chamber of both eyes by using sterile 20 gauze needle through a puncture 5-6 mm away from eye limbus near outer canthus. Samples contaminated with blood and turbid discarded. Clear samples included.	Not applied	Ion selective electrode	Not applied	Positive correlation between K ⁺ and PMI
11	Paul et al.2022 (Southern India)	75	Not applied	Not applied	Fully automated analyzer	PMI= $1.075 \times (K^+ \text{ in mmol/L}) - 2.53$	Consistent linear rise in K ⁺ with PMI
12	Singh et al. 2022 (Western India)	140	Samples aspirated from posterior chamber of eye from a puncture made 5-6 mm away from limbus by using 20 gauge hypodermic needle.	Not applied	Ion selective method	Not applied	Significant linear correlation between vitreous K ⁺ and PMI

revealed the positive correlation between vitreous potassium and PMI (P-value <0.001, statistically significant).¹⁰ In a study done by Dhuvarkesh (N=100) samples were distributed into various ranges of PMI (range of vitreous potassium inside brackets) i.e. 0-6 hours (109.5-119.1 mg/dL), 6.1-12 hours (119.2-137.9 mg/dL), 12.1-18 hours (139.4-155.7 mg/dL), 18.1-24 hours (156.3-171.1 mg/dL) and 24.1-36 hours (178.3-208 mg/dL) which implied strong correlation between PMI and vitreous potassium concentration.¹¹ The equation formulated was $PMI = 0.2038 \times (\text{Post mortem } K^+ \text{ Concentration}) - 16.7348$ and 95% confidence limit of the concerned study was approximately ± 90 minutes.¹¹ In study conducted by Ruia and Viswakanth (N=200, 2019)

observed linear increment in vitreous potassium up to 57 hours of PMI.⁶ Calculated range of vitreous potassium was 3.1-24 mEq/L and in 72% of sample size it was ranged between 6.1 and 12 mEq/L.⁶ In another study conducted by Murthy et al. (N=100,2019) calculated vitreous potassium 7.53 ± 2.26 mmol/L (Mean \pm SD).¹ By using pre-established equation proposed by Madea et al. $PMI = 5.26 \times K^+ - 30.9$, vitreous potassium concentration came out to be 9.51 ± 1.64 mmol/L (Mean \pm SD). P-value came out to be <0.0001 after performing t-test which implied the significant effect of cold chamber on vitreous potassium.¹ In a study done by Nasim and Selvaraj (N=100) concluded that age, temperature, humidity had no significant

Table 2. Summary of literature review in global perspective.

Sl. No.	Name of the author	Sample size (N)	Sampling technique	Storage condition	Method applied	Equation generated	Outcome
01	Prieto-Bonete et al. 2017 (Spain)	298	0.2 mL sample aspirated through scleral puncture using 1 mL sterile syringe	Immediately frozen at -720C until analysis	Multichannel autoanalyzer	Not applied	Combination of vitreous K ⁺ with other electrolytes e.g. sodium, chloride, urea and osmotic pressure may improve the PMI estimation within 24 hours
02	Agoro et al. 2017 (Nigeria)	50	Crystal clear samples without any tissue or blood contaminations were collected	Not applied	Ion selective electrode	Not applied	Spearman correlation analysis shows erratic and time dependant Potassium concentration for PMI estimation upto 15 hours
03	Cordeiro et al. 2019 (Portugal)	331	Clear fluid was aspirated through scleral puncture near outer canthus by using 10 mL syringe and 20 gauge needle. Samples contaminated with blood excluded. Samples were collected from deceased with closed eyes and with no history of chronic diseases, hypo-hyperthermia and within known post-mortem interval of 15mins	Not applied	Ion selective electrode	Not applied	Efficacy of potassium to estimate PMI is narrated with known margins of error. Impacts of ambient temperature, cooling of body on vitreous biochemistry are highlighted in the study. However, age related factor that influences on K ⁺ concentration are not given importance in the study as all samples were analysed for less than a day of PMI.
04	Risoluti et al. 2019 (Italy)	50	2 mL clear fluid aspirated by puncturing sclera at eye lateral canthus. Samples with tissue fragments were excluded.	-200C	Inductively coupled plasma optical emission spectrometry (ICP-OES) Chemometric method	Not applied	Vitreous K ⁺ were considered as good indicator of PMI estimation as long as 15 days
05	Pérez-Martínez et al. 2019 (Spain)	250	0.2 mL sample aspirated from right eye through scleral puncture near outer canthus by using 1 mL sterile syringe and 20 gauge needle	Immediately stored and frozen at -720C until analysis	Multichannel auto analyzer	PMI = 2.422 + 0.6 × K ⁺ + 0.107 × Uric acid - 0.018 Hypoxanthine (0-12 hours from natural death) PMI = 17.868 + 0.061 × K ⁺ - 0.156 × Uric acid + 0.131 × Hypoxanthine (13-24 hours from natural death) PMI = 0.243 + 0.593 × K ⁺ + 0.148 × Uric acid 0.046 × Hypoxanthine (0-12 hours from violent death) PMI = 15.960 + 0.147 × K ⁺ + 0.178 × Uric acid + 0.135 × Hypoxanthine (13-24 hours from violent death)	Strong correlation between vitreous potassium and PMI 0-24 hours since death Potassium concentration is affected by the post-mortem period and other ambient factors that bias the results are narrated.
06	Garland et al. 2019 (April) (New Zealand)	28	5-8 mL clear sample aspirated by using 10 mL syringe and 22 gauge needle. Drowning deaths were excluded for possible alterations with passive water osmosis	Not applied	Ion selective electrode method	Not applied	Post mortem vitreous K ⁺ reference range differs from cerebrospinal fluid.
07	Garland et al. 2019 (July) (New Zealand)	20	5-8 mL sample aspirated from both orbits by using 22 gauge needle and 10 mL syringe. Suspicious and homicidal death, sudden unexpected infant death, death due to immersion and cases with incomplete paired dataset excluded.	Not applied	Ion selective electrode method	Not applied	Significant association between vitreous K ⁺ and PMI
08	Focardi et al. 2020 (Italy)	120	3 samples aspirated from near the centre of both eyeball by using sterilized 20 gauge hypodermic needle. Cases with unknown PMI, unclear sample, ocular trauma, kidney failure, drug overdose, metabolic disorders, imbalance in body water prior to death excluded.	-800C for 7 days	Potentiometry and mass spectrometry quantification	PMI = 5.35[K ⁺] + 9.94[Albumin] - 27.93	Vitreous K ⁺ has effective role in estimating PMI particularly after 72 hours
09	Palacio et al. 2020 (Italy)	33	100-200 microlitre samples aspirated by puncturing sclera at eye lateral canthus. Death due to head trauma, opioid overdose excluded.	-240C (Not more than a week)	Capillary electrophoresis	[Vitreous K ⁺] = -0.0005 PMI ² + 0.2018 PMI + 6.173	Positive correlation between vitreous K ⁺ and PMI
10	Ioelu et al. 2021 (New Zealand)	125	1-2mL clear samples aspirated from both orbits by using 22 gauge needle and 10mL syringe. Potential suspicious and homicidal deaths, traumatic death, perinatal death, PMI >48 hours excluded.	Not applied	Ion selective electrode	NIL	Vitreous K ⁺ is useful in estimating PMI <24 hours
11	Ave et al. 2021 (Spain)	42	Bilateral aspiration through scleral puncture at palpebral fold by using 20 gauge needle Animal study (calves)	For frozen technique, samples were stored in -210C for 7-9 days	Catalyst analyzer	y = 1.33x - 0.8842	No significant changes were observed in quantitative estimation of vitreous K ⁺ after several freezing or thawing cycles

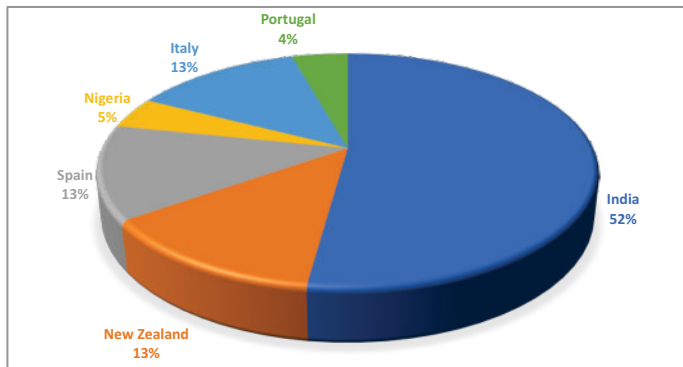


Figure 2. Pie-chart for vitreous potassium with global distribution.

effect on vitreous potassium.¹² It was observed that subjects suffered from burn injury, trauma related to road accident, hanging, poisoning, accidental fall and natural death had relatively high vitreous potassium as compared to subjects suffered from snake bite, electrocution and head injury. Although it was concluded that there was a linear relationship between vitreous potassium and PMI. 95% confidence limit of this study was over ± 12 hours.¹² Rama (N=100) also concluded that age had no significant effect on post mortem vitreous potassium but cause of death also did not affect vitreous potassium concentration.¹³ It was concluded that there was no significant correlation between vitreous potassium and PMI.¹³ In a study done by Shrivastava et al. (N=200) generated an equation to estimate post mortem interval i.e. $PMI = -16.22 + 3.75 \times K^+$ with coefficient of correlation 0.831.⁷ The value of coefficient of regression was calculated 3.46 mEq/L/hour. Vitreous potassium showed linear increment with PMI up to 57 hours. However, no significant correlation observed between right and left eye vitreous potassium concentration in relation to various modes of death.⁷ In a study conducted by Nasim (N=100) concluded that there was no significant elevation in vitreous potassium after 48 hours of PMI.⁵ Temperature, humidity and age had no significant effect. Higher vitreous potassium was observed in subjects suffered from burn injury, road traffic accident, natural death, accidental fall, hanging and poisoning as compared to subjects suffered from head trauma, electrocution, snake bite. The range of vitreous potassium was 6.02 to 18.2 mmol/L with SD 1.832. P-value calculated ≤ 0.001 implied statistical significance. 95% confidence limit of this study was ± 12 hours.⁵ Taware et al. (N=207) generated an equation $y=0.2115x + 8.9122$ with calculated coefficient of correlation 0.8024 implied significant correlation between PMI and vitreous potassium.² It was observed that there was increment in vitreous potassium up to 46 hours of PMI. 95% confidence limit of this study was ± 17.14 hours. P-value less than <0.001 implied statistical significance.² Tatiya et al. (N=67) concluded that there was no significant difference in electrolytes in both eyes.¹⁴

Table 1 summarizes the result with important study highlights.

Global perspective: Ave et al. (N=42) reported that there was no significant changes in quantitative estimation of vitreous potassium after several cycles of freezing and thawing, that were

experimented in different groups.⁴ In case of delay for analysis, samples were suggested to freeze and are recommended not to expose them to any external temperature or light as much as practicable. In general, storages were done at a temperature -21°C for 7-9 days which is difficult to be maintained throughout in most forensic cases. Equation generated as $y = 1.33x + 0.8842$, where y represents the PMI and x being vitreous potassium concentration.¹⁵ Ioelu et al. (N=125), established the positive correlation of rise in potassium at a postmortem time dependant state for <24 hours.¹⁶ One of the interesting observation that were presented in their study was, vitreous potassium were near accurate in cases of infants <1 year of age, as compared to adults.¹⁵ Palacio et al. (N=33) observed the relationship between vitreous potassium concentration and postmortem interval with equation generated as $[\text{Vitreous K}^+] = -0.0005 \text{ PMI}^2 + 0.2018 \text{ PMI} + 6.173$.¹⁶ However, storage conditions were suggested at -24°C for not more than a week. Samples were analyzed using capillary electrophoresis method.¹⁷ Focardi et al. (N=120), reported the efficacy of using vitreous potassium as a quantitative measure of time passed death over 72 hours of interval.¹⁷ Potentiometry and mass spectrometry quantification method were applied in their study. Equation generated were $PMI = 5.35 [\text{K}^+] + 9.94 [\text{Albumin}] - 27.93$, where other biomolecule e.g. albumin were considered together for estimation.¹⁸ In study done by Garland et al. significant association between potassium and PMI were established.¹⁸ In both their study ion selective electrode methods were considered, and any external ambient influences were not reported.¹⁹ In another study conducted by them (Garland et al. 2019), association between vitreous potassium and time interval were established. However, nature of sample influences on potassium concentration, as compared to cerebrospinal fluid.¹⁹ Pérez-Martínez et al. suggested for immediate storage of samples at -72°C until analysis, which is not always feasible to practice in most forensic cases.²⁰ However, the method applied as Multichannel autoanalyzer, could strongly correlate vitreous potassium concentrations with PMI upto 24 hours. The concentration is affected by the delay in postmortem period and other ambient factors may influence result. The equations generated in their study were categorized as per the modes of death e.g. hours from natural death and hours from violent death. Equations were constructed considering the concentrations of other biomolecules e.g. uric acid and hypoxanthine along with potassium ions within a range of time interval.²¹ Risoluti et al. established the use of vitreous potassium as a good indicator of PMI upto a period of 15 days since death, by using the method inductively coupled plasma optical emission spectrometry (ICP-OES), which is chemometric principle.²¹ In their study storage of samples at -20°C were reported for better accuracy on quantitative analysis.²² Cordeiro et al. demonstrated the efficacy of vitreous potassium to estimate PMI within known ranges of error, on a larger sample size (N=331) as compared to other studies reported in forensic literature.²² Samples were analyzed by ion selective method. Impacts of ambient temperature and cooling of body on vitreous biochemistry are narrated.²³ In the study by Agoro et al. spearman correlation analysis shows erratic and time dependant potassium concentration for PMI upto 15

hours.²³ Samples were analyzed through ion selective electrode method.²⁴ Prieto-Bonete et al. (N=298), suggested for immediate freezing of samples at -72°C until analysis.²⁴ However, according to them, vitreous potassium with other electrolytes e.g. sodium, chloride, urea and considering the osmotic pressure may improve the PMI estimation within 24 hours of death.²⁵ Table 2 summarizes the result with important study highlights.

Discussion:

Among 23 articles, 12 (52%) are reported from India, 3 (13%) are reported from New Zealand, 3 (13%) are reported from Italy, 3 (13%) are reported from Spain, 1 (5%) from Nigeria and 1 (4%) from Portugal as depicted in figure 2. The publication trend in the recent years has been depicted in figure 3. Vitreous humor had been a forensic interest to estimate the time of death, for its delayed bacterial putrefaction and protected anatomical privilege. However, certain pathological conditions, electrolyte imbalance, parenteral source, burn injury, trauma, poisoning and even snake bites have been reported to influx potassium concentration. This may appear as confounds during forensic investigation and has to be considered for case specific exclusions.¹²

Moreover, potassium concentrations from decomposing cadaver are subjected to climatic fluctuations. Daily fluctuations in ambient temperature and relative humidity are the most important confounding factor in assessment of any decomposition dependent changes. Therefore, regression equations generated at a particular climatic condition may vary on actual casework, considering a varied condition.¹ Though the previous studies did not emphasize the range of climatic fluctuations and seasons of their studies, stress in this part is required. Thus it is worth in generating baseline reference data, with per state seasonal variations otherwise, the working efficacies may not be valid.

However, some global studies outside India, suggested for immediate freezing at lower temperature ranges (-70 to -20)°C with maintaining the cold chain before analysis of samples. The process may be quite difficult to practice for some laboratories or mortuaries in meeting the quality infrastructure. Thus easy and feasible method without compromising quantitative analysis towards forensic standard must be worked out. Again authors conducted similar kind of studies using different methods of analysis, which may incorporate range of errors when applied for case work. Therefore, minimum methodological principles for all forensic laboratories need to be implemented as a general guideline, to meet equal standards.

Moreover, storage at 4 degree Celsius or cold chain, at least, is recommended immediately after collection of sample to avoid any light or heat induced changes in ionic concentration that could have hampered the time interval estimation. Thus proper research design towards the study needs to be considered for effective results and comparison, keeping the challenges narrated in this article in mind.

Conclusion:

Considering all factors discussed so far, that have an impact on fluctuations in estimation of PMI, it is seen that more research are

required. Apart from pathological conditions, generation of mathematical equations considering climatic or seasonal variations, storage conditions demand new studies for gap analysis. Moreover, a standard procedure for storage of vitreous humor, equal technique for analysis has to be generated so that the quantitative parameters of the target ions do not get compromised.

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Abbreviations: **Sl. No.:** Serial number, **PMI:** Post mortem interval, **mmol/L:** Millimole per liter, **K+:** Potassium, **mm:** Millimeter, **ANOVA:** Analysis of variance, **mL:** Milliliter, **mg/dL:** Milligram per deciliter, **mEq/L:** Milliequivalent per liter, **°C:** Degree Celsius, **SD:** Standard deviation.

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ORIGINAL ARTICLE

Impact of Clinical Forensic Medicine Department Imparting Training on Accuracy of Medical Record Documentation in Emergency Department

Kumar PN,¹ Nayak V,² Prasad LJ.³

Professor,^{1,2} Additional Professor & In-charge HOD.³

1. Department of Hospital Administration, Kasturba Medical College, Manipal, Manipal Academy of Higher Education, Manipal.

2. Department of Forensic Medicine & Toxicology, Kasturba Medical College, Manipal, Manipal Academy of Higher Education, Manipal.

3. Department of Hospital Administration, AIIMS, Bhopal.

Abstract:

Private hospitals find it difficult to have qualified manpower in emergency departments. To hire a person especially for documentation work is difficult to hospitals. Managing medico-legal cases and their documentation is a skill that requires patience, and diligence of doctors and nurses. To save doctors from legal troubles, training in documentation enhances the awareness about the court procedures. In emergency department of medical college hospital, 30 doctors and 10 nurses posted for more than 3 months duration in a year, were identified and in 3 batches of 10 people each training programs were imparted. Trainers were faculty from forensic medicine and hospital administration. Simultaneously, junior residents from Forensic Medicine are posted in Clinical Forensic Medicine Unit for completing medico-legal cases documentation. There is an increase in pre-test and post-test knowledge of about 45%. After 3 months and 6 months medical records were verified with a checklist by Forensic residents, the errors by clinicians were reduced by 50%. Forensic experts are experienced with court deliberations and if they conduct training programs to young doctors from clinical departments on a regular basis, it will add a great value in reduction of medical record documentation errors. A constant reminders by senior professors of same department will instil a sense of diligent duty nature amongst young doctors.

Keywords: Clinical Forensic Medicine unit; Forensic Medicine residents; Medical record documentation; Training; Pre-test & post-test.

Introduction:

“Healer safeguard thyself, lest you need healing for the anguish caused by deeds done by your hands in ignorance.” This exemplifies the vigilance and adequate training a doctor has to undergo on legal wrangles for acts committed in ignorance and lack of knowledge on errors of medical documentation.

Ineffective completion of medical records has severe implications on efficiency of managing patient care delivery and while dealing with medico-legal cases can have severe negative implications on the morale and motivation of healthcare providers and doctors. As the famous dictum says, “not being aware is not an excuse in medical field.” To save from court of law, one should give prime importance to documentation and communication with patients, documentation of communication and communication of documentation, and preservation of documents in emergency room practise. Communication of findings can be done both actively (through direct discussion) and passively (through written documentation).

Emergency Departments – In India: In many hospitals this department/unit is still called "Casualty" though nomenclature all over the world has changed. In India, it is being called as

Corresponding Author

Dr. P. Naveen Kumar

Email : naveen.kumar@manipal.edu

Mobile No. : +91 9019164899

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Emergency Department (ED) or Emergency Medicine Department (EMD) or Casualty and Trauma Services or Accident and Emergency Service (A&E). It is known for services being provided non-stop, 24X7, throughout the year, and it is an essential element in contributing to the health of the community. It is an administrator's dream for streamlining the functioning of the accident and emergency services to enhance good image of the hospital in the adjacent community. This area has been called as "miniature" hospital within hospital.

"Medical Emergency" is defined as a situation when the patient requires urgent and high quality medical care to prevent loss of life and limb. "Emergency" may also arise perceived by the patient or his/her relatives (attendants) as requiring urgent medical services, failing which, it could result in loss of life or limb. An "Accident" is defined as "an unexpected, unplanned occurrence which may involve injury" or "an unpremeditated event resulting in recognisable damage".

Types of emergency services: There are four types of emergency services:

i) Major emergency services: (Type I): All specialised facilities, both diagnostic and therapeutic categories are present. Generally such services are provided in large, teaching and tertiary hospitals.

ii) Basic emergency services: (Type II): All basic emergency facilities are available and is manned by general duty medical officer round the clock. Specialists in respective field are available on call duty.

iii) Stand-by Emergency Services: (Type III): This type of emergency service is seen in PHC and Community Health Centre as first referral centre. These are run by trained nurses round the clock and Medical Officers are on call duty.

iv) Referral Emergency Services: (Type IV): These are satellite centres with only first aid given by the Nurses and the patient is referred to the higher hospital according to the severity.

The medical record is a clinical care related document which notes the clinician problem assessment, treatment management and it provides other clinicians information for continuing the care and also it acts a legal document.¹ The quality of documentation of clinical records has been debated world over. There are many studies which point out deficiencies in medical record documentation, varying from correctness, legibility, completeness, reliability, appropriateness, and accuracy.¹

Article 51 A (h) of the Constitution of India, states that a treating doctor has a moral obligation and a legal duty, to maintain and preserve medical, medico-legal, and legal documents in the best interests of social and professional justice. All the written records, chart notes, radiographs, and photographs must be meticulous, and necessarily all the documents need to be signed with correct date.² As per Medical Council of India,³ statutory body responsible to ensure ethics in medical profession in India, suggestions on medical records maintenance is as follows: The retention period for all inpatient records of 3 years from treatment commencement date has to be followed by every physician. The format of which has been given in annexures. For medico-legal cases, the retention period is forever or till the case gets disposed in the court. If patients/authorised attendant or legal authorities involved request for medical records, the same should be issued within a period of 72 hours.

The details of Medical Certificates issued by a registered medical practitioner shall be maintained in a register. He/She shall record the signature and/or thumb mark, address and at least one identification mark of the patient on the medical certificates or report. All hospitals should put efforts to computerize medical records wherever possible, to ensure quick and prompt care continuity. Notwithstanding the busy schedules of physicians and others in generating records, the medical records must be: complete, accurate and legible.⁴

In 2016, a study conducted by Mahendra Kumar Bajpai, states that in India, year-over-year there is a 110% increase of medical negligence cases against hospitals, 12% of these are being decided by consumer courts. The leading cause of medical negligence against the hospitals is for not taking consent in proper format or content which amounts to 60 to 66% of the filed cases. It can be clearly understood that doctors and other healthcare personnel are not taking this aspect seriously.⁵

With an aim to improve trauma care in the country, the government has decided to make it mandatory for all medical colleges to have emergency medicine department by 2022. Several studies have said the absence of integrated and organised systems of trauma care in India is the main cause of high rate of injury-related deaths and disabilities in the country.⁶ Hence, we have proposed this research to extrapolate the utilisation of

Clinical Forensic Medicine Unit in every emergency department.

Educational Value of Documentation: The value of documentation activities rises from the point that doctors can self-reflect their own chart notes in future or notes from peers particularly during referral or transfer of cases to their care. Documentation activities provide immense educational value to residents in medical colleges. To achieve optimum benefits in educational value, the record writing should be critiqued and the faculty should provide feedback. A study done by Oxentenko et al.,⁷ identified that residents spend more than 4 hours per shift in documentation activities, and they rate importance of feedback from their faculty from “moderately high” to “very high” importance, but, they received in very less instances. With a regular ongoing structured feedback to residents, the documentation error has reduced from first year to third year.

Effectiveness of Training Program: Training aims to boost employee learning and complete organizational performance. It increases skills and current performance of employees. These are several ways to identify current employee's performance, like:⁸

- Performance appraisals,
- Job-related performance data (productivity, absenteeism, wastes, downtime, customer complaints).
- Observations by supervisors or other specialists.
- Attitude surveys.
- Special performance gap analytical software.

Aim and Objectives: To effectively improve medical record documentation in emergency departments of hospitals in Indian context. To conduct knowledge, attitude, practices study among doctors, nurses dealing with medical record documentation. To conduct training programs to emergency department doctors and nurses and measure efficiency of training programs in improving documentation.

Methodology:

The study used a qualitative research with data collected through questionnaire, and imparting training programs and observations noted. It was prospective Cohort study. Institutional ethics committee approval was received prior (IEC No. 211/2020).

Study Design: Qualitative, prospective, single centre study with trainings conducted with agenda topics (mentioned below) to assess current knowledge and practices in emergency departments of a medical college teaching hospital.

Study Area: Medical Record Department & Emergency Department of hospitals.

Study Requirements: Medical records, doctors, resident medical officers, senior residents, nurses, administrators, training plan & material.

Sample Size: Sample Size: 40 (30 doctors and 10 nurses). – Surgery, Orthopaedics, Medicine, Emergency Medicine – of grades of SRs, APs, medical officers, Consultants etc. Nurses – GNM, staff/ward nurse, ANS etc. using the formula method,⁹ $n_0 = Z^2 pq/e^2$

Study intervention tool: Training plan: Training to improve accuracy in documentation in medical records should be planned at the time of 1) Induction of employees, 2) Departmental orientation by senior staff members from Forensic Medicine, hospital administrators, and lawyers. In our study, we initiated now. Later, when we have 20 participants as new employees, we will conduct during induction.

Training program title: Impact of accurate medical record documentation to reduce future medico-legal implications. Type of Training: 4 Hours Workshops, half-day, 4 resource persons on the following topics: 1) What does a Complete, Adequate, accurate medical record means to a Court? 2) Importance of evidence collection, types of evidence, injury depiction. 3) What is importance of complete, accurate consent form? 4) Timeliness in filling the forms, 5) Relevance of documentation in electronic health records, 6) How can organisation support you, 7) How can you support the organisation by filling the records?

List of materials distributed to audience: case studies and previous medico-legal cases, sample case records of hospital, success stories of good medical record maintenance. List of training equipment used: projector, power point, checklist for error mitigation. Venue: seminar room in Emergency department.

Results:

In our study, the analysis was done for sample population of doctors and nurses from one hospital, before the training (pretest) and after the training (post-test). It was 4 hour workshops conducted with same content during 1 month period, to ensure covering all the 40 members in sample size. The researcher forwarded google forms as questionnaire before the workshop and ten minutes was given to answer the questions. For post training also another questionnaire was circulated to answer the questions.

As per data collected in table 1, the audience in training included people who had experience in treating emergency cases. In the sample size of 40, 6-10 years was the average experience for 18 people, rest of the 22 people were within 6 years of past experience. Their experience in handling medico-legal cases was in different hospitals. The youngest doctor was 28 year old and oldest doctor was 62 years old in the sample and youngest nurse was 22 years and eldest was 45 year old. 30-35 year age group people were more in number. The average score before the training was 7 marks out of 14 marks and post the training period the average score increased to 10 marks. The highest scores were 13 and 14 before and after training program. The lowest scores were 4 and 6 marks. There is a relative 21% increase in knowledge after the training programs. People who scored less than 50% of marks were reduced by 71%, people who scored full 100% marks increased by 23%. Overall, we found an average increase of knowledge levels by 55% between pre-test and post-test.

Discussion:

The American Health Information Management Association (AHIMA) states training as one of the most effective ways to improve the documentation process.¹⁰ Medical Council of India also proposes AETCOM modules to deliver improvement of

attitudes and communications among students. The other modalities suggested by AHIMA are; incentives, medical forms designing and updation, and providing physicians with the best and most appropriate time to access and complete medical records.

This study also gave importance to Instructive interventions as a way to enhance compliance in documentation significantly.¹¹ In one study done in 2015, Tavakoli et al. published that lack of education as the main reason for low quality in medical records.¹² In 2010, Khoshbaten et al. showed that a training workshop had a positive effect on medical record documentation.¹³ Jeanmonod et al. declared if faculty reinforce the importance to residents and provide feedback on the quality of documentation during education period, the charting quality can be improved.¹⁴ In one study the documentation rate was checked through record verification after educational workshop, 1 month and 6 months after the trainings.¹⁵ A study conducted in emergency department of a teaching hospital in 2022, describes that many requests that came for autopsy, the arrival pattern of patients was 70% of cases in ambulances, 30% through private cars, and most of the people documentary evidences of injury were recorded as per prescribed format by the forensic medicine residents.¹⁶ A model checklist for medical record audit program has been given in many published articles, which can be followed.¹⁷ In a study done on 459 mortality cases, where 106 death certificates were filled and verified retrospectively for errors in documenting, in 25 cases there were major errors in writing cause of death, and 30 cases minor errors in antecedent causes. The authors suggest training to the doctors.¹⁸ The findings in our study note that training programs can be effective in imparting knowledge on medico-legal cases and documentation. The training effectiveness in medicolegal documentation in case of sudden deaths in chronic kidney diseases, is lacking among medical college residents, the frequency and spectrum of renal pathologies have not been well documented in medicolegal cases and authors suggest adequate training programs through forensic medicine experts in all teaching hospitals.¹⁹

Table 1. Showing demographic variables and knowledge acquired after the training program.

	Criteria	Pre-test	Post-test	% Change after training
1	Youngest, eldest persons	28 year, 62 years	28 year, 62 years	
2	Age group 30-35 highest representation	17 out of 35	17 out of 35	
3	Experience after MBBS	18 people were 6-10 years	18 people were 6-10 years	
4	Average Score of Group	7	10	21% increase
5	Median Score	8	11	
6	Range of marks in 14 marks	4 to 13	6 to 14	
7	Less than 50% (or 7 marks)	16	5	71% reduction
8	Between 50-70% (7-10 Marks)	22	11	50% reduction
9	Between 70-90% (11-13 Marks)	2	16	75% increase
10	100% (14 Marks)	0	8	23% increase

Conclusion:

The backbone of performance analysis can be understood by understanding why performance is low. One has to differentiate whether it is a can't-do or won't-do problem. If it's a can't-do problem, for example, if employees don't know how to do or what standards are: there are obstacles in the system like lack of tools or supplies, no job aids or you have hired people who don't have the skills to do the job or there is inadequate training. Or it might be a won't-do problem. Here employees could do a good job if they wanted to, but they do not perform. To handle such situation, incentives is the way. In our study, we solved "can't do" problem by imparting training programs and noticed reduction in errors of documentation.

Conflict of Interest: We do not have any financial conflicts, material copyright conflicts.

Ethics Approval: IEC 211/2020

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ORIGINAL ARTICLE

Structural Changes of Tooth, Root and Root Canal Morphometrics using Conebeam Computed Tomography for Assessment of Age in South Indian Population-A Retrospective Study

Sangavi R,¹ Saraswathi GK,² Srividhya S.³

Senior Lecturer,¹ Professor and Head,² Associate Professor.³

1. Department of Oral Medicine, Radiology and Special Care Dentistry, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai.

2,3. Department of Oral Medicine and Radiology, Faculty of Dentistry, Meenakshi Academy of Higher Education and Research, Meenakshi Ammal Dental College, Chennai.

Abstract:

The estimation of age has been an antiquated exercise. The tooth with its highly resistant morphometrics provides us with a non-invasive modality to determine the age of the person. The major aim of this current study is to assess the accuracy of a chronological age of an individual by measuring the structural changes of tooth, root and root canal morphometrics, tooth and root length from CBCT images of mandibular right and left 1st premolar. A retrospective study involving 200 CBCT images between the age of 20–60 years were retrieved from the department database. The samples were further divided into five groups based on their age, each group contains 20 samples. Mandibular 1st premolar on both left and right side were analysed. The structural changes of teeth, attrition, secondary dentine and periodontal recession were graded according to Gustafson's method, the tooth length and root length were measured. The tooth length and root canal diameter were positively correlated to the chronological age of the patient on right and left side. In multiple regression analysis attrition on right and left side were positively correlated to the chronological age of the patient, secondary dentine and periodontal recession on the right and left side respectively were positively correlating to the chronological age of the patient. The reliability of chronological age estimation using the structural changes of teeth, root and root canal morphometrics provides fairly reliable results. This has resulted in the error of age prediction narrowing down to +/- 1.7 years to 2.35 years.

Keywords: Age estimation; Tooth; Root; Root canal; Structural changes; Forensics; Morphometrics; CBCT.

Introduction:

Age estimation is one of the crucial factors in human identification. The identification of human bodies from circumstantial data in the absence of clues to identity poses a strenuous problem to the investigator.¹ Age estimation in children and adults often relies on morphological methods, such as radiological examination of skeletal and dental development, however, in children, age estimation using teeth is relatively simple which is done based on the developmental stage of the teeth. But, age estimation in adults is a challenge in Forensic Medicine.² The changes in the dentition are reflected in every individual tooth.³

Human dentition is considered as a hard tissue analogue to fingerprints, it is unique to every individual.^{3,4} Teeth are present with unique and distinguishable features of age-associated regressive changes which make them a mirror reflection of age changes from birth to the death of an individual. Forensic Odontologists are often called into action for age determination of the unknown deceased individual or a living individual in case

of a criminal investigation.⁵ There have been various methods for assessing the age of an individual employed by several authors for many years. In the year 1950, Gustafson introduced a scientific methodology for estimating age using six age-related structural changes in the tooth such as secondary dentine formation, periodontal recession, attrition, apical translucency, cementum apposition, and external root resorption.⁶

Assessment of morphological changes requires tooth sectioning, which is not feasible to perform in living humans. To overcome this, Matsikidis et al. reported that the characteristics studied by Gustafson (except apical translucency) concerning extracted and ground teeth can also be determined using dental films.⁷ Assessment of the pulp to tooth area ratio, in particular, is an indirect indicator of secondary dentin deposition.⁸ This apposition is effective in age estimation as it is a continuous, age-associated process that alters the size of the pulp chamber. Since tooth ground sections are a destructive process and impossible to do in living humans to overcome these hassles radiographic assessment would be helpful to do age estimation in living individuals.⁹ CBCT is well suitable for the craniofacial area investigation as it delivers clear images of highly contrasted structures and is useful for evaluating teeth and bones. CBCT shows high contrast between bone, empty spaces, and soft tissues so it helps in visualization and evaluation of structural changes of teeth and pupal canal with good precision and accuracy.^{10,11}

The major aim of this current study is to assess the accuracy of a

Corresponding author

Dr. Sangavi R

Email : sangavir.sdc@saveetha.com

Mobile No. : +91 99405 88033

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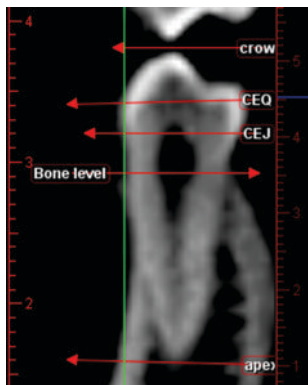


Figure 1.

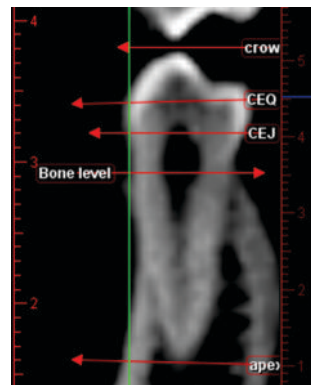


Figure 2.

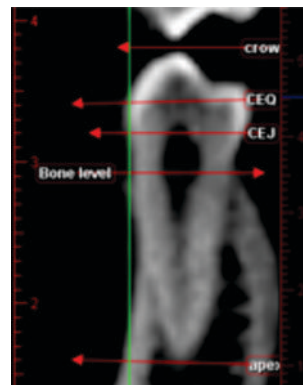


Figure 3.

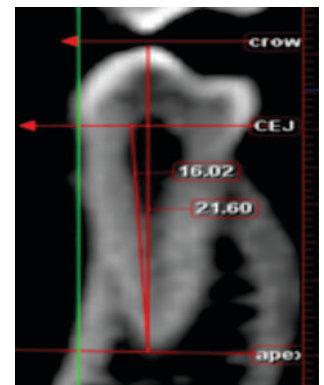


Figure 4.

chronological age of an individual by measuring the structural changes of tooth, root and root canal morphometrics, tooth and root length from CBCT images of mandibular right and left 1st premolar.

Materials and methods:

Sample collection: 200 Cone Beam Computed Tomography images were collected from the department database. All the images were recorded in Planmeca Promax 3D Mid Pro Face machine and were processed using Planmeca Romexis software version 5.2.0

The inclusion and exclusion criteria of the study are as follows.

Inclusion criteria:

- Full mandible CBCT images of patients above the age of 20.
- Good image and morphology of selected teeth with complete root formation. (i.e lower right and left mandibular first premolar)

Exclusion criteria:

- Carious/grossly decayed
- Prosthesis/Restored selected teeth
- Severely attrited/fractured/rotated/malaligned.
- Teeth with developmental anomalies

Sample size: Sample of 200 CBCT images obtained from the archives. Ages from 20- above 60 yrs and each group contain 40 images.

- Group I: 20-29years (20.1 to 29.9 years)
- Group II: 30-39 years (30.1 to 39.9 Years)
- Group III: 40-49years (40.1-49.9 Years)
- Group IV: 50-59years (50.1-59.9 Yeras)
- Group V: 60years and above (60.1<)

Further, each CBCT image was analyzed using Planmeca Romexis software. The images were sliced at 1.2 mm size thickness.

Methodology for metric analysis

Structural changes of teeth: To Assess the structural changes of teeth, Gustafson criteria for attrition, secondary dentine

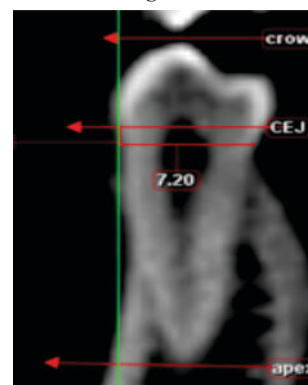


Figure 5.

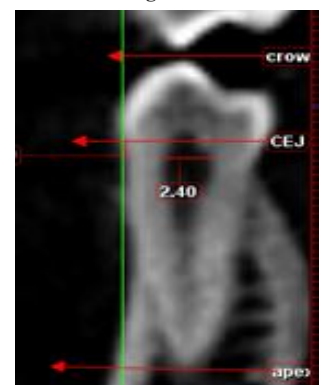


Figure 6.

deposition, and periodontal recession were measured in the sagittal section of the image in the center of the tooth and classified in accordance to the stages reported by Olze et al.

Step 1: The attrition is staged based on Gustafan's criteria

Gustafson criteria: I - Attrition

Stage 0: No attrition

Stage 1: Early attrition with loss of cusp tips

Stage 2: Attrition reaching into dentine

Stage 3: Attrition reaching into dentine opening of the pulp cavity

Gustafson's criteria: II - Secondary dentine formation

- A horizontal line traced between the cemento-enamel junction of the tooth, considered to be the division between the anatomical crown and the root.
- Parallel to the CEJ, another line is drawn across the crown's equator connecting the most convex surfaces of a tooth.
- The highest point of the pulpal horn is analysed.
- The secondary dentine is staged based on Gustfan's criteria.

Secondary dentine formation

Stage 0: Pulp horn crosses above the crown equator

Stage 1: Pulp horn approximates at maximum to the crown equator

Stage 2: Pulp horn falls short to the crown equator but exceeds enamel-cementum boundary

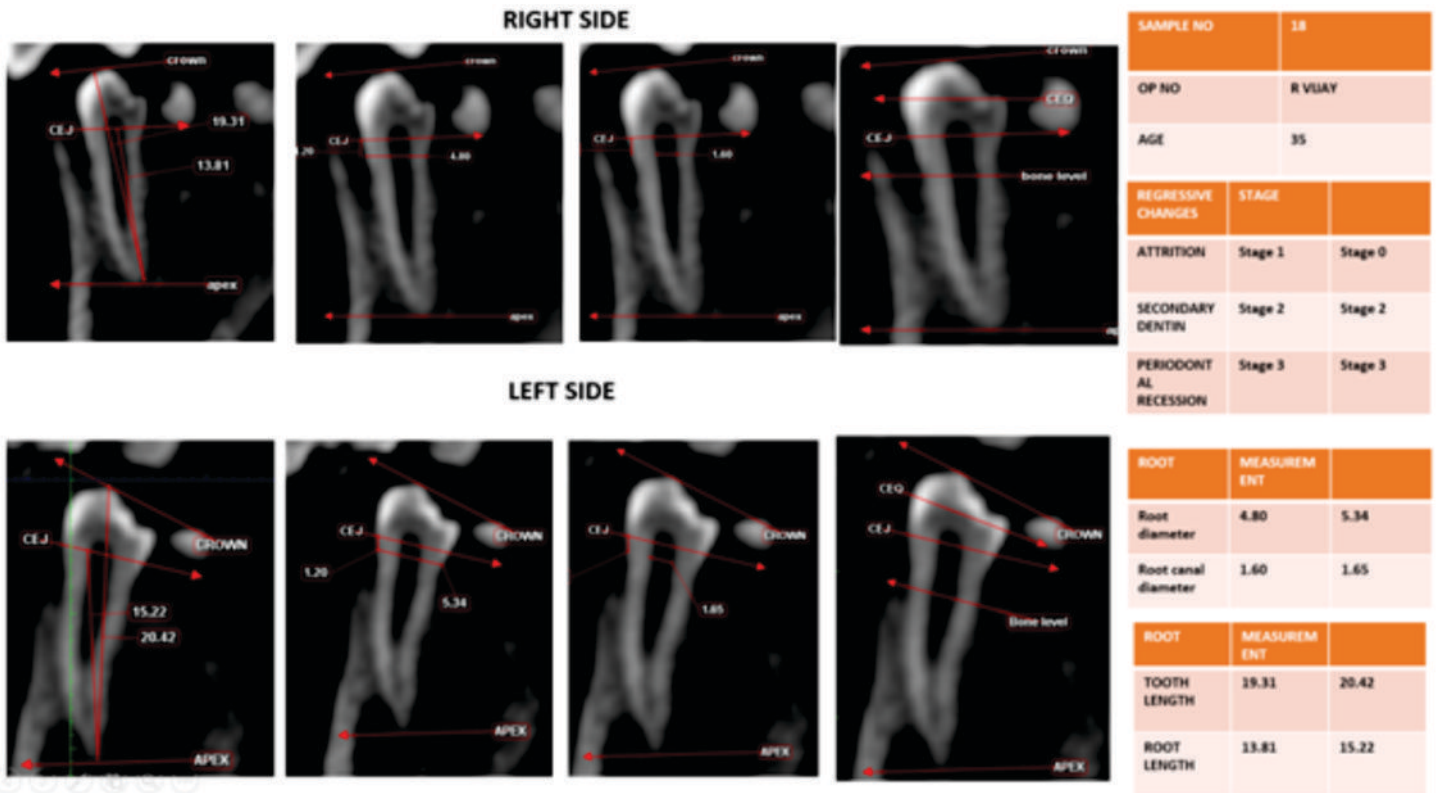


Figure 7. Samples of right and left premolar tooth.

Stage 3: Pulp horn reaches at maximum to the enamel-cementum boundary

Gustafson's criteria- III - Periodontal recession

- A horizontal line traced between the cemento-enamel junction of a tooth which is considered to be the division between anatomical crown and root
- Parallel to this line the alveolar bone level is marked by drawing a line across the root connecting the distal and mesial surface of the root.
- The periodontal recession is graded according to the Gustafson's criteria

Periodontal recession

- Stage 0: No periodontal recession.
- Stage 1: Periodontal recession at cervical root third.
- Stage 2: Periodontal recession at middle root third.
- Stage 3: Periodontal recession at apical root third.

Step 4: Tooth length

Tooth length was measured by drawing a vertical line connecting the most prominent cuspal tip to the apex of the tooth.

Step 5: Root length

- Horizontal line traced at the cemento-enamel junction of the tooth, considered to be the division between anatomical crown and root.
- The root length was measured by drawing a vertical line from

the midpoint of CEJ to the most prominent tip of the apex.

Step 6: Root diameter

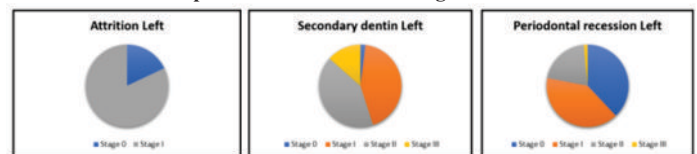
- Horizontal line traced at cemento-enamel junction of tooth which is considered to be the division between anatomical crown and root
- For the root diameter the linear measurement is taken 1cm away from the CEJ, a horizontal line is drawn across the root connecting the mesial surface of the root to the distal aspect of the root.

Step 7: Root canal diameter

- A horizontal line traced at the cemento-enamel junction of the tooth, considered to be the division between anatomical crown and root.



Graph 1. Frequency distribution of attrition, secondary dentine, periodontal recession on right side.



Graph 2. Frequency distribution of attrition, secondary dentin and periodontal recession on left side.

- For root canal diameter, a linear measurement is taken 1cm away from the CEJ a horizontal line is drawn across the pulp canal connecting the mesial to the distal surface of the pulpal canal.

The collected data were analysed with IBM SPSS statistics for windows, version 23.0.

Results:

The collected data were analyzed with IBM SPSS Statistics for windows, version 23.0.

Correlation between the tooth length & root length, root diameter and root canal diameter with chronological age on right and left side of an individual. (Table I and Table II)

On analysing the tooth length, root length and root diameter and

root canal diameter, on the right and left side using Pearson's correlation, the tooth length (p-value of 0.0005) and root canal diameter (0.0005) on the right and left side, were statistically significant to the age, were statistically significant to the age.

A statistical regression equation was curated using tooth length, root length, root diameter and root canal diameter on both right and left side

Regression formula for right side:

$$\text{Age} = \text{TL} (-1.299) + \text{RL} (1.024) + \text{RD} (0.726) + \text{RCD} (-6.607) + 58.955$$

Regression formula for left side:

$$\text{Age} = \text{TL} (-0.092) + \text{RL} (0.007) + \text{RD} (-0.866) + \text{RCD} (-0.980) + 52.629$$

Table 1. Correlation between the tooth length & root length with chronological age on right and left side.

Parameters	Patient Age	
	r-value	p-value
Tooth length Right	-.375**	.0005 **
		N
	200	
Root length Right	.045	.524 #
		N
	200	
Root diameter Right	-.041	.566 #
		N
	200	
Root Canal Diameter Right	-.590**	.0005 **
		N
	200	

Table 2. Correlation between root diameter and root canal diameter with chronological age on right and left side.

Parameters	Patient Age	
	r-value	p-value
Tooth length Left	-.610**	.0005 **
		N
	200	
Root length Left	.109	.124 #
		N
	200	
Root diameter Left	-.059	.404 #
		N
	200	
Root Canal Diameter Left	-.546**	.0005 **
		N
	200	

Table 3. Regression analysis for individual variables on right side.

Model	Unstandardized Coefficients		Standard-ized Co-efficients	t	Sig.	95.0% C.I for B	
	B	Std. Error				LB	UB
(Constant)	58.955	12.268		4.805	.000	34.759	83.151
Tooth length Right	-1.299	.213	-.403	-6.086	.0005 **	-1.720	-.878
Root length Right	1.024	.688	.098	1.490	.138 #	-.332	2.381
Root diaeter Right	.726	1.366	.036	.531	.596 #	-1.969	3.421
Root Canal Diameter Right	-6.607	2.642	-.169	-2.500	.014 *	-11.818	-1.396

Table 4. Regression analysis for individual variables on left side.

Model	Unstandardized Coefficients		Standard-ized Co-efficients	t	Sig.	95.0% C.I for B	
	B	Std. Error				LB	UB
(Constant)	55.629	13.946		3.774	.000	25.125	80.133
Tooth length Left	-.092	.518	-.013	-5.043	.0005 **	-1.114	.931
Root length Right	.007	.005	.101	1.409	.160 #	-.003	.017
Root diaeter Left	-.866	1.756	-.037	-.493	.622 #	-4.329	2.597
Root Canal Diameter Left	-.980	3.051	-.024	-2.791	.014*	-6.998	5.037

Table 5. Correlation of attrition to the chronological age of the patient on right side.

Attrition Right		N	Mean	SD	t-value	p-value
Patient Age	Stage 0	42	35.143	15.1054	4.801	0.0005 **
	Stage I	158	47.816	15.2327		

Table 6. Correlation of attrition to the chronological age of the patient on left side.

Attrition Left		N	Mean	Std. Deviation	t-value	p-value
Patient Age	Stage 0	36	35.278	10.7188	5.502	0.0005 **
	Stage I	164	47.323	16.2061		

Table 7. Corelation of secondary dentine to the chronological age of the patient on right side.

Stages	N	Mean	SD	F-value	p-value
Stage 0	76	40.605	15.0218	4.960	0.002 **
Stage I	80	45.888	15.1072		
Stage II	41	52.122	17.6977		
Stage III	3	45.667	3.5119		
Total	200	45.155	16.0267		

Table 8. Post Hoc Test for secondary dentin stages.

Multiple Comparisons						
Tukey HSD						
(I) Secondary dentin Right		Mean Difference (I-J)	Std. Error	p-value	95% C.I	
					LB	UB
Stage I	Stage II	-9.3993*	2.3469	.0003**	-14.942	-3.857
	Stage III	-2.5481	3.6103	.760 #	-11.074	5.978
Stage II	Stage III	6.8512	3.5225	.129 #	-1.467	15.170

*. The mean difference is significant at the 0.05 level.

Table 9. Correlation of periodontal recession to the chronological age of the patient on left side.

Stages	N	Mean	SD	F-value	p-value
Stage 0	76	40.605	15.0218	4.960	0.002 **
Stage I	80	45.888	15.1072		
Stage II	41	52.122	17.6977		
Stage III	3	45.667	3.5119		
Total	200	45.155	16.0267		

This regression formula can be utilised among south Indian population assess the age of the individuals.

✓ Correlation of structural changes of teeth to the chronological age of the patient

Attrition (Table V & VI) (Graph I & II)

Out of 200 samples analyzed, 42 samples had stage 0 of attrition and 158 were in stage 1 on the right side, on the left side 36 of the samples were in stage 0 and 164 samples were in stage 1.

An independent T-test was carried out to find the correlation of attrition on right and left sides to the chronological age which revealed statistically significant results with a P value of 0.005 on right and left sides respectively.

Secondary dentin (Table VII & VIII) (Graph I & II)

Out of 200 samples analyzed 78 samples were in stage I, 98 samples were found to be in stage II and 24 samples were in stage 3 on the right side. On the left side, 4 samples were in stage 0, 86 were in stage I, 83 were in stage II and 27 were in stage III.

An independent T-test was carried out to find the correlation of secondary dentin on right and left sides to the chronological age which revealed statistically significant results with a P value of 0.003 on right. This was followed by Post hoc Test in which stage I and stage II had a better correlation with the patient's age.

Periodontal recession (Table IX & X) (Graph I & II)

Out of 200 samples analyzed 93 samples were in stage 0, 72 samples were in stage I, 28 samples were in stage II, 7 samples were in stage III on the right side. On the left 76 samples were in stage 0, 80 samples were in stage I, 41 samples were in stage II, 3 samples were in stage III.

Independent T-test was carried out to find the correlation of Periodontal recession on right and left sides to the chronological age which revealed statistically significant results with a P value of 0.001 on the left this was followed by a post hoc test to find out the most significant stage of periodontal recession to the age. Stage II correlated better with chronological age with a p-value of 0.001.

Regression analysis for individual variables on right side

Regression analysis for tooth length had a standard deviation of +/- 0.213, root length had a standard deviation of +/- 0.688 root canal diameter had a standard deviation of +/- 1.366 and root diameter had a standard deviation of +/- 2.642

Regression analysis for individual variables on left side

Regression analysis for tooth length had a standard deviation of +/-0.518, root length had a standard deviation of +/-0.005 root

Table 10. Post HOC Test for periodontal recession.

Tukey HSD						
(I) Secondary dentin Right		Mean Difference (I-J)	Std. Error	p-value	95% C.I	
					LB	UB
Stage 0	Stage 0	-5.2822	2.4938	.151 #	-11.744	1.180
	Stage II	-11.5167*	3.0168	.001 **	-19.334	-3.700
	Stage III	-5.0614	9.1643	.946 #	-28.808	18.685
Stage II	Stage II	-6.2345	2.9902	.162 #	-13.983	1.514
	Stage III	.2208	9.1556	1.000 #	-23.503	23.945
Stage III	Stage III	6.4553	9.3116	.900 #	-17.673	30.584

*. The mean difference is significant at the 0.05 level.

canal diameter had a standard deviation of +/-1.756 and root diameter had a standard deviation of +/-3.051

Discussion:

On analysing 200 samples recruited from the department archives the tooth length on right and left sides showed statistically significant results to the chronological age of the patient. This study was in accordance with the study conducted by Hugo FV et al. (2009)¹³ he analysed skeletal remains of 88 patients and measured the tooth length for all the mandibular teeth on right and left side using periapical radiographs revealed a high accuracy of tooth length in estimating the chronological age.

On contrary, Study conducted by Sudhanshu Saxena et al. (2011)¹⁴ analyzed right maxillary canines in 120 ortho-pantomography, she evaluated pulp/tooth area ratio, pulp/root length ratio, pulp/tooth length ratio, pulp/root width ratio at the cemento-enamel junction level and correlated to the chronological age of the patient. He inferred that the pulp/tooth area ratio was positively correlated to the chronological age of the patient. Whereas the pulp/tooth length did not have a significant correlation with the age variation in these results could be due to the fact the maxillary canine in ortho-pantograph can have magnification and image distortion.

In our study, root length did not have any influence on the chronological age of the individual. Various studies have been conducted on the root length, where the root length had a positive significance for the sexual dimorphism rather than the age estimation.

The study performed by Soundarajan et al. (2020)¹⁵ on age estimation from root diameter and root canal diameter of maxillary central incisors among chennai population using cone beam computed tomography concluded that the root canal diameter had a higher correlation compared to root diameter. This study was analogous to our present study which had significant results for root canal diameter compared to root diameter. Gustafson (1950)⁹ was the first person to introduce a scientific method for age estimation using six age-related changes in tooth structure. Matsikidis et al. reported that the characteristics studied by Gustafson (except apical translucency) in relation to extracted and ground teeth can also be determined using dental films.

On evaluating the structural changes of teeth such as attrition, secondary dentine, and periodontal recession on right and left side, in our study the attrition on right and left were found to be

statistically significant which was in accordance with the study conducted by Lewis AJ et al. (2021)¹⁷ where he conducted a study on occlusal tooth wear on Karnataka population. He concluded that as age increases the occlusal tooth wear also increased.

A study conducted by Yayun Wu (2016)¹⁸ he analysed 420 CBCT images for the occlusal tooth wear on Chinese and Malaysian population as predictor of age his results revealed good correlation between age and teeth wear and lower standard error of the estimate. This study was analogous to our present study irrespective of ethnic differences among both the samples.

A study performed by Koh et al. (2016)⁶¹ on age estimation from structural changes of teeth and buccal alveolar bone level on a total of 284 CBCT images on Malays and Chinese patients using lower first premolars. He concluded that the characteristic of attrition seems to be a stronger predictor of age when compared to secondary dentine, periodontal recession, and also when all three characteristics were combined these results were in best accordance with the present study where the attrition on right and left side of the jaw were strongly correlating to the chronological age of the individual than secondary dentine and periodontal recession.

Conclusion:

Teeth can act as a biological marker of aging; dental age assessment is one of the most definitive methods of chronological age estimation. Teeth have a highly mineralized structure, which offers them resistance to post-mortem decomposition. CBCT is the most revolutionary imaging modality in dentistry which can be successfully utilized in the Forensic forum.

In our study, among the various parameters, analysed we were able to conclude that a linear correlation exists between the attrition and tooth length on the right and left side to the chronological age of the patient. When a multiple regression analysis was carried out, we were able to infer that the attrition on both the right and left side, secondary dentine on the right side, and periodontal recession on the left side had a positive correlation to the chronological age of the patient. So, we were able to formulate a regression equation based on the influencing parameters of the teeth and predicted the chronological age of the patient with the standard error of estimate between -1.75 years to 2.35 years, from the inference of the present study, the data analysis could be expanded by trying out the regression equation between the genders and formulate individual equations for age estimation among both genders.

Conflict of interest: Nil

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ORIGINAL ARTICLE

Prevalence of Anxiety and Factors Associated with Anxiety among Resident Doctors in a Tertiary Care Teaching Hospital in South Eastern Rajasthan

Shekhawat BS,¹ Meena V,² Moondra P,³ Yadav S,⁴ Dhaka V,⁵ Vignesh K.⁶

1,2,4-6. Department of Psychiatry, Government Medical College, Kota.

3. Bachelor of medicine and bachelor of surgery, Government Medical College, Kota.

Abstract:

Medical residency has been recognized as a period during which residents in training face a series of extreme emotional situations, such as long working hours, sleep deprivation, lack of autonomy and constant contact with human sufferings leading to anxiety. Anxiety in residents is an important problem because of the potential risk it imposes on individual health and medical care. The aim of this study is to estimate the prevalence of anxiety and identify the associated risk factors associated with anxiety among resident doctors. A cross-sectional study was conducted in a tertiary care teaching hospital. 200 resident doctors who fulfilled the inclusion criteria for the study were included in the study. Data was analysed by using SPSS version 21 software. Statistical analysis included chi-square-test, correlation, multivariate analysis, unpaired t test.

Overall prevalence of anxiety in resident doctors was 25.5 %, out of them 21.5% were suffering from mild anxiety and 4% were suffering from moderate anxiety. Mean anxiety score was more in female residents, General Medicine resident doctors, clinical speciality, surgical speciality, first year resident doctors and resident doctors who reported less sleeping hours and more working hours. This study throws light on the psychological problem like anxiety among resident doctors. The factors associated with anxiety were female gender, younger age, unmarried marital status, living single, sleep deprivation, prolonged working hours and first year of residency.

Keywords: Anxiety; Resident doctors; Tertiary care hospital.

Introduction:

Anxiety is a 'normal' phenomenon, which is characterized by a state of apprehension or unease arising out of anticipation of danger. Normal anxiety becomes pathological when its severity is out of proportion to the threat of danger and when it causes significant subjective distress and/or impairment in functioning of an individual. Anxiety is the commonest psychiatric symptom in clinical practice and anxiety disorders are the most prevalent psychiatric syndrome, nearly one-fifth (17 percent) of adults report a lifetime history of one of the major anxiety disorders, and 1 in 10 suffer from a current anxiety disorder. Its course is variable but tends to be fluctuating and chronic. Anxiety is associated with somatic and autonomic component. The feeling of dread and apprehension are accompanied by restlessness, worrying thoughts, irritability. The psychological or autonomic symptoms must be primarily the manifestations of anxiety. Symptoms of anxiety includes feelings of nervousness, trembling, muscular tension, sweating, light headedness, palpitations, dizziness, epigastric discomfort, worries about future misfortunes, feeling "on edge", trembling, inability to relax, and autonomic hyperactivity. GAD is characterized by an uncontrollable lasting greater than 6 months, and causing

significant impairment. The worry must be associated with at least three of the following six symptoms: restlessness or feeling keyed up or on edge; being easily fatigued; difficulty concentrating or mind going blank; irritability; muscle tension; or sleep disturbance. Anxiety disorder is common in resident doctors which is usually associated with stressful working conditions, particularly at work places. An Indian study conducted by Dave S. et al. (2018)¹ revealed that prevalence of anxiety was 36.58% in resident doctors. Various factors contributing to anxiety among resident doctors are time pressure to complete their assignments and others works; preparations for examinations; difficult patients; work/home conflicts. Raised level of anxiety among residents can lead to physical and emotional ailments, poor performance, absenteeism and negativity in terms of attitudes and behaviours.²

Therefore, it becomes extremely important to study the magnitude of this problem among resident doctors, so that timely and appropriate intervention can be done in this regard. A healthy resident delivers healthy health services. So, any intervention to improve mental health of residents will further improve the work capacity and will further strengthen the health system. So, this study is aimed to assess the prevalence of anxiety and it's associated factors among the resident doctors in a tertiary care teaching hospital in south eastern part of Rajasthan so that steps can be taken towards solving this issue in our setup.

Aims and Objectives : 1. To study Prevalence of anxiety among resident doctors.

2. To study factors associated with anxiety among resident doctors.

Corresponding Author

Dr. Sandhya Yadav (PG Resident)
Email : drsandhya0104@gmail.com
Mobile No. : +91 98174 31839

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Materials and methods:

Study design: Cross-sectional study.

Study participants: The study participants consisted of consenting 200 resident doctors.

The present study was conducted in department of Psychiatry of tertiary care teaching hospital. Before starting the study, permission & approval from institutional ethical committee was taken.

Inclusion criteria: Resident doctors who were doing 3 year post-graduate course in clinical, non-clinical and surgical departments in tertiary care teaching hospital and who gave consent for study.

Exclusion criteria: Resident doctors who were suffering from any major medical, surgical and psychiatric illness; resident doctors who are working on urgent temporary basis and resident doctors who are doing super-specialization and diploma.

All the resident doctors were evaluated on especially designed proforma that includes identification data, socio demographic details, factors associated with anxiety and clinical profile of the participants (including history of psychiatric, medical, surgical illness etc). Severity of anxiety was assessed using Depression Anxiety Stress Scale (DASS).

Statistical analysis: Statistical analysis was done using SPSS version 21. Data are expressed in term of proportion or percentage, mean (+ Standard Deviation). Comparison of variables was tested using Chi square test. Pearson correlation test was used to examine the relation between different continuous variables. P value <0.05 was considered significant.

Results & Discussion:

The age of resident doctors was between 24 years to 42 years and majority (55.5 %) of residents were below 30 years of age. The mean age of resident doctors was 30.40 ± 3.04 years. Among them 72.5% respondents were male and 27.5% were female. Majority of residents (59.5% were married. Likewise majority of resident doctors i.e. 68% were living single. Majority of residents were from hindu community. It was found that majority of resident doctors (77.0%) belonged to urban area and only 23 % belonged to rural area (Table 1).

A similar kind of study carried by Dave S. et al.¹ among resident doctors included 462 resident doctors. 91 % were aged below 30 years, 54.3 % were men and 36.1 % were either married or committed.

In the present study, when resident doctors were evaluated on Depression Anxiety Stress Scale (DASS), it was found that prevalence of anxiety in resident doctors was 25.5%. If we further classify, it was found that 21.5% resident doctors were suffering from mild anxiety & 4% were suffering from moderate anxiety and none of the resident doctors were found to be suffering from severe anxiety and extreme severe anxiety, (Table 2 & Figure 1).

A study conducted by Kelly L. et al. (2005)³ had shown 12% prevalence of generalized anxiety among resident doctors. Similarly, a study by Nisar K. et al. (2012)⁴ revealed that the prevalence of generalized anxiety in resident doctors was 26%;

Table 1. Distribution of residents according to sociodemographic profile and factors associated with anxiety.

Variable	N	%	
Age	≤ 30	111	55.5
	>30	89	44.5
Sex	Male	145	72.5
	Female	55	27.5
Domicile	Urban	154	77.0
	Rural	46	23.0
Marital status	Married	119	59.5
	Unmarried	81	40.5
Religion	Hindu	190	95.0
	Muslim	9	4.5
	Other	1	0.5
Living with family	N=64 i.e. 32%		32
	NO	136	68
Sleeping hours	< 6	54	27
	6 – 8	112	56
	> 8	34	17
Branch	Clinical	180	90.0
	Non-clinical	20	10.0
Speciality	Medical	136	68.0
	Surgical	64	32.0
Working hours	< 8	36	18.0
	8 – 12	106	53.0
	> 12	58	29.0
Year of residency	1st yr.	80	40.0
	2nd yr.	58	29.0
	3rd yr.	62	31.0

Table 2. Distribution of resident doctors according to severity of anxiety (Depression anxiety stress scale).

Severity	N=200	%
Normal anxiety (0-7)	149	74.5
Mild anxiety (8-9)	43	21.5
Moderate anxiety (10-14)	8	4.0
Severe anxiety (15-19)	0	0
Extreme severe anxiety (>20)	0	0

out of them, 18% had mild anxiety and 8% had moderate anxiety. Atif K. et al. (2016)⁵ conducted a study among resident doctors using Hospital Anxiety Depression Score Inventory (HADS) and revealed that 34% doctors had mild to moderate anxiety while 7.2% had severe anxiety. Similar finding was also reported by Dave S. et al. (2018)¹ who conducted a study using similar Depression Anxiety Stress Scale (DASS) which revealed that prevalence of anxiety was 36.58% in resident doctors, out of which 8.66 % had mild anxiety, 12.12 % had moderate anxiety, 8.66 % had severe anxiety and 7.14% had extreme severe anxiety.

If we correlate the anxiety with age, it was found that anxiety was negatively correlated with age that means as age increases, score of anxiety decreases ($r=-0.121$). It was found that resident doctors of age group ≤ 30 years were having more anxiety score than the resident doctors of age group > 30 year (7.07 vs 6.88) and this was statistically significant (Table 3a). Likewise the prevalence of anxiety was higher (27.02%) among age group ≤ 30 years than age group > 30 years (23.60%) but this difference was not statistically significant ($p > 0.05$) (Table 3b). This finding can be explained by the fact that older resident doctors have better tolerance due to better emotional maturity, better coping

Table 3a. Correlation between various factors with anxiety.

Factors		N=200	%	Mean anxiety ± SD	Correlation
Age	≤ 30	111	55.50	7.07 ± 1.38	-0.121*
	> 30	89	45.50	6.88 ± 1.58	
Sex	Male	145	72.50	6.88±1.40	0.118**
	Female	55	27.50	7.27±1.63	
Marital status	Married	119	59.50	6.88 ± 1.48	0.069
	Unmarried	81	40.50	7.16 ± 1.45	
With family	YES	64	32.00	6.89 ± 1.61	0.046
	NO	136	68.00	7.04 ± 1.40	
Branches	Clinical	180	90.0	7.05 ± 1.42	0.122*
	Non-clinical	20	10.0	6.45±1.85	
Specialist	Medical	136	68.0	6.97 ± 1.66	0.030
	Surgical	64	32.0	7.03 ± 0.94	
Alcohol Intake	YES	53	26.5	7.00 ± 1.81	0.004
	NO	147	73.5	6.98 ± 1.33	
Smoking Habit	YES	21	10.5	7.09 ± 1.34	0.025
	NO	179	89.5	6.97 ± 1.49	
Sleeping hours	< 6	54	27.0	7.17 ± 1.28	-0.172**
	6 – 8	112	56.0	6.98 ± 1.62	
	> 8	34	17.0	6.74 ± 1.21	
Working Hours	< 8	36	18.0	6.11 ± 1.55	0.090
	8 – 12	106	53.0	7.09 ± 1.43	
	> 12	58	29.0	7.34 ± 1.29	
Year or residency	1st yr.	80	40.0	7.16 ± 1.49	0.074
	2nd yr.	58	29.0	6.83 ± 0.976	
	3rd yr.	62	31.0	6.91 ± 1.79	

Table 3b. Distribution of anxious resident doctors according to various factors.

		N=200	Anxious		Non-anxious		
			N	%	N	%	
Age	≤ 30	111	30	27.02	81	62.98	X2 = 0.306 P > 0.05
	> 30	89	21	23.60	68	76.40	
Sex	Male	145	31	21.37	114	79.63	X2 = 4.713 P < 0.05
	Female	55	20	36.36	35	63.36	
Marital status.	Married	119	26	21.84	93	79.16	X2 = 2.062 p>0.05
	Unmarried	81	25	30.86	56	59.14	
With family	YES	64	15	23.44	49	76.56	X2 = 0.211 P > 0.05
	NO	136	36	26.47	100	73.53	
Speciality	clinical	180	46	25.55	134	74.45	X2 = 0.003 P > 0.05
	Non-clinical	20	5	20.0	15	80.00	
speciality	Medical	136	34	25.00	102	75.00	X2 = 0.056 P >0.05
	Surgical	64	17	26.56	47	64.44	
Alcohol intake	YES	53	16	30.18	37	69.81	X2 = 0.834 P > 0.05
	NO	147	35	23.80	112	76.20	
Smoking Habit	YES	21	7	17.39	14	82.61	X2 = 0.899 P > 0.05
	NO	179	44	27.89	135	72.11	
Sleeping hours	< 6	54	15	27.78	39	72.22	X2 = 3.196 p > 0.05
	6 – 8	112	29	25.89	83	74.11	
	> 8	34	7	20.58	27	79.42	
Working hours	< 8	36	3	8.33	33	91.67	X2 = 4.846 p=>0.05
	8 – 12	106	29	27.36	75	72.64	
	> 12	58	19	32.76	39	67.24	
Year or residency	1st yr.	80	26	32.50	54	67.75	X2 =2.374 p=>0.05
	2nd yr.	58	9	15.51	49	84.49	
	3rd yr.	62	16	25.80	46	74.20	

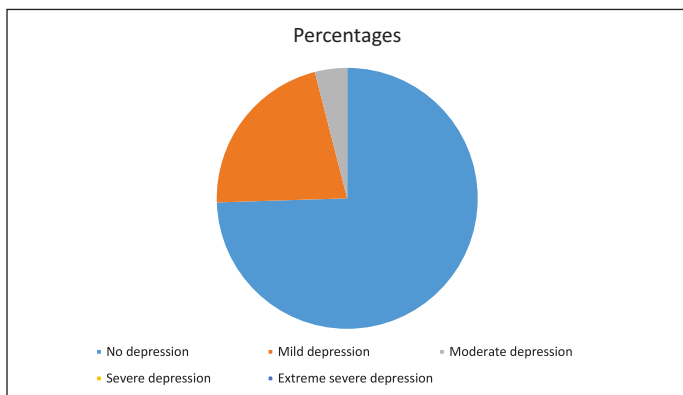


Figure 1. Distribution of resident doctors according to severity of anxiety (Depression anxiety stress scale).

mechanisms and more work experience. Dave S. et al.¹ revealed that prevalence of anxiety was found to be higher in >30 years old residents.

Among male and female residents, female residents reported more mean anxiety score than male residents (7.27 vs 6.88) (Table 3a). Similarly the prevalence of anxiety was higher in female residents (36.36%) than males (21.37%) and this difference was statistically significant (Tables 3b). Results similar to our study were reported by Monsef N. A et al.⁶ (2015) where prevalence of anxiety was found to be statistically non significant higher in female resident doctors (58.6% vs 50.6%). Similarly, Atif K. et al. (2016)⁵ revealed significantly higher prevalence of mild to moderate anxiety in female residents

(53.33%) as compared to male residents (17.31%).

The higher prevalence of anxiety in female residents may be due to additional responsibilities of family, child care, and societal norms apart from hospital work.

In this study, 10% residents were from non clinical speciality and rest 90% residents belonged to clinical speciality. When we compared mean anxiety score and prevalence of anxiety, it was higher in clinical branches than non-clinical branches (Table 3a & 3b). This could probably be due to the fact that clinical residents have to directly deal with patients, patient's life and their caretakers. The moral responsibility also increases as they are directly linked with treatment of patient. Dave S. et al. (2018)¹ also revealed that prevalence of anxiety was higher among clinical specialties (clinical: 29.8%; nonclinical: 20.4%).

If we correlate the anxiety with sleeping hour, it was found that anxiety was negatively correlated with sleeping hour that means as sleeping hours increase score of anxiety also decreases and this correlation was statistically significant (Table 3a). On comparing mean anxiety score with sleeping hours, it was found that it is maximum in those who reported sleeping hour <6 hr./day (7.17) followed by 6 to 8hr./day (6.98) and least in those with sleeping > 8 hr./day (6.74). (Table 3a). Similarly prevalence of anxiety was highest in those who reported sleeping hour < 6 hr. (27.78%) followed by 6 to 8hr./day (25.89%) and least in those with sleeping > 8 hr./day (20.58%) (Table 3b). This maybe because those having lesser time for sleep are not able to relax and rest properly and adequately leading to high anxiety.

When we compare mean anxiety score of resident doctors, according to year of residency, it was maximum (7.16) in 1st year

Table 4. Comparison of mean anxiety score according to speciality.

Branch	N=200	%	Mean anxiety
Anesthesia	28	14.0	7.18
Biochemistry	3	1.5	3.66
General –Medicine	33	16.5	7.60
General – Surgery	18	9	6.99
Microbiology	5	2.5	5.80
Obs. & gynecology	11	5.5	7.54
Ophthalmology	6	3	7.33
Orthopaedic	22	11	6.57
Otorino-Larngology	7	3.5	7.04
Paediatrics	10	5	7.50
Pathology	12	6	7.50
Psychiatry	12	6	6.17
Radiology	12	6.0	6.42
Respiratory Medicine	11	5.5	6.90
Skin & VD	10	5	6.40

followed by 3rd year (6.91) resident then 2nd year (6.83) (Table 3a). Prevalence of anxiety was seen maximum in 1st year (32.50%) followed by 3rd year (25.80%) and 2nd year resident doctors (15.51%) respectively. Higher prevalence of anxiety in first year residents may be due to the fact that they have to work in completely unfamiliar system with totally different routine and lifestyle. When mean anxiety score of 1st year and 2nd year resident doctors was compared, this difference was not statistically significant. Likewise the difference between mean anxiety of 3rd year and 2nd year resident doctors was also not statistically significant. Also the comparison of mean anxiety score among 1st year and 3rd year resident doctors was not statistically significant.

In this study majority (68%) of resident doctors were from medical speciality and 32% of all residents were from surgical speciality. Surgical specialities had more score than medical specialities (Surgical: 7.03 Medicine:6.97) and this difference was not statistically significant (Table 3a). Similarly the prevalence of anxiety was higher among surgical specialities (26.56%) than medical specialities (25.00%) but this difference was not statistically significant (Table 3b). This could be because surgical residents have to do many operative procedures, postoperative emergencies and dealing with complications during surgery.

Likewise in present study no significant difference was found in prevalence and mean score of anxiety on the basis of marital status, living with family, alcohol intake, smoking habit and working hours.

As per the available literature, anxiety level varies in resident doctors according to various specialties. In our study maximum mean anxiety was present in General-Medicine (7.60), followed by Obstetrics-Gynecology (7.54) & Pediatrics (7.50) respectively. Minimum mean anxiety scores was present in biochemistry (3.66). (Table 4). Monsef N. A et al. (2015)⁶ reported that prevalence of anxiety was more in General Surgery resident doctors. A study by Kashif N. et al. (2017)⁴ revealed that average anxiety score was (8.05). The anxiety score was maximum (15.7) in ENT, 12.0 in Pathology, 8.5 in Medicine, 7 in Basic Medical Sciences, 5.7 in Ophthalmology, 3.61 in Surgery, 3.3 in Radiology.

Conclusion:

In this study we tried to assess prevalence and factors related to anxiety in medicos undergoing their postgraduate training. The dual responsibility of training themselves and treating patients is reflected by the high prevalence of anxiety among residents. Younger age, female gender, unmarried, living single, first year of residency, sleep deprivation, more working hours, specialities like General Medicine are found to be associated with more anxiety. Significant correlation with anxiety was found with age, gender, branch and sleeping hours.

Limitations and strength of study: Sample size was small enough and from a single medical college giving questionable generalization of study. Further studies should assess more specific work conditions leading to anxiety such as relationships with co-workers and supervisors and autonomy. Longitudinal design and educational intervention, if possible would have been a better future option.

One of the strength of this study is that most of the studies are focussed on clinical branches only but we have also studied non clinical branches.

Implications of study: Considering the magnitude of this problem, measures are to be taken to halt the escalating anxiety among residents. Results from this study will be useful for planning and management of curriculum of residency programme. Most of the stressors can be modified easily to prevent burnout among resident doctors. Medical colleges should take care of mental health and well being of resident doctors and ensure that resident doctors should have adequate rest, weekly day off, time for recreational and social activities, regular sessions of yoga & meditation, availability of counselling and support.

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CASE REPORT

Masquerading of Homicidal Strangulation as Roadside Accident – A Case Report

Mittal P,¹ Sharma B.²

Assistant Professor,¹ Senior Resident.²

1,2. Department of Forensic Medicine, N.C. Medical College & Hospital, Israna, Panipat.

Abstract:

In many mechanisms of suspicious death, it is not unusual for the body to be discovered at a place that is not the actual location of crime. Perpetrators frequently attempt to prevent the recognition and solution of the crime committed by various means, such as by concealing or disposing off the corpse, removing the ligature or hanging device, and setting arson to make the victim's identification and death investigation difficult or even impossible. Cases of homicides with subsequent corpse disposal are of special criminological importance because the disposed-off victim and the unknown site of crime complicate the analysis of trace evidence. A case of homicidal strangulation followed by dumping-off of the corpse in an open area, located subjacent to a national highway, is herein reported that was formally thought to be a traffic-related fatality. The autopsy in conjunction with crime scene details and ancillary investigations concluded the death resulting from ligature and possibly manual strangulation that initiated a potential homicide investigation, culminating finally in the arrest of possible perpetrators. Details of the police investigation, confessions of the suspects, and court proceedings are highlighted. A reappraisal of the key autopsy findings in strangulation-related deaths is also provided.

Keywords: Strangulation, Identification, Autopsy, DNA profiling, Accident, Modus operandi.

Introduction:

Related few cases of death by ligature strangulation are recorded worldwide. When facing a case of death due to strangulation, the most important question is, whether it is homicidal, suicidal or accidental. Although the majority of cases are due to foul play,¹ cases of suicidal ligature strangulation have been well documented.^{2,3} Accidental self-strangulations are occasionally seen in the pediatric population,⁴ as autoerotic paraphilias,⁵ or asphyxial (choking) games played by preteens and young adolescents.⁶

Cases of homicidal strangulations are frequently disguised as suicides, accidents or natural deaths, which may be misinterpreted due to secondary cover-up activities of the perpetrator.⁷

An autopsy case is herein represented whereby the victim's dead body, after killing by strangulation, was dumped into a dried-up old drain, running along a national highway, to simulate a traffic-related fatality. The autopsy findings, in conjunction with the crime scene details, helped in concluding the cause and manner of death. Subsequent arrest and confessions of the perpetrators, medical testimony and basic *modus operandi* are explained.

Case Details:

Crime scene details: The dead body of a 47 years old male individual was found during an early summer morning, in a bushy

area located on the slant of a national highway (Figure 1). A trash collector notices the dead body and informs the local by-passers who then called the police. The police reached the spot, examined the scene thoroughly and called the decedent's relatives on the basis of a motorbike's details that was laid in the vicinity. The bike was largely hidden within long grass tufts, few meters away from the body, bearing specific registration number and a nick name that were traced to the victim. It was however free of any major damage or abnormal stains. A broken car bumper and an indicator light were additionally visible on the ramp.

Close-up view of the body displayed an optimally clothed male individual, with an upwardly displaced shirt, lying in a supine yet moderately right lateral tilt, with crossed over legs and left upper extremity extending backwards (overhead) (Figure 2). The head and neck were placed largely supine. The body's back was supported on round marble stones that were occupying majority of the surrounding area along with dense growths of flowers, bushes and grass. A tree stood few feet away cephalad to the body. Long creepers stemming from the tree were dangling over and around the body but did not encircle/enwrap it anywhere (enquired specifically).

The soft tissues over left side of face were apparently consumed by the scavengers. No antemortem injury was visible on exposed body parts. The police talked about moderate rigor mortis over extremities in the displayed position. Except for a small roundish blood patch underneath right side of the face, no major blood stains were found near/over the body, on the runway or the adjoining ramp. No personal documents or money were found in the clothes. No foot wears were present. Handling of the corpse by public, before arrival of the police, was ruled out.

The relatives did not raise any suspicion of foul play over the victim's death. The case's *prima facie* was concluded as 'death due to traffic accident' by the investigation police officer and the dead

Corresponding Author

Dr. Pawan Mittal

Email : drmittalpawan@gmail.com

Mobile No. : +91-99919 86390

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body was brought for autopsy after about 22 hours of its discovery.

Autopsy findings

The dead body was of a well-built and nourished male individual,



Figure 1. Crime scene located on the slant of a national highway. A corpse is lying amongst marble stones near a tree. A motorbike is hidden within long grass tufts.



Figure 2. Closer view of the male dead body, lying supine with moderate right tilt. Facial soft tissues are apparently consumed by scavengers. Creepers are dangling over the body.



Figure 3. Facial features are largely obliterated due to soft tissue scavenging, probably by rodents. Tip of tongue is clamped between front teeth.



Figure 4. Transverse, focally indented, an incomplete and parched ligature mark over right lateral-posterior neck region. Deeply congested rim surrounds the medial margin symmetrically.



Figure 5. Layered dissection of neck displays bruising and hemorrhaging in the middle layer strap muscles. Inset displays similar hemorrhaging near arytenoid margins of vocal folds of deep muscles above airways.



Figure 6. Inside of larynx depicting submucosal petechiae and flame-shaped ecchymoses, esp. confluent near arytenoid margins of vocal folds (arrows).

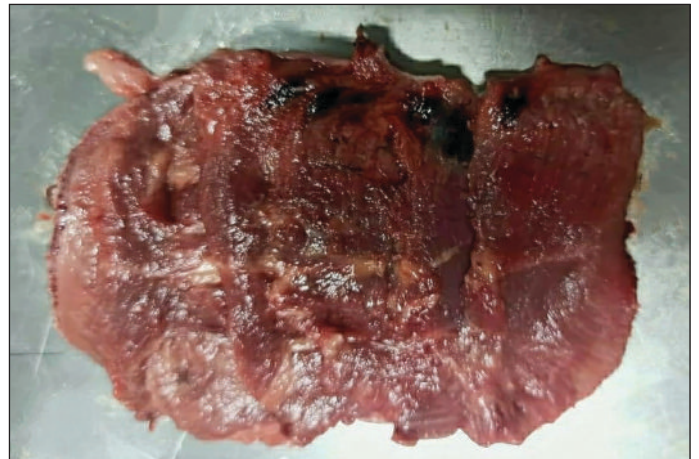


Figure 7. Horizontally sectioned tongue displaying multiple stripes of intramuscular hematomas just inner to right margin. A tiny hematoma is additionally visible just behind the left tip.

apparently dark complexioned, 174 cm in length that was clad in a blue full sleeved shirt, formal pants, and black sacred threads over the neck and torso. The clothes were completely devoid of any tears or scuffs, blood or major mud stains and worn as usual. Little rigor mortis was appreciated over fingers and toes (only).

Generalized soft tissue scavenging over whole of the middle-lower face, left supraorbital, right sub mandibular and right ear helix was present, with scalloped margins and tiny puncture marks in the vicinity. The tissues were devoid of any vital hemorrhage (Figure 3). The tongue's tip was slightly protruded and wedged between front teeth with postmortem darkening over right. Fixed, bluish-purplish PM hypostasis was symmetrically distributed over dorsum of the body but absent over front of the neck and further down the body. No vibices (postmortem hypostatic hemorrhages) were present anywhere.

The forehead's skin was livid-congested, additionally showing confluent to isolated dark scrape-like marks, possibly from bird (s) beak (s), in the vicinity of scavenged margins.

The following injuries were seen over the body:

(1) A transverse albeit wavy, brownish-black parched ligature abrasion of 14 cm x 0.8 cm over right lateral-posterior region of neck situated 8 cm below mastoid process and 6 cm belowinion (Figure 4). The surface was smooth and showed three separate areas of indentations along its course. It was rimmed by an intense congested zone, 1.5-2 mm wide, more prominent medially. On dissection, the dermis and superficial subcutaneous tissues showed intermittent ecchymoses in congruence with the external mark. Rest of the tissues in depths, nuchal and paraspinal muscles were unremarkable. No similar mark was seen anywhere else on the neck (or the back of head). Spine was intact on general palpation. Facial and orbital petechiae could not be appreciated due to soft tissue scavenging.

(2) No external injury marks were present over front of the neck. On layered and bloodless dissection of the neck, however, subcutis over frontal-bilateral neck regions showed oval to irregular almond-sized ecchymoses at few places. The strap muscles revealed confluent areas of bruising and hemorrhage at different levels, some of which were discoid-shaped, and overlaid fascia ruptured at places (Figure 5). The epiglottic and laryngeal mucosae depicted multiple petechiae and flame shaped ecchymoses. The latter were confluent in the vocal folds near arytenoids (Figure 6). On sagittal and transverse sectioning of individual vocal folds, bilateral deep laryngeal muscles depicted diffuse and marked ecchymoses.

The right lateral margin of tongue was uniformly bruised and confined intraorally. On slicing the tongue horizontally in two halves (from tip to base), multiple striped fresh intramuscular hematomas just inner to the right margin and a single tiny muscle hematoma just behind the left tip were appreciated (Figure 7). No dental or jaw trauma was present.

The complete laryngeal-hyoid skeleton was ossified yet intact. Laryngeal articulations, vascular intima, cervical spine with pre- and paravertebral soft tissues and posterior cricoarytenoids were unremarkable.

(3) Multiple faint-bluish focal blurred bruises over bilateral frontal scalp region. Underlying scalp layers, including right subgalea, were ecchymosed. The galeal scalp and bilateral temporalis were deeply congested, with multifocal congestive ecchymoses over right temporalis.

The visceral and neurocranium were intact. Brain revealed moderate oedema with generalized cortical congestion and two focal subarachnoid effusions over right frontal pole and middle of right central sulcus. Coronal sections of cerebrum and hindbrain were unremarkable.

(4) An oblique, reddish linear sharply defined scratch abrasion with reddened hem, over right lateral lumbar abdominal wall.

(5) A pale rectangular area of confluent punctate excoriations just beneath (4).

(6) An oval area comprising of fronds of peeled-off dark parched epidermis and exposed pale moist dermis, over back of right

lumbar region.

No additional musculoskeletal injuries were found. Layered preparation of torso and extremities did not reveal any deep soft tissue ecchymoses or fractures. Thoracic and abdominal viscera were intact. No abnormal fluid accumulations in any serous cavity.

Lungs were congested and focally emphysematous and atelectatic at places. Cut pulmonary surfaces were hemorrhagic and edematous. Non-hypostatic surfaces of abdominal viscera were deeply congested. Numerous subpleural and epicardial Tardieu's spots were present. Dark-red fluid blood could be well appreciated.

In consideration with the crime scene findings, the cause of death was given as mechanical asphyxia due to ligature and possibly manual strangulation. Injuries 1 through 4 were antemortem while injuries 5 and 6 were peri-or postmortem in nature. A femur bone was preserved for DNA profiling, as the facial features were largely obliterated and unidentifiable. The general body features and osteological profile were consistent with the alleged age.

Chemical analysis of viscera, peripheral blood and bile samples were negative for ethyl alcohol, common poison, or stupefying agent. No significant internal organ or vascular pathology was found.

Subsequent police investigation and court trial

Two days before discovery of the dead body, an FIR had been lodged under section 346 of Indian Penal Code (IPC) (punishment for wrongful confinement and restraint of a person), on the concern of deceased's father, as the deceased had left home without information and turned untraceable.

After receiving autopsy results, the police investigations were initiated towards a potential homicide. The police apprehended deceased's wife and two young men after a couple of weeks who conspired jointly in murdering the victim. An extramarital affair and resulting domestic violence were found to be the perpetuating factors. Important facts were established from the suspects' confessions, as follow:

The victim was called in the fields of one of the male suspects, to convince and agreeing with the affair between deceased's wife and suspect. He was insisted to divorce and to let all of them live happily. An escalating argument ensued and the decedent was strangled with a white cotton parna (male scarf). Thereafter the dead body was placed in the trunk of an SUV car and dumped (placed) at the site of body's discovery. The suspects made another round to the fields and bring the deceased's motorbike for disposing it off near the dead body. The broken car bumper and signal lights, already present over the ramp of scene, were additionally brought to simulate a real car-bike collision scene. After arrest, the primary and secondary crime scenes were pointed out by suspects to the police. The spouse planned the whole modus operandi.

The additional belongings of the deceased, including personal (ID-related) documents, a wallet and those mentioned in the FIR (a pair of golden ear rings and foot wears), were also retrieved from the suspects. The male suspects had fled away from their

resident village after killing the victim. The whole (documented) story was communicated to the forensic doctors by the investigation officer while seeking opinion to a set of queries. The ligature was, however, not produced for medical examination (submitted at Regional FSL by the police).

The case is currently under trial. The charge sheet has been filed under sections 302 (punishment for murder), 120B (criminal conspiracy to commit an offense punishable with death) and 201 (causing disappearance of evidence of offence) of IPC.

During medical testimony, the counsel for the defense raised question about possibility of strangulating the victim with a rope (in general), the possibility of which could not be denied. The soft tissue bruising over neck and additional internal neck trauma was however denied to be sustained from a 'friendly' application of hand over neck. No additional details of the case are currently known.

Discussion:

Intentional simulation and dissimulation of criminal acts are behavior patterns frequently met in both police investigations and forensic medicine.⁷ Cases of homicidal strangulations are commonly simulated as suicides,^{8,9} and rarely also as accidental deaths.¹⁰ Evidence of ligature strangulation is frequently detected in conjunction with other traumatic violence like manual strangulation and blows, thereby, ligature strangulation may be either the eventual or a concurrent cause of death or even may be a secondary finding.¹¹ As a secondary finding, cases of recent assaults by strangulation with major add-pathoanatomic findings, yet with entirely different cause of death at autopsy have been recorded.¹²

The autopsy findings in strangulation-related death are subjected to multiple variables such as composition of ligature, intensity and duration of force, victim's age and constitution, status of alcohol/drug intoxication, prior infliction of any blunt/bleeding trauma and interposition of any material between victim's neck skin and ligature/hands.^{11,13} The morphological findings are generally attributed to one of the two major classes: (1) local neck injuries as a result of the mechanical compression, (2) signs of a cranial congestion from vascular compression.¹³

Physical evidence of massive venous congestion, referred to as congestion syndrome, is predominantly seen in ligature strangulation, manifesting as petechiae and/or confluent bleedings above the level of neck compression.¹¹ The increase in venous compression from ligature strangulation, in the presence of continued arterial input, damages the venous endothelium and tunics, resulting in minute points of bleeding referred to as petechiae.¹⁴ The petechiae become visible predominantly in the eyes, face, and neck. Severe cranial congestion may also cause bleedings from nose, ear and mouth,¹⁵ in extraocular muscles (subfascially),¹⁶ retina,¹⁷ mucosa of sphenoid sinuses,¹⁶ and ethmoidal labyrinth.¹⁸

Hemorrhages of the tongue have been found to be useful for the diagnosis of a lethal neck compression, especially protracted strangulations.¹⁹ In majority of the cases, they may be categorized in two classes: (1) Bruises/bite marks of the apical or marginal

parts of the tongue that are considered typical of violent assaults to the neck, especially homicides by manual and/or ligature strangulation.^{8,9,19,20} They are typically absent in suicidal ligature strangulation and rare in suicidal hanging,¹⁹ (2) Congestion-related bleedings in victims with severe cranial venous congestion where the local engorgement of blood may cause intramuscular bleedings/hematoma in the central-middle and posterior parts of the tongue, as well as submucosally over the root, regardless of the kind of strangulation.^{19,21} Severe intramuscular bleedings may be fashioned in a rope-ladder like arrangement, likened to an apoplexy or infarction of the tongue.^{11,19} In one case, focal intramuscular bleeding into base of the tongue, depicting pattern of the impacting hyoid bone, was decisive in proving homicidal ligature strangulation at autopsy.²²

Forensically, similar intravital bleedings into tongue musculature have been reported in burnt corpses too, caused by burn-induced shrinkage of neck's soft tissues generating a (pseudo) strangulation-like mechanism, and cephalic congestive bleedings akin to ligature strangulation.²³

In the current case, apart from few non-specific perimortem injuries over torso, typical defense or struggle injuries were absent. This may be attributed to certain contextual factors such as physical disparity, sudden unanticipated attack, and prior (blunt) head trauma, thereby leaving the victim defenseless/incapable of act, and facilitating the strangulation process. Additional contributory factors may be physical infirmity, age extremes, and alcohol/drug intoxications.

Diffuse bleedings into the deep laryngeal/vocal muscles (esp. mm. vocalis) in strangulation or severe blunt neck violence has been related to local trauma caused by compression of the larynx leading to severe deformation of the vocal folds and dislocation of arytenoid cartilage(s).²⁴ The hemorrhages generally outnumber the cases of manual over ligature strangulation.^{24,25} Severe vocal fold bleedings are unusual in suicidal strangulation (by ligature as well as by hanging), and have not been reported so far in any forensic study.^{13,26} The finding may be the sole evidence of a fatal neck compression, esp. in younger individuals that all-too-often have an uninjured throat skeleton despite documented evidence of a lethal strangulation.²⁴ Vocal fold bleedings of congestive nature are often petechial and of minor degree in comparison to mechanical compression type.^{13,23}

Additional important 'hidden laryngeal injuries' in violent neck compressions are non-dislocated fractures/fissures of cricoid and thyroid cartilage plates, perichondrial tears, bleedings into posterior cricoarytenoid muscles and perichondrium of thy. c. laminae, and in synovium and/or capsule of laryngeal articulations.^{24,26}

Fractures of the hyoid bone or the thyroid cartilage are regarded as common findings in victims of strangulation, though by no means obligatory. No fractures of larynges were found in a study involving 12 female victims of homicidal strangulation.²⁵ Isolated fractures of hyoid bone have been found to be rare in homicidal strangulation while fractures of bilateral superior cornua of thyroid cartilage is the most common finding and cornual fractures of hyoid bone and thyroid cartilage is the most

common combination.²⁴

Additional studies have described 'intracartilaginous laryngeal hemorrhages' in the thyroid cartilage, as an isolated finding,²⁵ as well as morphological component of 'triad of laryngeal hemorrhages',²⁷ claiming their diagnostic value for the postmortem diagnosis of strangulation. The finding however could not be substantiated in a later study.²⁸

The presence of an incomplete ligature mark, as in the present case, is not too often an infrequent finding,²⁹ and may be due to various modifiers such as interposition of victim's hands/fingers or shirt's collar between ligature and the skin,³⁰ or due to unique ligature's characteristics. A possibility of strangulation with the creepers in the present case could not be ruled out at the first instance, especially from indentations in the course of mark. The appearance of such indentations is however more subjected to ligature's constitution and/or knot(s) pressure. In this context, a case of child sexual homicide by strangling with creeper plants has been previously reported.³¹ Similarly, female victims have been strangled with their own scalp hairs – natural³² as well as artificial extensions,³³ with nearly invisible to subtle external marks over the neck.

Tight stretching of a cotton parnaacross the neck, however, commonly creates narrow folds that form the base for a narrow-parched mark, such as seen in the present case.

On dissection, the ligature mark of an intense strangulation is generally well perfused and depicts hemorrhages in the underlying soft tissues to variable depths along its course, representing its internal counterpart.¹³ An internal mark with deep soft tissue injuries is however unusual in suicidal-ligature strangulation and hanging. In the former, an intense ligature pressure may rarely produce hemorrhage in the underlying strap muscles,³⁴ tears into carotid intima,³⁵ and peri-carotid soft tissue bruising.³⁶ The intensity of the pressure rather than ligature's characteristic is the leading factor determining the severity of internal cervical injuries.¹³ Similarly, in survived/resuscitated hanging victims, subcutaneous hemorrhage below the hanging mark may be seen irrespective of the duration of survival,^{37,38} which is rare in successful primary hanging.¹¹ If there is underlying tissue swelling, the mark may appear very faint or completely obliterated.

In suicidal strangulations, the victims are frequently found with the strangulation device still in-situ around the neck which is uncommon in homicidal strangulation, although the reverse is sometimes seen on account of personal/criminal motives. The number of knots and ligature turns are of little use in ascertaining the mode of strangulation.¹³

Diffuse hemorrhages and discoid-shaped bruises of the strap muscles, sometimes in different layers, usually characterize an intense manual strangulation.^{24,39} The vital nature of such hemorrhages, however, mandates careful scrutiny as they may be introduced during corpse retrieval at the scene,^{40,41} as well as in the areas of declivous lividity.⁴² A microscopic differentiation between vital and postmortem skeletal muscle alterations has been suggested,^{41,43} although not absolutely validated.⁴⁴ Thereby, a

complete elucidation of corpse removal at the scene must be made, before making any conclusions.

The dead body in the current case was lying in a right lateral tilt at discovery, thereby necessitating exclusion of any hypostatic hemorrhages in dependent body regions. It was achieved on the basis of criteria already suggested,^{42,45} such as a complete lack of vibices any where, a regular patterned hypostasis over dorsum of the body devoid of any discordant/dual distribution, and lack of lividity over front of neck and further down the body. The head and neck were placed largely supine without any head/face down component (esp. no abnormal livores over right side of neck (cf. fig. 4)). The lividity (if present) would have been, presumably, completely translocatable at the crime scene.⁴⁵ The same holds true even if the body position had been changed by anyone else before arrival of the police (viz. trash collector, public, etc.).

The finding of rigor mortis in the discovered body posture was already suspicious at the scene.

The little (and only) blood loss, seen as small blood patch near the head region, was consistent with postmortem scavenging of facial soft tissues (possibly by some rodent species).⁴⁶ Although, a remote possibility of strangulation-related congestive bleeding from cranial natural orifices has to be kept in mind.¹¹

The disposal of a killed victim in an open place also merits due attention in the present case. Concealment or disposal of a corpse is not unusual, although an infrequent forensic entity. Several disposal methods have been described and graded in forensic literature, depending upon the complexity of procedure. As per Schneikert's grading, abandoning a dead body in an isolated area constitutes grade 1 of body disposal.⁴⁷ In a study over different 'homicide with corpse disposal' methods, De Matteis et al. found strangulation to be the cause of death in 21% of the cases while blunt head trauma was the leading entity.⁴⁸ Dogan et al. described two homicide cases that were dumped into the empty wells, out of which one had been killed by ligature strangulation.⁴⁹

The involvement of a female perpetrator in the corpse concealment, as in the present case, is not entirely uncommon as majority of the perpetrators are closely related to victim.⁵⁰ Ligature strangulation is the commonest mode of killing among all homicidal asphyxiation methods.¹ The most frequent motives for homicidal strangulations are rape, sexual disputes and personal rivalry, with females outnumbering the males as victims.¹

Key Points

- A careful and systematic approach is required towards every autopsy, unbiased of police history or preconceived assumptions and (all-too-often) appealing circumstances.
- Mutilation of the corpse does not imply mutilation of the cause and manner of death.
- Differentiation between different modes of strangulation should be made, whenever possible, based on a careful crime scene interpretation and autopsy findings.
- Bruising and/or intramuscular hemorrhages of the tongue are highly indicative of a ligature/manual strangulation-related

death in pertinent forensic situations.

- Deep laryngeal muscle hemorrhages suggest a violent compression of the neck when taken in appropriate context. The finding may be the sole evidence of strangulation, esp. in younger individuals.
- Soft tissue bleedings in the hypostatic regions must be carefully interpreted, especially in the presence of vibices.

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CASE REPORT

Methanol Poisoning: A Report on 4 Cases in a Border State of North East India

Phanjoubam M,¹ Keisham S,² Singh KP,³ Adhikari U,⁴ Angami A.⁵

Professor,¹ Assistant Professor,^{2,3} Post Graduate Trainees.^{4,5}

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

Abstract:

mass casualty which occurs after consumption of spurious liquor is usually called a 'hooch tragedy'. Methanol poisoning occurs very frequently in India and causes large number of casualties known as hooch tragedies. Though it happens in almost every part of India, the condition is being reported here as this is the first instance in a small border state in North East India without any precedence. Four people died after consuming locally brewed liquor and were autopsied in the mortuary of a tertiary health care centre in North East India. History revealed the typical symptoms of methanol poisoning and toxicological analysis confirmed the presence of methanol in the samples of blood and tissues. The cases are being reported here to serve as an eye opener for the people who have not encountered a hooch tragedy in this part of the country. Licensing of local brewery is absent in this small border state. Therefore, the quality control is almost nil which has in fact led to the present tragedy. Public health measures need to include steps to curb this menace in the bud. Legal statutes need to be strengthened regarding licensing, sale and trafficking of illicit liquor. Quality control is the need of the hour before it causes more deaths and hooch tragedies become a routine affair in this region. Good will from both the Government and the people are necessary for this.

Keywords: Local liquor; Incomplete distillation; Blindness; Death; Hooch tragedy; Methanol poisoning; Quality control.

Introduction:

Methanol is also known as methyl alcohol, wood alcohol, wood spirit and colonial spirit. It is a constituent in industrial solvents and in adulterated alcoholic beverages.¹ Ingestion causes severe toxicities. In December 2016; 78 people died in Russia due to a counterfeit body lotion which contained methanol.² During the COVID-19 pandemic, 300 people died in Iran believing that drinking methanol could help with the disease.³ India has a thriving moonshine industry, and methanol-tainted batches have killed over 2,000 people in the last 3 decades.⁴ Hooch tragedy claimed 93 lives in Mumbai in 1991. It happened in Gujarat where 136 people died in Ahmedabad after the consumption of hooch in July 2009. In 2011, a hooch tragedy in West Bengal claimed the lives of 172 people. It happened again in Mumbai in 2015 where 102 people died at a slum in Malvani, Mumbai after consumption of the poisonous alcohol. Consumption of poisonous alcohol led to the death of 13 people in Bihar in 2016. Presence of large quantities of methanol in the liquor was found to be the cause behind the deaths. In 2019, a Hooch tragedy claimed the lives of 99 people in Uttarakhand and Uttar Pradesh. In 2019, at least 114 people died after allegedly drinking spurious liquor in upper Assam districts of Golaghat and Jorhat.⁴

Surprisingly, the local brewery in this border state of north east India has never given rise to such tragedies before which has been reported either in the local media or in scientific journals.

Corresponding Author

Dr. Memchoubi Phanjoubam

Email : mem010177@gmail.com

Mobile No. : +91 9612811931

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Therefore, the present cases are being reported here to spread awareness of this deadly health risk which is looming in the horizon.

Case Reports:

Two years before the onset of Covid-19 pandemic, four daily wage earners went to a local vendor on the city outskirts for drinking and consumed locally brewed alcohol. All of them suffered from vomiting, blurred vision and unconsciousness after consumption of the alcohol as per the police reports. Following this, all of them died and their bodies were brought for autopsy in our centre.

Case No: 1 The first victim, a 48-yr old Meitei man, died at a private hospital 12 hours after the incident. PME revealed no external injuries except for congestion of organs. Stomach and small intestine contained about 60 ml of dark fluid with spiritous odour.

Case No: 2 The second victim, a 55-yr old, died at the same private hospital 5 hours after the incident. Similar symptoms were reported in this case. On PME, conjunctiva congested, cyanosis present. No external injuries seen. All internal organs congested.

Case No: 3 The third man, 51-yr old Meitei man with similar symptoms died at another private hospital 12 hours after the incident. On PME, marked cyanosis present; no external injuries seen. Internally, all organs were congested. Stomach cavity contained around 500 ml of straw-colored fluid.

Case No: 4 The fourth victim, a 49-yr old Meitei male died at his residence, 37 hours after complaining of similar symptoms. On PME, marked cyanosis was present; no external injuries were seen. All internal organs were congested. Stomach contained about 300 ml of brownish fluid.

Toxicological analysis in the first 3 cases detected ethyl alcohol, methyl alcohol and traces of metabolites in stomach contents, liver, kidney and blood. And in the 4th case, it was detected in the blood and tissue samples.

The sample of blood in the above cases contained 183.69mg%, 155.98mg%, 154.14mg % and 17.47mg% of methyl alcohol respectively.

Histopathological examination (HPE) in the 3rd and 4th cases revealed micro and macrovesicular steatosis and focal tubular necrosis.

Based on the postmortem findings and toxicological analysis and HPE reports, the deaths were due to methanol poisoning.

Discussion:

When multiple deaths occur after consuming contaminated liquor, it is known as hooch tragedy. The word 'Hooch' is derived from Abbreviation of hoochinoo, name of a specific liquor, from Tlingit Xutsnoowú Kwáan, the group that produced it, from Hutsnuwu ("grizzly bear fort"), the name of the village on Admiralty Island in which they lived.⁵ According to Webster's dictionary, Hooch means an alcoholic liquor especially when inferior or illicitly made or obtained.⁶ Methanol is produced during the brewing process and concentrated by distillation. Commercial manufacturers reduce it to levels which are safe for human consumption. Unscrupulous backyard brewers may add industrially produced methanol to increase profits. Contaminating microbes can also produce methanol during traditional ethanol fermentation.^{7,8}

Methanol poisoning is fairly common in our country usually involving a huge death toll⁹. The present incident involved four deaths which were autopsied in our centre. This may be due to the small scale nature of the home industry. Patients usually present with symptoms, 12-24 hours after ingestion of methanol. In the present series, onset of symptoms was much earlier resulting in a fatality within 5 hours in 1 case. This may be due to a higher amount of consumption or general physical morbidity. One of the most striking features of methanol poisoning is Snowfield vision (photophobia and blurred and misty vision). Temporary or complete blindness due to optic neuritis and atrophy due to accumulation of formic acid within optic nerve.¹⁰⁻¹²

Some other commonly reported symptoms of methanol poisoning include gastrointestinal, visual disturbances and neurological symptoms.¹¹⁻¹² Based on the history provided by accompanying people, all our cases had visual symptoms, followed by respiratory, gastrointestinal and cerebral symptoms which is usually found in methanol poisonings.^{1,13,14} Methanol's toxicity is due to its metabolic products. The by-products of methanol metabolism cause an accumulation of acid in the blood (metabolic acidosis), blindness, and death. Death may occur from respiratory depression following metabolic acidosis. CNS depression is a minor factor.

The fatal dose is 60-120 ml and the fatal period is 24-36 hours or can be delayed for 2-4 days. Although both ethanol and fomepizole are effective, fomepizole is the preferred antidote for methanol poisoning.^{1,13}

Indian law on Hooch: The directive principles of state policy (DPSP) in the Constitution of India (article 47) state that "...the State shall endeavor to bring about prohibition of the consumption except for medicinal purposes of intoxicating drinks and of drugs which are injurious to health".¹⁵ Liquor regulations are a state subject in India, giving rise to wet and dry states. It breeds a complicated situation where licensing and excise regulations cannot be done clearly making it hard for firms to operate with transparency and very easy for corruption and criminality to seep in. This creates an opportunity for some people to make money by purchasing alcohol from dry states, and smuggling it into wet states at an inflated rate. It is possible to make hooch tragedies a thing of the past, if we can move beyond looking at alcohol policy as a matter of good and evil.

Experts have opined that there is a need to make an urgent shift to a public health paradigm in the approach to alcohol use. This would entail measures to reduce overall consumption — by raising minimum-age requirements, tightening enforcement of drunken driving laws, regulating retail and advertising. Along with this, Governments must target high-risk behaviours through the public health system.¹⁷

Conclusion:

Methanol poisoning may occur accidentally as a result of defective distillation of ethyl alcohol or adulteration to make more money. Ophthalmic, cerebral, pulmonary, and renal systems are commonly affected by methanol poisoning. Knowing the history, clinical features and the metabolic process will help in the prompt management of such cases. Further, autopsy, including histopathological examination and toxicological findings, can elicit the adverse effects of methanol on different organs. This will also assist the judiciary in providing justice to the sufferer, besides confirming the cause of death. Public must be educated and made aware of the consequences of consuming alcohol adulterated with methanol. Legal statutes need to be strengthened too. Quality control is a must. Good will from both the Government and the people are necessary for this.

Conflict of Interest: Nil

Source of Funding: Nil

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CASE REPORT

Autopsy Findings- A Unique Case of Homicidal Strangulation

Saha N.

Senior Resident, Department of Forensic Medicine & Toxicology Medical College, Kolkata.

Abstract:

To present and share, the classical autopsy findings of a unique case of homicidal strangulation. After meticulous scrutiny of relevant documents, autopsy was carried out at Kolkata Police Morgue, using standard autopsy protocol and ancillary investigations. Still photographs were taken observing standard protocol of Forensic Photography. A 62 year old man was found lying in a pool of blood, in injured condition. A long cloth was found behind his neck, in untied condition, which gave an initial suspicion of a case of ligature strangulation. Face, neck and fingernails, cyanosed. Blood on wearing apparel, noted. Hematoma over frontal region of scalp was present. Both eyelids, both ears, nose and both lips, were bruised. Nasal bones, fractured. Evidence of multiple nail scratch abrasions over anterior aspect of the neck but no ligature mark could be found after careful examination. On dissection, strap muscles of neck, were bruised. On opening the thorax, thyroid and cricoid cartilages, were found bruised and left greater cornu of hyoid bone showing inward compression fracture. Manual strangulation/throttling cases are not uncommon in a tertiary hospital morgue and usually a common method of committing homicide. Meticulous autopsy examination can solve riddles that may lead to erroneous conclusions, as presented in this case.

Keywords: Ligature; Manual strangulation; Homicidal.

Introduction:

Asphyxia is often associated with the phrase "lack of oxygen".¹ Mechanical asphyxia occurs due to compression of the neck, blockage of the external respiratory orifices, impaction of foreign body, compression of the chest or inhalation of fluids, may cause this dearth of oxygen which leads to an asphyxia death.² Hanging, manual strangulation, strangulation by ligature, smothering or gagging, to name a few, may cause mechanical asphyxia.^{3,4} Important publications have pointed out a few salient features of asphyxia; namely, petechiae, congestion, cyanosis and engorgement of the right heart. But these are non specific.⁵⁻⁷ Signs like ligature mark or nail scratch abrasions or a fractured hyoid bone may help us come to a more specific conclusion.⁸⁻¹⁰ We faced a few challenges with this particular case. Initial signs pointed us in one direction, but after conducting post mortem examination, we arrived at a different cause of death.

Case report:

A 62 year old man was found lying in a pool of blood, on a mattress, in injured condition, at the southern side of a workshop room situated in Kolkata. He was wearing a saffron coloured printed kurta and white pajamas, both were stained with blood. His legs were tied loosely with a cloth (gamcha), and another cloth (gamcha) was found behind his neck, in untied condition, which gives an initial suspicion of a case of ligature strangulation (Figure 1a). He was taken to Medical College & Hospital, Kolkata and was declared "brought dead", five hours since the

discovery.

The deceased is a male subject, moderately built with a body length of 177.8 cm and weight 83 kg. Sub conjunctival haemorrhage present on the conjunctiva of both eyes and pupils fixed and dilated on both sides. Cyanosis noted over the fingernail beds. Congestion is present all over the face, neck and anterior aspect of the chest wall extending upto 9.3cm below the suprasternal notch (Figure 3b). There is evidence of blood coming out of the mouth and nostrils. The belongings are; one printed saffron coloured "kurta" (Figure 2a), one white coloured "pajama" (Figure 2b), one white vest (Figure 2c) and one purple underwear. These are stained with blood at multiple places. One red and white printed cloth ("Gamcha") with a fixed knot is found loosely tied over both legs. It is cut open, keeping the knot intact. The parts from the knot to the cut ends, measuring 35.5cm x 6.9cm and 40.7cm x 6.9cm on either side. The fixed knot measures 3.8cm x 2.5cm in dimension. The tail of the ligature material measures 76.4cm x 7.2cm (Figure 2d).

Injuries: 1) Multiple abrasions, the largest measuring 7.6cm x 1.1cm and the smallest measuring 1.3cm x 1.1cm, present over an area, measuring 7.6cm x 3.8cm, situated on the vertex of the scalp, present 12.1cm in front of the external occipital protuberance and on the midline (Figure 3a). 2) On dissection- i) and retraction of the scalp, evidence of scalp hematoma, measuring 7.6cm x 3.8cm, diffused over the different layers of the frontal region of the scalp, and located 4.6cm above the nasal bridge and on the midline, extending 3.5cm on the right and 4.1cm on the left of the midline (Figure 4a). ii) Bruise, measuring 7.6cm x 3.8cm, present all over the right temporalis muscle (Figure 4b). iii) Bruise, measuring 1.3cm x 1.3cm diffused over the pinna of the left ear, present 1.7cm behind the left tragus (Figure 5a). iv) Bruise, measuring 1.4cm x 1.1cm diffused over the pinna of the right ear, present 2.3cm behind the right tragus (Figure 5b). v) Bruise, measuring 7.6cm x 6.9cm diffused over

Corresponding Author

Dr. Nirjhar Saha

Email : sahanirjhar08@gmail.com

Mobile No.: 7980609295

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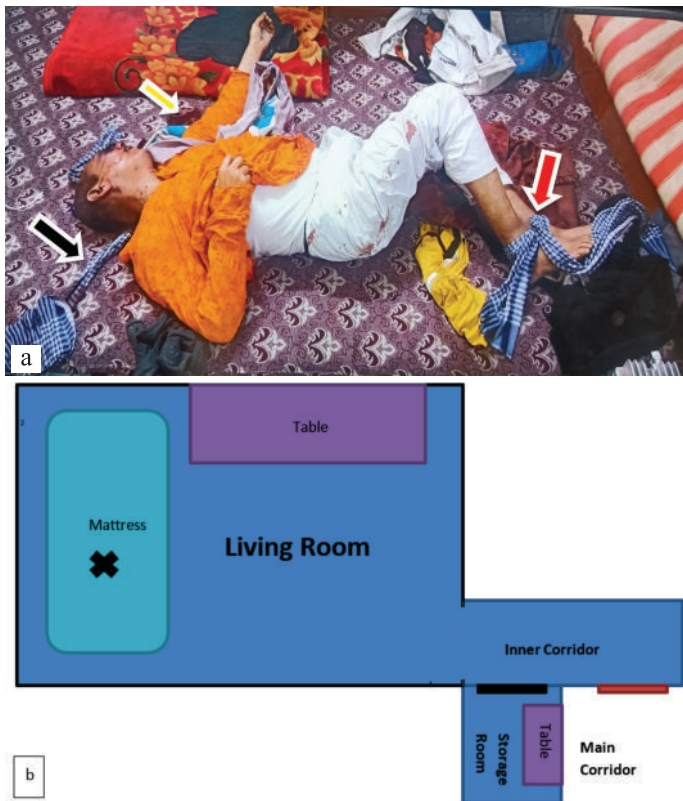


Figure 1a. Crime Scene Investigation; black arrow showing the cloth present behind the nape of the neck, yellow arrow showing the blood present on the mattress, red arrow showing the legs tied with a cloth. **Figure 1b.** Crime scene area mapping, (Recreated digitally by the authors); the black cross showing where the deceased was found.

both eyelids of the right eye. vi) Bruise, measuring 5.3cm x 5.1cm diffused over both eyelids of the left eye. vii) Bruise, measuring 6.4cm x 5.1cm diffused over the whole of the nose. viii) On further cleaning, fracture of both nasal bones, horizontally placed across both the bones, 12.6cm below the vertex of the skull, with evidence of bruise in the nasal cavity (Figure 4c). ix) Bruise, measuring 3.8cm x 2.5cm diffused over the left cheek, present 9.2cm in front of the tip of left mastoid process and 7.7cm above the left angle of mandible. 3) One lacerated wound, measuring 1.5cm x 0.8cm x muscle deep, on the inner aspect of the upper lip, present 1.3cm left of midline, with evidence of bruise (Figure 5c). 4) One lacerated wound, measuring 1.1cm x 0.5cm x muscle deep, on the inner aspect of the lower lip, present 0.3cm right of the left angle of mouth, with evidence of bruise (Figure 5d). 5) Multiple linear scratch abrasions (Total 13 in number) present over the anterior aspect of neck over an area measuring 22.9cm x 15.2cm, the right side margin being 11.5cm right to midline and the left side margin being 11.4cm left to the midline largest measuring 2.1cm x 0.5cm, and smallest measuring 0.8cm x 0.3cm (Figure 6 a & b). On dissection, multiple bruises diffused and spread out, present over whole of the anterior aspect of neck (Figure 7a). 6) On dissection of the strap muscles of the neck, bruise, measuring 8.9cm x 3.8cm, diffused over the whole of the anterior aspects of the thyrohyoid membrane, thyroid cartilage, cricothyroid membrane and cricoid cartilages, with evidence of



Figure 2. Belongings, all the black arrows showing blood. **Figure 2a.** Saffron coloured printed kurta. **Figure 2b.** White coloured pajama. **Figure 2c.** White coloured inner vest. **Figure 2d.** Cloth tied around the legs, yellow circle showing the knot.

blood in the lumen of the trachea (Figure 7b). 7) On further dissection, inward compression fracture at the junction left greater cornu and body of hyoid bone with diffused bruise (Figure 7c). 8) On dissection, bruise diffused at the base of tongue and epiglottis. No other injuries were noted.

On internal examination, all organs were congested. There is evidence of multiple petechial hemorrhagic spots on the interlobar areas of both lungs and plurae. Materials preserved were viscerae in saturated solution of common salt, blood without preservatives, belongings, nail scrapings and cuttings and tuft of hair. No significant findings are present in the FSL reports.

Discussion:

Wahlsten et al. (2020) conducted a study in Finland of asphyxia homicides during 30 years time. Total number of cases was 383. Of all the victims, 7% had no observable external injuries.

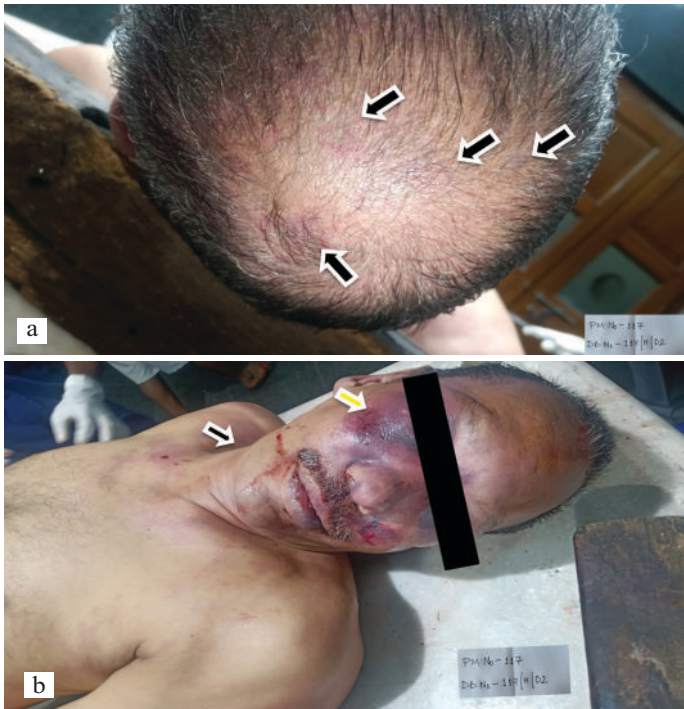


Figure 3a. Abrasion present over the scalp. Figure 3b. Black arrow showing congestion over the anterior aspect of chest, yellow arrow showing bruise over the eyelids.

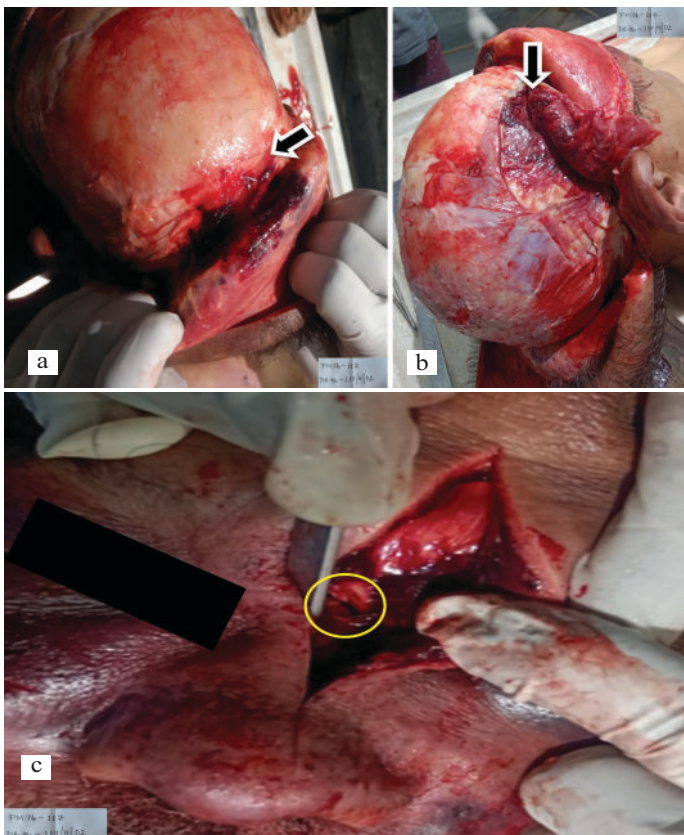


Figure 4a. Scalp hematoma over the frontal region. Figure 4b. Bruise over the right temporalis muscle. Figure 4c. Yellow coloured circle showing fracture of both nasal bones.



Figure 5 a & b. Bruise over the left(a) and right(b) ears. Figure 5c&d. Yellow coloured circle showing lacerated wounds over both lips, black arrows showing bruise.



Figure 6. Nail scratch abrasions over the left(a) and right(b) side of neck.

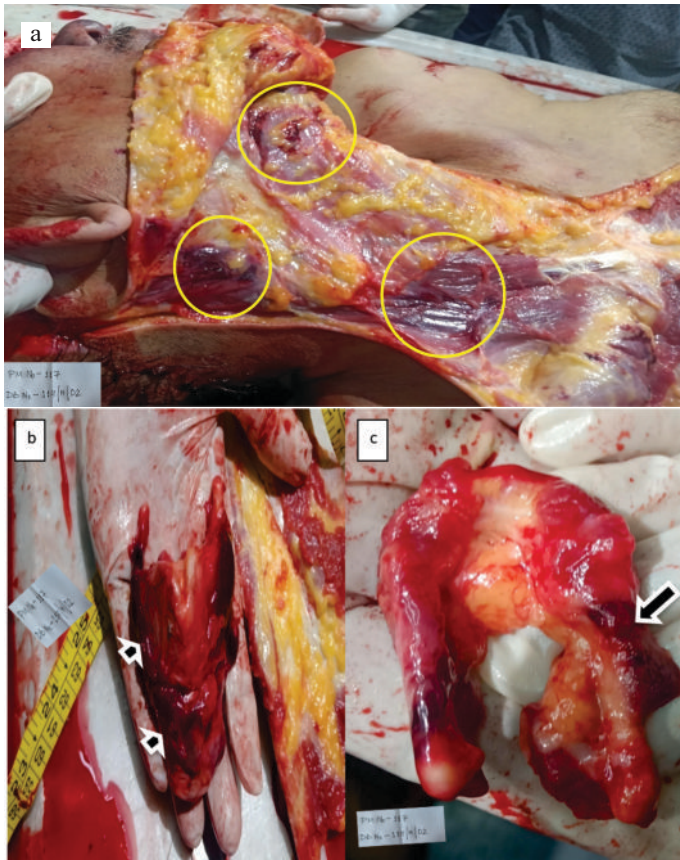


Figure 7a. Bruise present over the strap muscles of the neck. They are diffused and spread out. **Figure 7b.** Bruise present over the thyroid cartilage, cricothyroid membrane and cricoid cartilage. **Figure 7c.** Inward compression fracture over the left greater cornu and body of the hyoid bone with bruise.

Petechiae were recorded in approximately in 61%, laryngo-hyoid fractures in 47%, and vocal cord haemorrhages in 16% of the cases. Almost half of the victims died from manual strangulation, one in three from ligature strangulation. Smothering, choking, neck compression with a firm object and thoracic compression were more rare methods.¹¹ DiMaio (2000) stated in his study that from 1985 to 1998 in Bexar County Medical Examiner's Office, a total of 133 asphyxial death cases were found, all homicides. There were a total of 41 deaths from manual strangulation (27 female, 14 male). Petechiae were present in 89% of the cases, fractures of the hyoid, thyroid, or cricoid cartilage were found in all the male victims and more than one half of the female victims.¹² Rayamane et al. (2015) conducted a study from 2010 to 2012 in India. Out of a total of 31 cases, ligature strangulation accounted for 18 cases and manual strangulation 13 cases. Fractures of the hyoid and/or thyroid cartilage were present in 23 cases. In manual strangulation cases, hyoid bone fracture was noted in 4 cases (31%) and thyroid cartilage fracture was seen in 8 cases (62%). Among external features sub-conjunctival haemorrhage was seen in 19 cases and nasal bleeding in 10 cases. Haemorrhage in strap muscles were seen in all cases.¹³ Homicidal deaths by asphyxia in general is a rare phenomenon, majority of these cases were done by manual or ligature strangulation.

This case presented to us with multiple findings. On crime scene investigation, we found a cloth which was untied, present at the nape of the neck. This led the police to an initial conclusion of strangulation by ligature, and they informed us of their suspicions. We conducted the post mortem examination in a meticulous manner. There were abrasions, bruises and a fracture over the scalp, eyelids, lips, ears and nose; which suggests there was considerable struggle and violence. We found sub-conjunctival haemorrhage, cyanosis of the face and neck, petechial haemorrhage over lungs and pleurae; which are suggestive of death due to asphyxia. Evidence of nail scratch abrasions over the neck, diffused and spread out bruises over the strap muscles of the neck, bruising over the whole of larynx and an inward compression fracture of the hyoid bone, which narrowed down the cause of death to, asphyxia due to homicidal manual strangulation. Moreover, no ligature mark was found over the neck.

Das et al. (2016) reported a case of death of a healthy male in his early forties is described, where three different asphyxial methods, i.e., manual strangulation, smothering and traumatic asphyxia by thoracic compression were used. The interest in the case is generated because all these three methods were carried out by a single assailant.¹⁴ Lupascu et al. (2003) reported the case of death of a 75-year-old Caucasian woman, produced by three different ways of mechanical asphyxia: smothering and strangulation by hand and traumatic asphyxia by thoracic compression. All these criminal offences were carried out by one single assailant.¹⁵ Many case reports have been reported where multiple methods of mechanical asphyxia have been used by the assailant, but no case was found where it appeared that two methods were used but after conducting post mortem examination it was seen that one method was actually used.

Conclusion:

It is essential to perform meticulous autopsy without being biased by the history, police information or any incidental crime scene findings. Meticulous dissection & inference is essential in such cases, or the autopsy surgeon may miss essential findings. This case has been published by the authors to enlighten the autopsy surgeons to be vigilant and not be biased before performing the post mortem examination.

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CASE REPORT

A Rare Case of Suicidal Hanging with Ligature Tied around the Abdomen – A Case Report

Bansal S,¹ Kalakabandi SD,² Dhokia GR,³ Radhakrishna KV.⁴

Assistant Professor,^{1,2} Senior Resident,³ Professor & Head.⁴

1,3,4. Department of Forensic Medicine & Toxicology, Armed Forces Medical College, Pune.

2. Department of Forensic Medicine & Toxicology, Institute of Naval Medicine, INHS Asvini, Mumbai.

Abstract:

Hanging is a common method of committing suicide. Usually in hanging, ligature and knot form a fixed or running noose around neck and seldom simple loop without knot is used. A 35 years old male committed suicidal hanging using a saree as ligature wherein the compression of neck has occurred in the absence of a noose, loop and knot around the neck. The body of the deceased was suspended from hook in ceiling by a saree used as ligature material, with the two limbs of the ligature passing around the neck, crossing over to opposite sides of the chest, and finally knot tied in front of abdomen after encircling the back. This arrangement of ligature material tied around the abdomen acts like a harness supporting the body weight. As a result, despite complete suspension of the body from the suspension point, the fatal pressure on the neck is produced only by the head and maybe by the forward leaning chest and arms, as in partial hanging.

Keywords: Suicidal hanging; 'V' shaped ligature mark; Ligature tied around abdomen.

Introduction:

Opining on asphyxial deaths by fatal pressure on neck is one of the most frequent problems encountered by forensic pathologist in their medicolegal work. Among the various modes of asphyxial deaths, suicide by hanging using ligature remains the commonest.¹ The apparent quickness of death, makes hanging a commonly chosen method of suicide.²

Hangings are virtually suicidal.^{3,4} Accidental hangings are rare, and hangings by homicidal intent are even rarer.^{3,4} Forensic pathologists are customarily able to deduce suicidal hanging based on the characteristic ligature mark findings over the neck, asphyxial stigmata and the circumstantial evidences in the case barring homicidal design.

However, seldom a case of apparent suicidal hanging may confound the forensic examiner by its odd presentation and circumstances which could only be explained by a meticulous and comprehensive autopsy supplemented by the circumstantial evidence provided by investigating agency.

This case report discusses a rare case of suicidal hanging in which an odd ligature mark was detected over the neck, running across the chest, and encircling the back and abdomen. The peculiar ligature mark could be explained after considering the circumstantial evidence obtained by the police from scene of incident inquiry, including photographs depicting the deceased victim in a hanging posture.

Corresponding Author

Lt Col (Dr) Sandeep Bansal

Email : sandeep85w@gmail.com

Mobile No. : +91- 9101180758, 7620889356

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Materials and methods:

As per the inquest papers, the deceased was a 35-year-old male who lived with his wife and two children in a single room accommodation. By occupation, he was a daily wage labourer. Couple had a quarrel in evening and the wife went to her mother's house in nearby area with her children. When she returned home in the morning at 06:00 AM, she discovered her house's gate had been shut from the inside, and she received no response to her knocks and calls. Wife peered through the window and saw her husband hanged from the ceiling (Fig.1). Wife informed the relatives and police. Police arrived at the scene at 08:00 AM and busted open the door.

The body of the deceased was suspended from a hook in the ceiling by a dark pink colored printed saree used as ligature material, with the two limbs of the ligature passing around the neck, crossing over to opposite sides of the chest, turning towards back and encircling it and finally the knot was tied in front of the abdomen (Fig. 2).

The body was brought down by the police by untying the knot of ligature material. Examination of the scene did not reveal any evidence of struggle and no suicide note was discovered. Deceased's body was brought to our mortuary for post-mortem examination.

Autopsy findings: Deceased was dressed in a sky-blue full-sleeve cotton shirt, blue jeans, a white sleeveless vest, and brown underpants. Examination of clothes was unremarkable. Rigor mortis was complete, and post-mortem lividity was established in a glove and stocking pattern in the hands, forearms, and legs. No signs of putrefaction were found. Facial features appeared congested. The conjunctivae were pale and there were no petechiae. Tongue was protruded and bluish black in colour. The lips and nails appeared blue.



Figure 1. Body suspended from hook in ceiling. Ligature mark encircling the back.



Figure 2. Ligature material diagonally crossing over chest. Knot tied in front of abdomen. Complete hanging, feet above the floor.



Figure 3. 'V' shaped ligature mark over neck.

Examination of neck revealed a 'V' shaped brown colored pressure abrasion present over its anterior aspect (Fig. 3). The two limbs of the 'V' shaped ligature mark ran diagonally upward and backward behind the ears over the mastoid processes and merged into hairline. Length of right and left limb of 'V' shape ligature mark is 14 cm and 13.5 cm respectively. As both the limbs of 'ligature mark join to form 'V' at the suprasternal notch, they cross over to the opposite side and run diagonally across both sides of the chest as a faint blanchered mark measuring 35 cm in length and 3 cm in width (Fig. 4). At a distance of 20 cm below the axilla, the faint blanchered mark turns towards the back and encircles both back and the abdomen at a level 3 cm above the umbilicus [Fig. 5 and 6]. The circumference of ligature mark encircling the back and abdomen is 87 cm and its width is 5 cm. No other external



Figure 4. Both limbs of 'V' shaped ligature mark crosses over to the opposite side and run diagonally across sides of the chest.



Figure 5. Ligature mark running diagonally across chest and turning towards back. Ligature mark over abdomen.

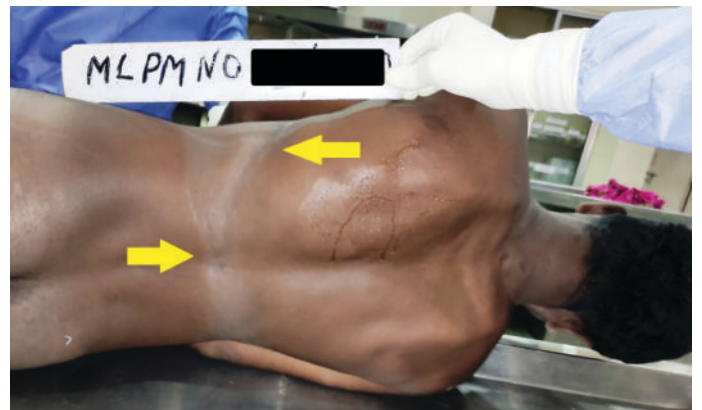


Figure 6. Ligature mark over back.

injuries were found on his body.

Internal examination of the neck revealed small haemorrhages on the bilateral sternocleidomastoid muscles beneath the external ligature mark. Laryngeal cartilages and hyoid bone were found to be intact without any evidence of fracture. Bronchi contained frothy blood-stained fluid. Lungs were oedematous and congested. The rest of the viscera including kidneys, liver and spleen showed congestion. No significant abnormality was detected on examination of stomach and intestines. Visceral sample for chemical analysis were not preserved.

The cause of death was ascertained as "Fatal neck compression consequent to hanging by ligature".

Discussion:

Hanging is defined as a form of asphyxial death caused by constriction of the airway at the neck as a result of the body being suspended by a ligature in the form of a noose, applied in such a way that the weight of the body or another portion of the body, such as the head, acts as a constricting force.^{5,6} In most hanging cases, the ligature and knot will form a fixed or running noose.⁷ However, a few cases where suicidal hanging has been committed using a simple loop without any knot have been documented in the literature.^{8,9} Hanging has been classified as typical hanging when the ligature runs from the midline above the thyroid cartilage symmetrically upwards on both sides of the neck to the occipital region and the point of suspension is over the centre of the occiput.^{5,6} Any deviation from the features of typical hanging has been classified as atypical hanging.^{5,6}

The case discussed presents a unique scenario of typical hanging wherein the compression of neck has occurred in the absence of a noose, loop and knot around the neck. The two limbs of ligature have caused the fatal neck compression as they cross over each other towards the opposite side of the chest making a 'V' shaped ligature mark.

Depending upon the position of body, hanging can be either complete or partial.^{5,6} In complete hanging the body remains fully suspended without the feet or any part of the body touching the ground and the constricting force is the weight of the body. Partial hanging is asphyxial death produced by partial suspension of the body by a ligature around the neck in the form of a noose, where the constricting force is the weight of the head and not of the body.^{5,6}

The case discussed presents a unique anomalous situation where although body is in complete hanging but the constricting force is not the whole body's weight. The ligature material after passing around the neck and over the chest, encircles the back and finally knot is tied in front of the abdomen. This arrangement of ligature material tied around the abdomen acts like a harness supporting the body weight. Therefore, despite complete suspension of the body from the suspension point, the fatal pressure on the neck is produced only by the head and possibly by the forward leaning chest and arms, as in partial hanging.

The case further emphasizes the importance of Forensic photography at the site of incident. In this case photos of the victim in a suspended position were immensely helpful in comprehending the peculiar ligature mark that covered the victim's neck, chest, back and abdomen.

Conclusion:

The field of forensic medicine never ceases to astonish and puzzle Forensic pathologists by offering strange and perplexing instances to be solved. The case discussed here presented a unique perplexing situation due to a peculiar and unconventional ligature mark which could be explained after meticulous and comprehensive autopsy supplemented by circumstantial evidence. Uniqueness of this case, in which fatal pressure over neck is not produced by whole body weight in a complete hanging, emphasizes the importance of an open scientific mind for a forensic pathologist.

Conflict of Interest: None to declare.

Financial Assistance: None to declare.

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CASE REPORT

Bottoms Up in Pelvis. How can it really happen? – A Case Report of Foreign Body in Rectum

Saiyed MZG,¹ Sharma V,² Jani CB.³

Professor & Head,^{1,3} Professor.²

1. Deptt. of Forensic Medicine, GMERS Medical College, Hospital, Kharvad Medan, Sipor Road, Vadnagar.

2. Professor, Deptt. of Surgery, GCS Medical College, Hospital & Research Centre, Opp. DRM Office, Naroda Road, Ahmedabad.

3. Professor & Head, Deptt. of Forensic Medicine, SAL Institute of Medical Sciences, Science City Road, Sola, Ahmedabad.

Abstract:

A 50 years old, male patient was admitted with complaints of pain in abdomen & anal region with bleeding per rectum. Alleged history revealed that he was intoxicated by some substance mixed in tea, offered by a rickshaw driver while he was travelling alone at midnight. After regaining consciousness, he found himself lying under a bridge with dust & blood stains on clothes & at anal region, respectively. He bathed at his home & came to the hospital as outdoor patient. He was found to have a metallic foreign body in pelvis on per rectal examination. On X-ray examination of abdomen & pelvis, a radio-opacity in shape of an inverted glass was visualized simulating the phrase “Bottoms up”, used when the bottom of one's glass is tilted upwards until it is empty. Various interesting medical and medico legal events followed during the course of the treatment which are discussed in this case report.

Keywords: Bottoms up; Foreign body; Pelvis.

Introduction:

Generally foreign bodies can be found in upper gastro-intestinal tract due to accidental ingestion. Cases of foreign body insertion into the anus or rectum irrespective of whether done for sexual gratification or to produce harm, voluntarily, accidental or by the other person, are less frequently encountered & hence less reported. Objects of various sizes and shapes like a marble,¹ hand shower,² bottle,³ deodorant container³ or any other instrument are reported in literature to have been inserted into the anus or rectum in majority cases by self¹⁻³ or by force or accidentally.⁴ Generally cylindrical objects are used but wide mouthed glass like objects are less preferred. Torture can be the reason for inserting foreign objects in majority of the cases, but voluntary insertion is also not less frequent. We are reporting here a case of a 50 years old male, who presented himself at our hospital with bleeding per rectum and pain in pelvic and anal region with complex history. On examining the patient, a metallic glass was present at recto-sigmoid junction. This case is reported here not only because of uncommon object being used & presentation, but also various medical & medico legal events that followed during the course of the treatment.

Case Details:

A 50 years old male patient consulted the surgical OPD (outdoor patient department) of a tertiary care level hospital in Ahmedabad with complaints of pain in lower abdomen & anal region and

bleeding per rectum since 6-7 hours. The detailed alleged history revealed that while he was travelling in an auto-rickshaw around 4 am in early morning, he fell unconscious after consuming tea offered by the auto driver. When he regained the consciousness, he found himself on roadside, under an over-bridge with blood stains on his pants & mud stains all over clothes & body. He experienced extreme pain at lower abdomen & anal region and believed some foreign body was inserted in his anus by the offenders. After returning home, taking bath and changing clothes, he consulted the doctor, around 6-7 hours after the incident.

On examination, patient was well oriented to time, place and person with stable vitals. Abdomen was soft and non-tender. Fresh blood around anus and margins of a hard, hollow object was palpable 4-5 cm above anal verge on per rectal examination. No fissure, crack or perianal abscess was noted. Proctoscopy showed ring of a hard foreign body around 4x3.5 cm size with inflamed mucosa & fresh bleed in rectum. X-ray abdomen erect showed multiple air fluid levels while, X-ray both hips AP view revealed presence of opacity in shape of inverted glass, with bottoms up in pelvic cavity (Image 1). Medico legal case was issued and police was informed. Sample of blood was preserved, labeled and sealed for chemical analysis. Ultrasonography of abdomen & small parts of perineum showed enlarged prostate & mild subcutaneous oedema in bilateral perianal region respectively. Under general anaesthesia, trial for per rectal removal of the foreign body was given but, failed. Exploratory laparotomy revealed presence of a metallic glass with base at recto-sigmoid junction & the glass lying in inverted position. Rectotomy, removal of the foreign body (a metallic glass) and loop ileostomy was performed by Surgery department. The metallic glass (Image 2, 3 & 4) measuring 7 cm (length), 4 cm (base diameter) & 6 cm (diameter at top) was recovered, preserved, labeled and sealed.

Corresponding Author

Dr. Mohammed Ziyauddin G. Saiyed

Email : dr.ziya.saiyed@gmail.com

Mobile No. +91-9662737129

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Figure 1. X-ray both hips AP view showing radio-opaque foreign body in pelvis with the shape of a glass in inverted position.



Figure 2,3. Metallic glass recovered from rectum.

Surprisingly, on the third day of admission, the patient and the relatives expressed their will to the doctor for not proceeding in any police investigation. They also informed the investigating officer for not doing any further procedure in the case. Patient was discharged after 11 days. Police neither requested for examination of the victim for any un-natural sexual offence nor came back to collect the injury certificate or the exhibits of the case.

Discussion:

Anal continence is maintained by an anal sphincter complex that consists of an internal sphincter which is involuntary, smooth muscle component & has ambiguous role in maintaining anal continence, while the other component known as external sphincter is voluntary & striated in nature, which is known to have a tonic activity at rest, even during sleep.⁴ Distension of the rectum or a spontaneous pressure increase evokes a contraction of the sphincter that lasts for 20-30 seconds. This guarding reflex is maintained through a neural arc at the low spinal level and probably the similar reflex contractions shall occur when any object attempts to accidentally penetrate the anus.⁴

It is observed in majority of the literature that foreign bodies are inserted in the rectum either for the non-sexual purposes like

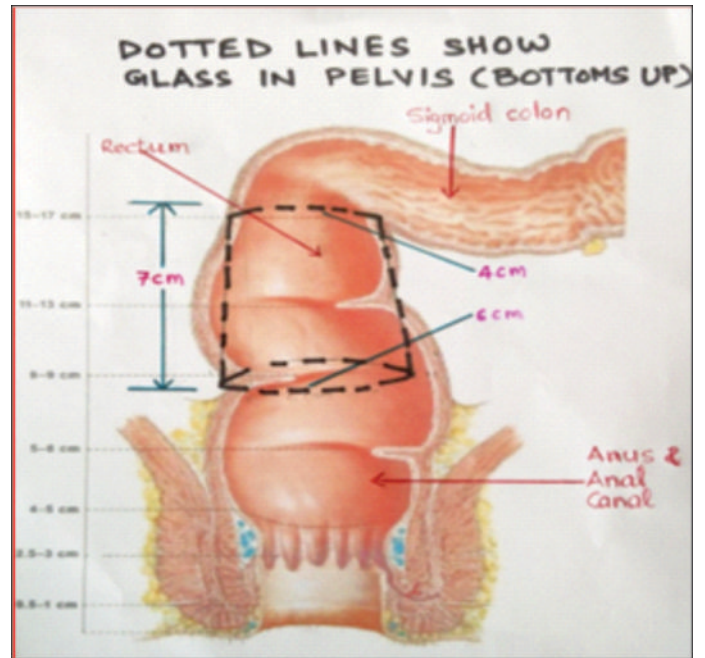


Figure 4. Schematic presentation: glass with bottoms up in pelvis.

transport of illicit drugs (body packing) or generally for the purpose of obtaining sexual gratification by prostatic massage,^{1,5} due to the proximity of lower one third of anterior rectal wall to the prostate.⁶ While attempting to insert the foreign body only up to lower one third of rectum voluntarily, by self or by force from the partner or entirely by accident, it may pass up, beyond lower one third of rectum accidentally. In present case, the base of the glass was stuck at the level of recto-sigmoid junction as both have same diameter (4 cm).⁶ Accidental entry of the foreign body in the anus can be possible if the anal canal or the object is already lubricated or position of the victim is favoring, like supine position with hips abducted, fully flexed and with pelvic tilt.⁴ The pre-requisite for this is unclothed anal area. In present case, such a situation could not be established by any means. On the other hand, in forceful insertion of a foreign body, such as a metallic glass used in this case, injury to the anal canal or rectum may be evident taking into consideration the diameter of the glass & the anal canal as well as rectum. Signs of trauma or injury are absent in this case, so again, initial story of forceful insertion of foreign body narrated by the victim is being negated, although intoxicated status of the victim may support it. Absence of any external or internal injury, delayed presentation of the patient to the doctor & refusal of the patient and the relatives for any further legal inquiry into the case suggests possibility of insertion of this foreign body by self or with the help of some partner.

Conclusion:

Before decriminalization of some parts of S. 377 of Indian Penal Code, Registered Medical Practitioner (RMP) was bound legally to make all such cases medico legal and the aspect of age of patient/victim were of no consideration for making the case medico legal. But, since Honorable Supreme Court judgement in Navtej Singh Johar & Ors v Union of India, Thr. Secretary,

Ministry of Law and Justice⁷ has held that "...In view of the aforesaid findings, it is declared that in so far as Section 377 criminalizes consensual sexual acts of adults (i.e. persons above the age of 18 years, who are competent to consent) in private, is violative of Articles 14, 15, 19 and 21 of the Constitution. It is, however, clarified that such consent must be free consent, which is completely voluntary in nature, and devoid of any duress or coercion..." now, such act involving consenting adults no more falls within ambit of S.377 of IPC. In present case the patient/victim was adult and probably reconfirmed with concerned police authorities that the insertion, either by self or by someone else, was with his consent and hence, they didn't register the crime and dispensed with the need of further medico legal investigation/s.

Another aspect which needs to be addressed here is, whether the act of providing false information regarding the incident initially & refusal of further investigation is sufficient to attract the punishment to the victim under S. 182 IPC [S. 182 IPC. False information, with intent to cause public servant to use his lawful power to the injury of another person.—Whoever gives to any public servant any information which he knows or believes to be false, intending thereby to cause, or knowing it to be likely that he will thereby cause, such public servant— (a) to do or omit anything which such public servant ought not to do or omit if the true state of facts respecting which such information is given were known by him, or (b) to use the lawful power of such public servant to the injury or annoyance of any person, shall be punished with imprisonment of either description for a term

which may extend to six months, or with fine which may extend to one thousand rupees, or with both] or not?

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

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REVIEW ARTICLE

A Narrative Review on (CBME) Modified Competency Related to LGBTQIA+**Singh OG.**

Professor & Head, Forensic Medicine Department, AIIMS, Kalyani.

Abstract:

Of late the National Medical Commission (Undergraduate Medical Education Board) has recommended certain modifications to the existing competencies on issues related to LGBTQIA+. This was based on the decision taken by an expert committee formed by the Undergraduate Medical Education Board in compliance with an order dated 18.02.2022 by the Honorable Madras High Court. Accordingly, the Undergraduate Medical Education Board (UMEB) recommended certain modifications to the CBME competencies of Forensic Medicine and Psychiatric subjects. In the subject of Forensic Medicine, the affected competencies are FM3.13, FM3.16, FM3.17, and FM3.18. As per the modified new competency, the concept of adultery and other unnatural sexual offences related matters need to be dealt under different headings such as gender and sexuality-based identities, decriminalization of adultery, consensual adult homosexual behavior, nonconsensual or forced touching, forced or nonconsensual fingers or objects insertion, paraphilia and paraphilic disorders, and unscientific, inhuman and discriminatory nature of finger test on female genitalia. The new modified competency also mentions about POCSO Act related to medical examination, emergency medical care, and police information. In the present article, the discussion is confined to LGBTQIA+ as this topic is not included in almost all current available textbooks of Forensic Medicine & Toxicology.

Keywords: LGBTQIA+; CBME curriculum; Forensic medicine; Lesbian; Gay; Bisexual; Transgender.

Introduction:

We may presume that the history of LGBT (Lesbian, Gay, Bisexual & Transgender) dates back the ancient civilization when there were instances of same-sex love. The first celebrated achievement in the history of LGBT occurred when Queen Beatrix, a member of the Dutch Royal House, signed a law making the Netherland the first country to legalize same-sex marriage in the year 2000 which took effect on 1st Apr'2001.¹ Until now there are 32 countries in the world where same-sex marriage is legally recognized, with the most recent being Chile on 10 March 2022, Switzerland on 1 July 2022, and Slovenia on 8 July 2022 respectively.²

To know more about this category of people, first, let's know something about the acronym LGBT.

Lesbian: The first letter to come into existence was 'L' representing 'Lesbian'. Lesbians are women who are primarily attracted to women. This word had been associated with the works of Sappho, an ancient Greek woman who lived on the island of Lesbos.^{3,4}

Gay: Gay is a man who is primarily sexually attracted to men. But in a broad sense, it may also be used to denote both men and women attracted to the same sex. Sometimes, it is also known as homosexuality.^{5,6}

Bisexual: An individual who is sexually attracted to both males and females is known as bisexual. In a broader term, the concept of bisexual may also include any romantic or sexual attraction to people irrespective of their sex or gender. Such a type of sexuality is known as pansexuality.^{7,8}

Transgender:

An individual whose gender identity differs from their assigned sex at birth is known as a transgender.⁹

Queer: This broad term includes people who have non-binary, gender fluid, or gender nonconforming identities. This is a very vague term, still not accepted universally amongst their own LGBTQIA+ community.¹⁰

Questioning: It includes a group of people who are questioning their sexual orientation or gender identity. Sometimes, when the 'Q' is seen at the end of 'LGBT', it may also mean 'questioning'.¹⁰

Intersex: It denotes people where there is an intermingling of both male and female sexual characteristics in varying degrees. So, in cases of intersex, the assigned sex as a male or female at the time of birth may not match the gender identity of the child later on.¹⁰

Asexual: This term is used for those who don't feel sexual attraction to either sex or that don't feel romantic attraction in a typical way.¹⁰

+ **Plus:** This 'Plus' sign is used to include all cases of gender identities or sexual orientations that letters and words cannot describe properly.¹⁰

History of LGBTQIA+ in India: There was acceptance and celebration of all forms of sexual relationships in ancient India. According to ancient Hindu myth, lord Krishna took the form of a

Corresponding Author**Dr. O. Gambhir Singh**

Email : drgambhirsingh@gmail.com

Mobile No. : +91 9629047798

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woman to marry Aravan before the battle of Mahabharata. Still today their marriage is celebrated as the Koovagam Festival, one of the largest festivals where thousands of trans people or Hijra gather annually. According to Bhagwada Purana, once Lord Shiva saw Lord Vishnu as Mohini and fell in love with him and Lord Ayyapa was born as their son. The great epic Mahabharata also mentioned the renowned characters of transgender like Shikhandi and Brihannala. In Ramayana it was mentioned that the birth of king Bhagirath was the result of the union of his mother and widow of the king Dileep, by the blessings of the Lord Shiva. Vatsyayana described about lesbianism and various sexual activities in his famous book Kama Sutra written during the second or third century. Various temples constructed in Puri and Tanjore during 6th to 14th centuries have graphic images of same-sex intercourse on their walls. The 12th centuries temples in Khajuraho, Madhya Pradesh also show overt erotic sculptures showcasing the existence of sexual fluidity between homosexuals.^{5,6}

During medieval times, there was some disapproval of homosexuality but LGBT people were not ostracized. Society was tolerant towards them and nobody was hounded for having a different sexual preference.

During the Mughal Dynasty also there were many incidents of homosexuality. Babur wrote about his love relationship with a boy named Baburi. There were many such incidents in which noble-class Mughals engaged in homosexuality. After the arrival of Britishers, in 1861, all sexual practices against the order of nature including all homosexual activities were banned legally under Sec.377, IPC. In 1994, Hijras were legally granted voting rights as a third sex. The first petition challenging section 377 was filed by the AIDS Bhedbhav Virodhi Andolan in 1994, however, it was eventually dismissed. In 2001, a PIL was filed by Naz Foundation to challenge section 377 in the Delhi High Court. In 2009, Delhi High Court found section 377 in direct violation of the fundamental rights of life, liberty, privacy, and equality provided by the Constitution of India.

In Apr 2014, the honourable Supreme Court of India directed that all transgenders must be recognized as the third gender. On 24th August 2017, the honourable Supreme Court of India has given the LGBTQ community the freedom to express their desired sexual orientation freely without any fear. This one's sexual orientation was protected by the right to privacy law. On the 6th of September 2018, the Honourable Supreme Court of India removed part of section 377, IPC.⁷

The Parliament passed the Transgender Persons (Protection of Rights) Bill on 26th Nov 2019. This law prohibited discrimination against the community in employment, education, healthcare, and other services. But the Queer community rejected it as it made mandatory for each person to be recognized as transgender on the basis of a certificate to be issued by a district magistrate after proof of sex reassignment surgery is provided. The main problem was it gave more emphasis on Hijras or transwomen and there was little importance on intersex, gender Queer and transmen. Accordingly, Ministry of Social Justice and Empowerment passed the revised Transgender Persons

(Protection of Rights) Rules, 2020.^{5,6}

Important Milestone of LGBTQIA+ Movement in India:⁷

1. During the British period homosexuality was considered unnatural and was declared a criminal offence under chapter 16, sec 377, IPC.
2. After independence, on 26th Nov' 1949, the right to equality was implemented under article 14 but homosexuality still remained a criminal offence.
3. The first known protest for gay rights was held in 1999 in Kolkata. It was named as Calcutta Rainbow Pride.
4. In 2009 a landmark Delhi High Court decision in the Naz Foundation V. Govt. of NCT of Delhi case held that treating consensual homosexual consummation between adults as a crime is a violation of fundamental rights protected **the** by Indian constitution.
5. In the Suresh Kumar Koushal and another V. Naz Foundation and other cases in 2013, the Supreme Court overturned the Delhi High Court Naz Foundation V. Govt. of NCT of Delhi case and reinstated section 377, IPC.
6. The then MP Sashi Tharoor introduced a bill to decriminalize homosexuality but it was rejected by the Lok Sabha.
7. In Aug 2017, the Supreme Court upheld the right to privacy as a fundamental right under the constitution in the landmark Puttuswamy judgment. This gave renewed hope to LGBT activists.
8. On 6th Sept 2018, the Supreme Court ruled that sec.377, IPC was unconstitutional and subsequently, it decriminalizes consensual homosexuality in adults.

Discussion:

The LGBTQIA+ acronym stands for Lesbian, Gay, Bisexual, Transgender, Queer, Intersex, and Asexual and others. In India, a specified social group of people known as Hijras is also included in the LGBTQIA+ community. They are culturally defined either as "neither men, nor women", or as men who behave like a woman. At present they are referred to as the "Third Gender".⁷

There are no official demographic figures for the LGBTQ population in India. However, approximately 2.5 million gays are there in India as per the report submitted by the government of India to the Supreme Court in 2012.¹⁰ As per a report on "LGBT+ Pride 2021 Global Survey" conducted between April 23 and May 7, 2021 published by Ipsos, a multinational research firm based in Paris, 3% of the Indian Population identified as homosexual (Including Gay and Lesbian), 9% identify as bisexual, 1% identify as pansexual and 2% identify as asexual. Totally, 17% identify as not heterosexual (excluding 'do not know', and 'prefer not to answer').¹¹ The actual number may be manifold than these figures because many of them will not come forward for fear of social discrimination.

On 6th Sept 2018, the five-judge bench partially struck down Sec.377, IPC decriminalizing same-sex relations between consenting adults. Now Indian law allows adult LGBTQIA+ individuals for consensual sexual intercourse,⁸ However, the

court has upheld provisions in Sec. 377, IPC that criminalize non-consensual acts or sexual acts performed on animals.

The four judgments cited fundamental right violations in reading down Sec.377, IPC. They observed that Sec.377, IPC discriminates against individuals on the basis of their sexual orientation, or gender identity. This violates articles 14 and 15 of the Indian Constitution. They pointed out that Sec.377, IPC also violates the rights to life, dignity, and autonomy of personal choice under Article 21 of the Indian Constitution. Further, they found that Sec.377, IPC inhibits an LGBTQIA+ individual's ability to fully realize their identity, by violating the right to freedom of expression under Article 19 (1) (a).⁸

In a survey conducted by Edelweiss Tokio Life Insurance in 2019, across 12 cities in India, revealed that 56% of Indians would refuse an organ from a homosexual person while 54% believe that LGBTQ persons should not be allowed to donate organs at all.¹²

Still, we are very far from being the land of 'Acceptance'. There is discrimination against a person due to their sexual or gender identity and orientation. This discrimination haunts them in employment, relationships, adoption choices, and general acceptance in society by and large. Our society is still full of Homophobia, Transphobia, and Biphobia. This leads to harassment, forced conversion, and sometimes killing.

A person's choice of partner should not be restricted because of his or her sexual orientation. It not only restricts their basic fundamental rights of equality and privacy but it also takes away their right to live with dignity enshrined within the right to life and liberty. In India persons not conforming to the socially accepted male or female genders are ostracized and rejected on the ground that they belonged to a third gender. It remains as taboo if we continue to disrespect and not treat them equally. It is high time that the regressive laws need to be abolished and shunned. It is better to embrace and practice progressive laws.¹³

Conclusion:

Sometimes people face violence, discrimination, torture, and even killed only because of how they look, who they are, and whom they love. Probably we forget that sexual orientation and gender identity are integral aspects of ourselves and this should never lead to abuse or social discrimination. It's high time that LGBTQIA+ should be freed from the shackles of orthodoxy for a better and equally developed society.

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REVIEW ARTICLE

The COVID-19 Pandemic and its Medicolegal Aspects in the Indian Context

Purohit P,¹ Ateriya A,² Setia P.³

Additional Professor,^{1,3} Assistant Professor.²

1,3. Department of Biochemistry, All India Institute of Medical Sciences, Jodhpur.

2. Department of Forensic Medicine and Toxicology, All India Institute of Medical Sciences, Gorakhpur.

Abstract:

Coronavirus disease (COVID-19) is an infectious viral disease caused by a novel coronavirus. The disease has crossed international boundaries and is affecting a large number of people. The present coronavirus outbreak started in China in December 2019 and rapidly spread to other countries. It has involved almost 205 countries around the world and has been declared a pandemic by WHO in March 2020. Human coronaviruses have different strains and these strains cause a severe degree of infection leading to higher mortality in the community.

In the time of the recent COVID-19 pandemic, the priority of every healthcare professional was to provide treatment to the affected and suspected person. With no vaccine and insufficient treatment in sight as of now, it is concluded that it is a combined duty of healthcare personnel and citizens across the globe, that correct measures of screening, quarantining, and social distancing are maintained. Healthcare professionals need to be aware of relevant medicolegal issues to avoid future litigations in the court of law. The governments can also work in tandem with the medico-legal experts for improving existing policies and drafting new ones wherever required, so as to be better prepared for any future pandemics.

Keywords: COVID-19; Novel coronavirus; Law; Quarantine; Infection.

Introduction:

Coronavirus disease (COVID-19) is an infectious viral disease caused by a newly discovered coronavirus. 2019-novel Coronavirus is officially called SARS-CoV-2 and is the cause of the recent pandemic.¹ A pandemic is defined by World Health Organisation (WHO) as “A worldwide spread of a new disease” i.e the disease has crossed international boundaries and is affecting a large number of people.² WHO declared COVID-19 as a “pandemic” on March 11, 2020. It has involved 205 countries having 53,02,66,292 confirmed COVID-19 cases till date (Table-1) as per the WHO datasheet.³

The coronaviruses were first identified in the 1960s. Currently, there are a total of 7 known strains. Human coronaviruses 229E, OC43, NL63, and HKU1 are the four commonly detected strains causing mild infection.¹ They are responsible for 15% of the common cold.⁴ Three other strains of coronavirus include severe acute respiratory syndrome coronavirus (SARS-CoV), Middle East respiratory syndrome coronavirus (MERS-CoV), and severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). These strains cause a severe degree of infection leading to higher mortality in the community.¹

Most people infected with COVID-19 virus experience mild to moderate respiratory problems and recover without any special

treatment. Children, older people with pre-existing cardiovascular, diabetes, respiratory diseases, etc are more prone to develop a life-threatening illness. The coronaviruses primarily spread through droplets of saliva or discharge from the nose upon coughing or sneezing by an infected person. At present, there are no specific treatments or vaccines available for COVID-19. Thus, preventive measures like regular hand washing or using alcohol-based sanitizer, not touching the face, and maintaining social distancing are very essential to reduce the spread of infection.^{1,5-8} In the time of the COVID-19 pandemic, the priority of every healthcare professional is to provide treatment to the affected and suspected person. But, they must be aware of important medicolegal issues that can be encountered while dealing with such patients, so that any future litigation can be avoided in a court of law. Various legal and medical issues applicable to the present COVID-19 pandemic are discussed here.

Review:

Laws in India Applicable to COVID-19 pandemic

1. Indian Penal Code (IPC), 1860: Section 188, 269, and 270 IPC specifically deal with the spread of infectious disease. Any person disobeying any regulation or order made under The Epidemic Diseases Act, 1897 shall be punished with imprisonment of either description for a term which may extend to six months, or with a fine which may extend to one thousand rupees, under section 188 of the Indian Penal Code. Section 269 IPC deals with negligent acts likely to spread infection or disease dangerous to life, and punishment for the section is imprisonment extended to six months with or without a fine. Section 270 IPC goes one step ahead of the previous one stating malignant act likely to spread infection or disease dangerous to life and attracts

Corresponding Author

Dr. Navneet Ateriya

Email : dr.navneet06@gmail.com

Mobile No. : +91-9971629313

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punishment as imprisonment extended to two years with or without fine. States had also imposed the charge of an attempt to murder under section 307 of IPC against a person belonging to a specific community/group for deliberately hiding the information about attending the religious events and violating curfew in the state.^{9,10}

2. The Indian Telegraph Act, 1885: The government is also using the power given by this act during coronavirus outbreaks. department of Telecommunication has developed an application called COVID-19 Quarantine Alert System (CQAS). The government is using the provision of the India telegraph act to get information from telecom companies at regular intervals to track the quarantined person. This will act as “geo-fencing” for such a person. If any such person violates quarantine or isolation, e-mails and SMS alerts will be sent to the government agency. The location of that person will be shared based on a person's mobile phone signals identified by the nearest telecom tower. The government will collect this data only for tracking and monitoring coronavirus-affected persons. The mobile numbers of all such persons will be deleted from the list after the quarantine period is over. Violation of any provision of this act would attract appropriate punishment.^{11,12}

3. The Epidemic Diseases Act, 1897: This 1897 law was enacted to tackle the epidemic of bubonic plague in the then Bombay state. It gives special powers to the local authorities to take necessary action to control epidemics. It states that “When at any time the state government is satisfied that the state or any part thereof is visited by, or threatened with, an outbreak of any dangerous epidemic disease, the state government, if it thinks that the ordinary provisions of the law for the time being in force are insufficient for the purpose, may take, or require or empower any person to take, such measures and, by public notice, prescribe such temporary regulations to be observed by the public or by any person or class of persons as it shall deem necessary to prevent the outbreak of such disease or the spread thereof, and may determine in what manner and by whom any expenses incurred (including compensation if any) shall be defrayed.” This act also confers the provision of inspection of a person in different premises.¹³

4. The Live Stock Importation Act, 1898: Livestock has led to economic development across the world. But, this also resulted in various diseases transmitted to humans due to proximity. The central government has the power to regulate, restrict or prohibit the import of any livestock which are likely to be affected by any infectious or contagious disorders. The central government has the power to detention, inspection, disinfection, or destruction of imported livestock or their product (meat and meat products of all kinds) which may affect human health.¹⁴

5. The Indian Ports Act, 1908: This act helps to prevent the

danger of introduction and spread of infections through the vessels entering the country. The government has the necessary power for inspection, and detention of vessels and/or on-board passengers as well as the crew. It is the liability of the master of the ship as well as the other crew members and onboard passengers to provide necessary information regarding the infection to the government agency. The suspected person can also be sent to the hospital for further check-ups. In the case of suspected infectious contamination, cleansing and disinfection of the ship can also be done.¹⁵

6. The Drugs and Cosmetics Act, 1940: It deals with the import, manufacture, sale, and distribution of drugs in the country. In case of emergency, there are certain relaxations in the provisions to ensure the availability of drugs. For example, the toxicological and clinical data requirements of any drug can be deferred if the intended drug is to be used to treat life-threatening diseases. In these cases, the medical officer of the hospital (also certified by the medical superintendent) may import such drugs making sure this drug is approved in the country of origin and will be used solely for the treatment.¹⁶

7. The Aircraft (Public health) Rules, 1954: According to these rules, the aircraft may be refused to enter if it's coming from an infected area or if any of the onboard passengers is infected or suspicious. The medical officer at the airport can examine the passenger and/or crew members medically upon arrival in India. Based on the examination and history of infectious contact, the passengers can be put in isolation or quarantine. Originally these rules were meant to quarantine the affected/suspected person of yellow fever, plague, cholera, smallpox, typhus, and relapsing fever. But, these rules are equally applicable in the current pandemic and are being used by the government.¹⁷ In the prevailing crisis of COVID19, the government of India imposed a complete grounding of all International as well as domestic flights for a period of 21 days in order to quarantine and control the spread of this deadly disease.

8. The Essential Services Maintenance Act (ESMA), 1968: This act came into effect to provide for the maintenance of certain essential services and the normal life of the community. Any type of service which is required to maintain public utility, and public safety and are necessary for the life of the community are to be declared an essential service under this act. These services also include health and medical services. Cessation of work by a body of persons employed in any essential service is prohibited under this law. If any activity compromises essential services, the government may evoke ESMA to maintain the normal life of the community. The police have given the power to arrest any person without a warrant if he is suspected of having committed any offense under this Act.¹⁸

9. International Health Regulations (IHR), 1969: The World Health Assembly adopted a revision of the 1969 International Health Regulations in May 2005. The 1969 version had focused on three diseases (cholera, plague, and yellow fever) only. The IHR 2005 has broadened its scope by including existing, new and re-emerging diseases in the community. The IHR (2005) also includes provisions regarding designated points of contact, disease control measures such as quarantine and border controls,

Table 1. Current situation of confirmed cases of COVID-19 globally.³

WHO Region	Confirmed cases
Europe	22,16,99,970
Americas	15,83,05,571
Western Pacific	6,12,57,605
South-East Asia	5,81,85,955
Eastern Mediterranean	2,17,97,169
Africa	90,19,258

and others. It was accepted by WHO and the member states, that they will work together to prevent the spread of the infection across the countries. India is also a signatory to WHO's International Health Regulations 2005. As per IHR 2005, it is mandatory to have dedicated health units present at all international airports. The health units should have capacities for undertaking routine public health measures (24X7) and at the times of Public Health Emergencies of International Concern (PHEICs) like H1N1, Zika, etc.¹⁹⁻²⁰

10. The National Security Act, 1980: The doctors and the police across the country are doing their duty to treat and prevent the transmission of novel coronavirus. There have been incidents in the various states in which doctors and policemen were attacked by people. The home ministry has taken cognizance of incidents of such attacks and directed the authorities to take stringent action under national security act.¹⁰ According to this act "The central government or the state government may if satisfied with respect to any person that with a view to preventing him from acting in any manner prejudicial to the security of the state or from acting in any manner prejudicial to the maintenance of public order or from acting in any manner prejudicial to the maintenance of supplies and services essential to the community it is necessary so to do, make an order directing that such person be detained." If any person fails without sufficient cause to surrender himself he shall be punishable with imprisonment for a term which may extend to two years, or with a fine, or with both as per the said act.²¹

11. Management of biological disaster guidelines (National Disaster Management Act 2005): These guidelines were prepared with a focus on prevention, mitigation, preparedness, medical response, and relief in cases of biological disaster management including bioterrorism. More emphasis was given to preventive approaches such as immunization on one hand and developing medical facilities to reduce the number of deaths during biological disasters whether accidental or intentional on the other. This act gives power to the government to restrict or quarantine the affected person. The importance of social distancing in disease control is highlighted in the act. A competent central office has been established under the ministry of health & family welfare, government of India, to transmit relevant information regarding the pandemic to various agencies as well as to the general public.²²

12. Declaration of Public Health Emergency of International Concern, 2009: On April 25, 2009, WHO declared that the influenza A (H1N1) virus outbreak constituted a "Public Health Emergency of International Concern" under the IHR (2005). PHEICs are the extraordinary events that require a coordinated international response against the diseases having a risk of global spread.¹⁹ COVID-19 management has proven to be a global public health issue in developed as well as developing countries and thus it is covered under the aegis of this law and the Indian government has taken a lead internationally by forming a task force of the SAARC (South Asian Association for Regional Cooperation) nations for a coordinate effort to overcome this menacing pandemic.

13. Public Health (Prevention, Control, and Management of Epidemics, Bio-terrorism, and Disasters) Bill, 2017: The Epidemic Diseases Act, of 1897 is almost a century old and needs modification to deal with various challenges. For this, the central government of India drafted the Public Health (Prevention, Control, and Management of Epidemics, Bio-terrorism, and Disasters) Bill, 2017. Apart from the provisions of the previous act, it includes a provision on bioterrorism which involve various biological agents such as viruses, bacteria, or toxin released in the environment. This act has also defined social distancing as a "public health practice designed to limit the spread of infection by ensuring sufficient physical distance between individuals" as a measure of disease control. The current crisis of COVID-19 is being managed by social distancing in many countries and this has been effective in containing the infection and not letting it spread in the community. It is due to this mode of infection control that the trajectory of COVID-19 in South Korea, Singapore, or India for positive cases is much flatter as compared to the United States or Italy, or Spain, where there has been a huge surge in positive cases owing to the lack of social distancing.²³

Liabilities of healthcare professionals: When pandemics occur, it is the responsibility of healthcare professionals to provide medical services. It is also very common for volunteer health professionals to go-to hot spot areas of infection and renders their services to the affected population. Whatever may be the case, they have certain civil liabilities towards the patients such as:

1. Duty of care: COVID-19 is a pandemic, which is spreading rapidly from human to human. Healthcare workers are at great risk while dealing with such patients. Once the doctor-patient relationship is established, it is the responsibility of the doctor to provide due care and treatment. Healthcare professionals should clearly define their roles and responsibilities in such pandemics.

2. Privacy and confidentiality: The right to privacy has been an integral part of medical ethics. The International Code of Medical Ethics mandates that health practitioners must maintain confidentiality regarding the personal information of the patient they encounter during the treatment. But, in certain situations like the pandemics, where the ultimate target is the beneficence of the society, the information of the patients can be divulged to the government officials when necessary. However, it must be remembered that the information can be divulged only to the concerned government official and not to any other person or on social media.

3. Autonomy of the patient: During the usual course of treatment, the autonomy of the patient has to be maintained at all times. However, during pandemics like the current one; the government has the power to restrict the autonomy of the patient in an attempt to prevent the spread of infection.

4. Product liability: It is the liability of manufacturers for any harm caused to the patient by supplying a defective product. Thus, it means the duty of care is owed by the manufacturer responsible for the maintenance of the products used in the treatment of the patient.

5. Medical claim reimbursement: Currently, health insurance coverage to the healthcare professional and their dependents are

given by the employer hospital. This insurance covers all types of ailments including COVID 19. The general public is also availing of health insurance coverage from private insurers, but they cover only certain types of illnesses. Presently private medical insurance companies are also giving provisions for reimbursement for the COVID-19 affected person.

Civil rights of the person affected by pandemics: Infectious diseases, such as the current COVID-19 pandemic, may raise various civil rights issues. The important one is to what extent the liberty of the person can be withheld to ensure goodness for society as a whole? Article 14 of the Constitution of India reads: "The state shall not deny to any person equality before the law or the equal protection of the laws within the territory of India". The law provides for the protection of individual rights in the country, but these rights need to be balanced for the sake of the community. In specific situations, like the present one; classical health measures eg. Isolation, quarantine, and contact tracing are crucial to prevent the spread of infectious/contagious diseases. Article 15 secures the citizens from every sort of discrimination by the state, on the grounds of religion, race, caste, sex, or place of birth or any of them.²⁴

Therefore, in the modern era, it is very important to keep a balance between individual rights and the beneficence of society. Isolation and quarantine may also cause a wrongful discharge of the person from their duties. A person cannot be terminated simply because he was absent from his duty due to isolation and quarantine. The law should not allow the termination of such an employee because isolation of the person was necessary for the public welfare.

Conclusion:

COVID-19 is a pandemic that has affected the health and economy of almost all the countries worldwide, including India. With no vaccine and no appropriate treatment in sight as of now, it is concluded that it is a combined duty of healthcare personnel and citizens across the globe, that correct measures of screening, quarantining, and social distancing are maintained. The governments can work in tandem with the medico-legal experts for improving existing policies and drafting new ones wherever required, so as to be better prepared for any future pandemics. It is important to maintain individual rights e.g. autonomy, privacy, confidentiality, etc. Attention to the needs of all populations regardless of their legal status has to be ensured by the appropriate authorities. Apart from this, surveillance and contact tracing of the affected and/or quarantine population, development of the central policy with public involvement to deal with such pandemics, and maintaining transparency regarding the use of the identity of the person are vital issues to deal in such situations.

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REVIEW ARTICLE

Current Practices of Sample Packaging, Sealing, Storage and Drying Techniques in a Medico-legal Case

Vidua RK,¹ Abraham SO,² Arora A,³ Yadav J,⁴ Bhargava DC.⁵

Additional Professor,¹ Junior Research Fellow,² Professor & Head,³ Professor,⁴ Senior Resident.⁵

1-4. Department of Forensic Medicine & Toxicology, All India Institute of Medical Sciences, Bhopal (AIIMS Bhopal)

5. Department of Forensic Medicine & Toxicology, All India Institute of Medical Sciences, Jodhpur (AIIMS Jodhpur)

Abstract:

Evidence is the basis of a medicolegal case. Forensic Pathologists collect biological evidence in cases of unnatural, violent, or unexpected deaths. The collection and preservation of biological evidence is one of the most crucial components of any forensic investigation. Even the slightest change or tampering can change the fate of a case. It can make a major impact in seeking justice and adhering to applicable laws. Although it may seem intuitive to place evidence in a bag or container for storage but it's critical to utilise specific evidence collection bags and containers for specific categories of evidence to preserve its integrity and efficacy in lab testing procedures. Proper evidence submission includes proper collection, drying, packaging, sealing and transportation etc. This paper aims to review all types of methods presently used to dry, pack, seal and preserve the integrity of biological evidences and recommend the necessary changes that should be made to make the process rapid and the biological evidences as tamper-proof.

Keywords: Biological evidence, Drying techniques, Tamper-proof packaging, Sealing, Preservation.

Introduction:

A Forensic autopsy is a postmortem investigation performed to resolve medico-legal concerns. All unnatural deaths (homicides, suicides, and accidents etc), suspicious deaths, and unexpected deaths require a legal inquiry, which involves an autopsy as part of the evidence gathering procedure.¹ The samples collected during such autopsies are mostly arterial or venous, femoral and cardiac blood, urine, vitreous humour, stomach content, and organs (particularly the liver and lungs, always after dissection) and various other types of samples (e.g., blood clots, blood from the thoracic or abdominal cavities, cerebrospinal fluid, brain, spleen, bile, bone, synovial fluid, bone marrow, maggots, skeletal muscle) are collected in specific cases. These all samples are then submitted to respective Toxicology, Histopathology or Forensic Science laboratories for further examinations.^{2,3} A proper analysis requires appropriate sample submission and as opposed to it, improper sample submission can jeopardize the procedure and leads to inaccurate results.⁴ Proper evidence submission includes proper collection, drying, packaging, sealing and transportation. This study provides a global overview of sample collection, drying, packaging, sealing and transportation processes.

Biological evidence: Evidence is the basis of a medicolegal case. Forensic Pathologists collect biological evidence in cases of unnatural, violent, or unexpected deaths.⁵ Biological evidence is a blanket term that encompasses anything that contains a

biological component or evidence that contains biological material.⁶ Depending on the scenario, different types of biological samples such as blood, urine, vitreous humour, stomach content, hair, nail, oral fluid, gastric content and viscera, etc. are collected as evidence, packed and sent for analysis.⁷ Likewise, evidences such as ligature, cloth with seminal or bloodstains recovered from cases of homicide, suicide or sexual abuse are packed and handed over to police personnel.⁶ All these types of evidence would require a different collection method and accordingly the type of packaging material.

Traditional methods of collection, packaging and sealing of biological evidence: Although every mortuary and lab have its own protocols for gathering, packaging, and sealing biological evidence but there is no uniform process followed across mortuaries and labs. The samples are collected in either glass or plastic containers with screw caps.^{8,2} These containers are packed using gauze or cloth and sealed with lac material which is heated over a flame and dropped over the gauze, following which a metallic impression of the sample collecting centre is placed. (Fig.1) Sometimes, this process is not smoothly followed, resulting in improper sealing and exposing the handlers to the risk of burn injuries and other health hazards.

The samples are kept unattended until they are handed over to the police. If samples like cloth or ligature soaked in blood, semen or water from drowning are received, they require air drying before packaging to avoid contamination. Even wet bloodstains on small objects should be dried, and objects should be preserved as it is. In case of larger objects, wet bloodstains should be transferred onto a clean cotton cloth which should be dried and packed. During packaging and transportation, it should also be dried to preserve the integrity of any bloodstain pattern.⁹ However, this process is quite time-consuming. Due to lack of time, such samples are

Corresponding Author

Dr. Raghvendra Kumar Vidua

Email : raghvendra.fmt@aiimsbhopal.edu.in

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packed in plastic bags or paper envelopes before completely drying and handed over to the concerned authority. This creates a favorable environment for the microorganisms to flourish and destroy the biological evidences.

Transport and storage of evidence: Once evidence is collected in a paper bag or container, it should be sealed, labelled, and transported to ensure a proper chain of custody. While transportation and storage, evidence should be kept in a dry place and at room temperature as it could get destroyed and incompetent for further analysis. If the evidence is designed for DNA analysis, it should never be stored in plastic bags as it will retain moisture and destroy the evidence. All wet blood and body-fluid stained items should be air-dried and not subjected to any heat. All stained items, except for metal or glass (e.g., knives or bottles), post drying can be frozen if stored for a longer duration.

During transportation, it is advised to take samples in air-conditioned vehicles. Care should be taken that evidence collected from the suspect and victim are stored and transported separately or in separate packages to avoid cross-contamination.⁹ But presently in most of the centres, attention is not paid on these aspect either due to ignorance or lack of resources so there are high chances of reduction in quality of evidence with time. Further the police transports the samples in most of the cases after a gap of keeping them in their storage rooms and that too in public transport in non-air conditioned vehicles so further the quality of samples is further degraded with chances of cross contamination by handling, storing and transporting samples from multiple cases together.

Importance of proper drying, packaging and sealing of evidence : In demonstrating the victim's case and the accused's innocence, medico-legal evidence of substantial quality is fundamental. Proper collection, drying, tamperproof packaging, sealing, and preservation of evidence significantly impact the quality of the evidence. All specimens of body fluids and tissues collected during autopsy are susceptible to contamination and degradation because of environmental conditions and microbial growth.^{10,11} Therefore, when these samples are sent for biochemical and toxicological analysis, tamperproof packaging guarantees that damage/pilferage is avoided, the chain of custody is maintained and useful information is obtained through the analysis.

Drying of Biological evidence: Biological evidence can be submitted in two different physical states: wet and dry. Evidence such as blood samples and viscera must be submitted in liquid form, mostly collected from a mortuary, crime laboratory or medical facility. While other wet evidence, such as a bloodsoaked garment, should be dried so that it can be properly stored and tested in the future. Drying these wet samples should be the first thing done by the one handling them. There are two types of methods currently being utilized by a few countries for drying such wet samples- Low-Tech and High-Tech methods.

Low tech drying methods: Evidence is dried in a secure and secluded location, such as a room or locker. This area should have surfaces that allow easy decontamination, such as tiles. Stainless steel rods should be present for hanging the articles with traces of

biological evidence over it (Fig: 2). It is not recommended that the space allocated for drying biological evidence be exposed to direct sunlight. Furthermore, the temperature and humidity should be kept as consistent as possible, with temperature variations limited between 15.5 °C and 24 °C (60 °F and 75 °F) and relative humidity not exceeding 60%.¹² However at present mostly the labs and mortuary even don't have such a dedicated area for drying and the samples may be either lying in any corner of the mortuary or lab under ceiling fan for drying or packed without drying therefore making it susceptible for attack by microorganisms. Low tech procedures are used by organisations that do not have adequate funding or prerequisite for equipment specifically developed for drying evidence

High-tech drying methods: Commercially available high-tech evidence dryers are already manufactured in countries like the United States and the United Kingdom.¹³⁻¹⁵ These cabinets use high-efficiency particulate air (HEPA) filter through which air is circulated, and any air-borne particles are drawn out through the filter. This also has a locking mechanism on the door handle that prohibits unauthorised access, thus preserving the evidence integrity (Fig: 3).

Sample/Evidence Containers (packaging): As evidence travels between locations for forensic examinations, it is packaged to safeguard it from the start of the inquiry. Some agencies use primary and secondary layers of protection for packaging recovered biological evidence. Primary packing protects the evidence, whereas secondary packaging preserves its continuity and integrity. Two considerations must be addressed when determining which packaging material is ideal for a specific type of biological evidence: degradation and contamination.¹¹ Although biological evidence collected from the mortuary is brought to a laboratory, immediate testing is unlikely.¹⁶ Thus, packaging must be suitable for transit and storage. Deterioration and contamination may occur if improper packaging and sealing are employed during the preservation period.

It's critical that the sample container is suitable for the intended purpose and not jeopardize the analytical results. Unless the manufacturer indicates otherwise, use only new, distilled-water rinsed, and sterile containers. Samples need separate container and plastic, especially polypropylene, doesn't break when frozen. Volatile samples (such as solvent abuse or anaesthetic gas intoxication) should be collected as soon as feasible in glass containers sealed with Teflon® or aluminium foil-lined lids to reduce diffusion losses.⁷ The size of the container should also be such that it is appropriate for the volume and weight of the sample leaving the least possible head-space.¹⁷ Although plastic containers are routinely used to store samples, glass containers are the best materials for collecting and storing fluids or tissue specimens as glass is inert and does not contain plasticisers like phthalates found in some plastics, which could interfere with the analysis.^{5,2,8} The only drawback with glass is that it is prone to breakage; thus, storing and transporting them in proper storage racks is recommended.¹ If plastic is to be used, it is recommended to use Nalgene, an inert plastic that lowers the chances of chemical interference and doesn't break on freezing.¹⁸ Many commercially available containers are composed of



Figure 1(A-E). Method of packaging and sealing of biological evidence in a mortuary.



Figure 3. High-tech drying method. (Source: The Biological Evidence Handbook: Best Practices for Evidence Handlers).



Figure 2. Low-tech drying method. (Source: The Biological Evidence Handbook: Best Practices for Evidence Handlers).

polycarbonate, polyethene, or polypropylene with extremely low quantities of plasticisers appropriate for collecting tissue specimens.¹⁹ To prevent samples from being tampered with, self-adhesive tamper-resistant stickers should be placed on container lids.¹⁷ However at most of the places at present, the attention is not being paid on this aspect so either plastic or glass containers, locally available in the market are being used for the purpose. **Sealing of biological evidence:** The package or container should be sealed so that opening it results in noticeable damage or alteration to the container or its seal.⁶ There are three common ways to seal any evidence heat seal, tape seal and lock seal. Lac sealing wax stick (Fig.4A) is the most commonly used heat seal method for sealing evidence.²⁰ Some laboratories, and even at the crime scene, heat sealers are used to seal plastic evidence bags. (Fig.4B) They are handy and can seal plastic bags and tubes in no time. Another most commonly used material for sealing is evidence security tape (Fig.4C). They are tamper-evident acetate tapes that tear if tried to remove physically, and if tampered with

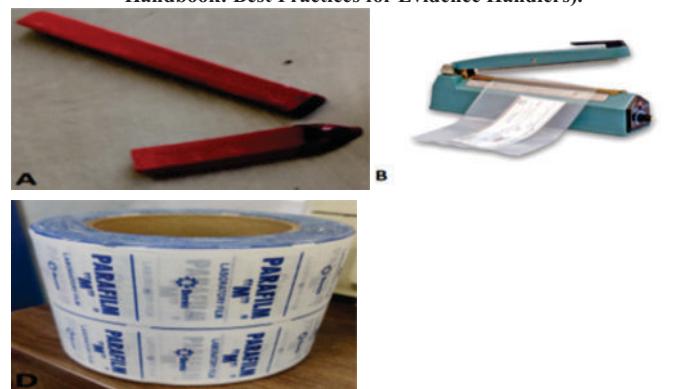


Figure 4 (A-D). Different types of evidence sealing materials.

using any chemical, the solvent sensitive dye dissolve and smears.²¹ Parafilm is another tape seal material used for sealing screw top containers with evidence (Fig.4D).²²

Standard operating procedures being followed to avoid the risk of contamination: When identifying, collecting, and preserving evidence, especially for DNA analysis, increased care for contamination issues is required. The following steps are being followed variedly and nonuniformly while handling any evidence or biological sample:⁹

- Wear gloves, use disposable/clean instruments, avoid coughing, talking or sneezing around biological evidence or stains.
- Avoid touching face, nose, and mouth.
- Avoid touching the place where DNA might be present.
- Allowing evidence to air dry completely before packaging.
- Not placing evidence in plastic bags and not using staples.
- Handle each stain independently.
- Use tweezers with smooth, easy-to-clean operating surfaces
- Separately packaging the "unstained control" from the evidence stain.
- Container- big enough for air to circulate the evidence item.
- Place the clean paper on (or in) bloodstained clothing and fold it such that the paper restricts contact between different

stains. Ensure that the staining pattern(s) are not altered or cross-contaminated with other wet stains while the objects are drying.

- Attaching a metal or glass evidence item to the bottom of the box with wire so that it doesn't pierce the edges of the box/container.
- Metal or glass evidence items with bloodstain or body fluids is not frozen.
- Samples submitted to the lab as soon as feasible.
- Tape seal, initial and date all samples

Discussion:

Until now, forensic expert testimony has helped the court in many cases. Medical evidence is vital in determining a person's time of death, cause of death, nature of injuries, the weapon used to inflict injuries, assailant's handedness, etc. Postmortem reports and autopsies can help determining the accused's guilt.²³ To maintain integrity, all evidence must be identified, inventoried, and secured from the mortuary to the trial. It's crucial to prove that the evidence presented in court is the same evidence gathered at the crime scene/mortuary and that access was regulated and documented. To ensure court admissibility, an investigator must observe chain-of-custody standards. Evidence preservation needs drying, tamper-proof packaging and sealing, safe storage, and transportation. The majority of "laboratory errors," according to laboratory medicine, come from the preanalytical phase (i.e., collection, packaging, sealing, storage and transport), not from difficulties with the analytical process.^{24,25} Jansch^{5,26} observed in 1922 that in cases of suspected poisoning, the use of improper containers and long-distance transit led to inaccurate findings. Also, there are no current best practice standards and guidelines to help forensic experts and pathologists. In response to an upsurge in evidence tampering cases in Himachal Pradesh, India, the High Court determined that the current standard of gathering, packing, and sealing is exceedingly low and that a tamperproof, scientific alternative to cloth packaging and wax sealing is needed.²⁷

Moreover, several underlying factors influence law enforcement's ability to properly store evidence for optimum preservation, which includes limitations in the storage facility's management and capacity, insufficient packaging materials, inadequate or improper temporary storage, technological changes, and the intervals between evidence collection and transport to the evidence storage unit.²⁸ The ethical, legal and policy aspects of bio-specimen collection is also quite complex and even more than the technical matters.²⁹ A quality management system is also an essential element in managing biological evidences and key to this system is strict adherence to standard operating procedures which should guide through every step of biological evidence preservation.³⁰

Conclusion:

Numerous procedures are available, and new approaches are being developed to improve the examination of biological evidences. However, no such universal standard protocols exist

in the way these samples should be packed, sealed, and stored in mortuaries and laboratories, which could significantly impact the testing quality and such practices vary from place to place for collection of evidences. Therefore, it is critical to standardize the drying, packaging and sealing techniques and materials used to maintain the integrity of the samples at every step from the moment it is collected through its final disposition. The demands of adequate storage space and staff personnel should be prioritized by authorities and some research initiatives on this aspect. It must also be ensured that institutions have adequate resources and the acceptable methods and procedures are being followed to ensure that biological evidence is suitable for future analysis. Until the samples are handed over to the concerned parties or police, there should be dedicated sample storage cabinets with limited access, effective sample's dryers, suitable containers and packaging materials in every mortuary and laboratory to safely store all biological evidences collected from medico-legal cases in a tamperproof manner to ensure sanctity and acceptability at the time of submission in the court of law.

Conflict of Interest: nil

Ethical approval: As this study is a part of extramural research project entitled "Developing a tamperproof sample packaging and sealing kit with an effective sample's dryer technique and a handy device to seal the samples in a medicolegal case "under Indian Council of Medical Research (ICMR), New Delhi there for the ethical approval was taken from Institutional Ethical committee of All India Institute of Medical Sciences Bhopal (AIIMS Bhopal) India(IHEC LOP/2020/ EF0180 dated 21/05/2020).

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REVIEW ARTICLE

Virtual Autopsy and Digitalization of Medico-legal Records: A Need in Covid Era

Dutta A,¹ Saini V.²

1,2. Department of Forensic Science, Faculty of Science, SGT University, Gurgaon.

Abstract:

Post-mortems are done as a tool in proceedings of medico-legal cases. Autopsy exposes the forensic medical practitioners to body cavities, underlying organs and biological fluids that may be major sources of contamination, especially during the pandemic era. Since death tolls have been higher during these times, to prevent spread of viral infections, post-mortem services had been completely halted. Virtual autopsy examinations were then considered by Forensic Medical experts throughout the world during the Covid outbreak and stands as an important future tool in the post-covid era too. Also, documents pertaining to medico-legal examination needs to be handled with integrity and ethics, which prompts its digitalization. This paper aims to study the risks encountered by forensic medical practitioners while conducting death investigations, techniques of virtual autopsy, its legal admissibility, online portals for maintaining reports, their current scenario and future prospects.

Keywords: Virtopsy; SARS-Covid 2019; Medico-legal reports; Digitalization.

Introduction:

During the early months of 2020, a new form of pneumonia called COVID-19 caused by the novel coronavirus SARS-CoV-2 had broken out throughout the world. India has noted millions of cases till February 2022. The death toll also has been high during the initial outbreak followed by its different variants. The World Health Organization had declared COVID-19 to be a pandemic due to its high rate of infection. Health-care personnel, who were seen as the most precious resources in such difficult moments, were extremely vulnerable to infection. In this situation, hospital management must assure that the health and interests of health-care personnel and patients are not jeopardized along with continuous maintenance of health-care services. The same can be said for competent death management and medico-legal services. However, an increase in the number of deaths, combined with a lack of experience, infrastructure, and protective equipment, will inevitably affect Forensic medical practitioners while conducting autopsies. Evidence suggested that the Covid pandemic also contributed significantly in delayed medical care of affected persons and increased suicides, drugs and alcohol associated deaths.¹ During the onset of COVID-19 the rate of Covid infected un-natural death had increased significantly and due to the lack of awareness while dealing with virus infected bodies, the Forensic medical practitioners were in a difficult situation. At first the autopsy staff doesn't know the accurate health condition and travel history of the deceased. Further, a few infected people are asymptomatic, so their examination is also doubtful. Studies have shown the survival of this virus at lower temperatures; thus, chances of contamination were higher during cryopreservation.

Corresponding Author

Dr. Vineeta Saini (Assistant Professor)

Email : vineetasaini2012@gmail.com, vineeta_fpssc@sgtuniversity.org

Mobile No. : +91 9971790222; 9971793868

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During autopsy, the mortuary staff and doctors are subjected to infected body tissues, fluids, and aerosols from the bodies of SARS-CoV-2 infected diseased which is a HG-3 pathogen and causes serious threat of infection.² The Indian medical system's guideline regarding autopsy of infected deceased states that death of a person due to COVID-19 in the hospital under medical treatment would not be considered as a medico-legal case, hence autopsy would not be required. But, brought dead cases suspected to be COVID-19 positive, to the hospital has to be essentially treated as a medico-legal case as it may be suicidal, homicidal or accidental. In such cases a medicolegal autopsy is required.³ An RTI revealed that in 57% reported unnatural deaths, autopsy was not conducted during March-August 2020 in Nagpur (Maharashtra).⁴ Almost the same situation was faced in all other states of India during 2020 and 2021 and may be again faced in near future due to recent outbreak of Monkey virus.

The Italian National Institute of Health and other health institutions worldwide have advocated the limitation of body dissections in ascertained and particularly in suspected SARS-COV-2 cases to limit the risk for the operators. The high number of bodies to examine and the high risk for operators are the reasons why there is a reduction in the rates of autopsies on SARS-COV-2 infected subjects.⁵ With the ever-changing viral strains, and emergence of a new variants termed as Deltacron, which is found to be rare and similar to the Omicron strain, Monkey Pox etc. there is an increased need of virtual autopsy using minimal intervention without compromising the accuracy of diagnosis.

All aspect of modern medicine is now heavily reliant on technology. Health organizations in India have digitised medical data to save money, improve security, and, most crucially, improve access to information. Despite the fact that most branches of modern medicine have absorbed technological advancements, most departments of forensic medicine appear to be trailing behind. Many medicolegal reports, such as autopsy reports, wound certificates, age estimation reports, opinions

regarding rape or assault, requests to forward the samples to the Forensic Science Laboratory, summons to experts and witnesses for deposing evidence in courts, requisitions from police, and so on, are still written by hands and photocopies of the same are commonly submitted in a court of law. Poor writing or photocopies might make it difficult to comprehend reports, resulting in interpretation errors.⁶

Virtual autopsy: Current Scenario

The word "VIRTOPSY" was designed from two words "virtual" which was further derived from the Latin word "Virtus" meaning 'useful, efficient and good' and "autopsy" derived from the Greek word "autos-opsomei" meaning 'self-I will see'. It is a development in the field of modern Forensic Medicine, where imaging technologies and computed tomography is being used to obtain a three-dimensional view of the deceased using techniques like PM-MSCT, MRI, Radiography and so on. Virtual autopsy is defined as a non-invasive tool for conducting autopsies by sophisticated imaging technologies that can give high resolution visuals. Research also shows that virtual autopsies can depict fractures, mechanical injuries, grievousness of injury and can be used as admissible evidence in the court of law.⁷ Radiological examinations using X-rays have always been a significant visualization as well as diagnostic tool in medicine. But it was never much considered for examination of dead bodies. However radiological examination of the dead could replace conventional post mortem examinations only if it could suitably answer the cause of death, time since death sequence, nature and type of injury specifically whether it is anti-mortem injury or a post-mortem one.

Conventional radiology is accurate and non-intervening but still is able to give only two-dimensional images. Therefore, more sensitive imaging technologies have been found effective in virtual autopsies. In a first such case of sudden Covid-19 death using virtual autopsy in Indian setting a 29-year-old male was found unconscious, bleeding in his engineering hostel, and was declared dead when brought to the hospital, virtual autopsy was conducted using whole-body non-contrast PMCT.⁸ Post Mortem Multi Slice Computed Tomography is a non-intervening examination tool that has an X-ray tube and detectors placed in continuation to obtain an image of higher clarity. The images are obtained at different angles to obtain a cross-sectional view of the dead body, such that virtual images in the form of "slices" can be visualized. PM-MCT is also used for examination of the body kept within a body bag or inside a coffin. However, there are factors that affect the quality of image like radiation, motion artifacts, but still there are certain adjustments that can be made by the user. These include acquisition adjustments to be done prior to scan and reconstruction adjustments to be done post scan while studying the slice stacks. Magnetic Resonance Imaging works on the principle of combining an externally applied magnetic field and computer-generated radio waves to obtain detailed images of underlying organs and tissues within a cadaver.⁹ Once the dead body is placed within the MRI unit, the water molecules in the body are realigned by the externally applied magnetic field. The computer-generated radio waves help to generate weak signals that give a cross-sectional view of

the dead body. MRI can provide high quality visuals of soft tissue injuries and pathologies with more appropriation as compared to Computed Tomography (CT).¹⁰

Photogrammetry is defined as a method of deducing measurements from photographs and works on the principle of triangulation. It has been widely used in recording crime scenes as well as examination of dead bodies. It can generate three dimensional models of an object either in the digital format like measurement, surface and areas or in the graphical format like sketches and maps. This technique uses overlapping photos taken from varying angles which gives a three-dimensional textured appearance.¹⁰

In cases of mass fatalities and burnt cases during the pandemic, medicolegal autopsies had to be conducted as a part of the investigation procedure. Virtual autopsy had given defined results over traditional autopsies in the examination of the head and neck region especially where the dental cavity is blocked in cases of bodies in rigor mortis condition. It also serves as an indispensable tool in determining dental age for personal identification.¹¹ Virtual Autopsies not just help in examining injuries and underlying organs but also act as a diagnostic tool for evolution of medicine. A biopsy is mainly performed to extract sample cells and tissues to study their pathology and extent of any disease. Therefore, combining biopsy procedures with a non-invasive technique like post mortem guided computed tomography is subject to excellent results. Research also shows that CT guided minimally invasive needle biopsy can be conducted for collection of fluid or tissue samples for their histological examinations.¹² Post-mortem CT-guided angiography is a developmental field of Forensic Radiology for vascular imaging and soft tissue examination. It is a minimal invasive procedure unlike conventional autopsy. It includes a CT scan with an injection of a special dye that allows contrast between backgrounds for visualization of the blood vessels and the tissues.¹³

Digitalization of medico legal reports: With the growing need of technology in every sector, Forensic Medicine departments are also incorporating the use of online portals or specialized apps for storing, receiving and forwarding of all documents related to different crime scenes. Appreciable works on digitalization of medico-legal examination of sexual assault victims have been done in few African countries by Mishori and associates.¹⁴ Some Indian states like Tamil Nadu, Haryana, Madhya Pradesh have started the process of digitalization of medico-legal reports to maintain authenticity of documents. An effort has been made to provide the copy of the post-mortem (PM) report to the deceased's family member.⁶ Also, for crimes against humanity like sexual violence, abuse and assault more enhanced techniques of documentation are required to maintain confidentiality of sensitive information. This has led to the development of a specialized mobile app named Medi-Capt for ensuring proper implementation of medical, ethical and legal practices while handling documentation of victims of sexual violence. However, it is still in the processing stage and will be launched soon especially focussing in the low resource areas and regions of conflict.¹⁴

Discussion:

Since the onset of COVID-19, medico-legal examination of the dead has been a difficult task. Therefore, techniques like the above-mentioned ones have been introduced to reduce chances of contamination. Virtual autopsy is a proposed method that has been adopted by a few countries for conducting autopsies and giving practical sessions to medical students. Research shows that virtual autopsies can generate near accurate results as compared to conventional autopsies. It also looks into the aspect of dignified management of the dead. Especially in the covid era where the rate of infections in both symptomatic and asymptomatic conditions may persist, it is better to have virtual examinations rather than interventional methods. Radiological examinations can give images of bones, dental remains as well as in burnt, charred and decomposed bodies that may be COVID infected as well. It can also be used to study bullet fragments and skeletal trauma without dissection, thereby reducing chances of infection amongst the forensic practitioners. Post Mortem-Multi Slice Computed Tomography also gives a cross-sectional view of the body which is an indispensable tool in cases of road traffic accidents. A study also shows virtual autopsies in cases of infectious death, are important for public health management and accumulated virtual autopsy data is important for studying different pathological mechanisms and diagnosing COVID-19 among the deceased.¹⁵ In research, virtual autopsy is important for visualization of areas like spine, limbs and pelvis region that cannot be examined in conventional autopsy. In a recent advancement of virtual autopsy, Nuclear Magnetic Resonance has also given satisfactory results while studying the metabolomic profile of the tissues.¹⁶ Apart from these factors, reproducibility of results, reducing chances of infection, cross-contamination and also improving psychological and social notions regarding examination of the dead are distinct advantages of virtual autopsy over traditional autopsy.¹⁷ Currently, there are very few organizations who have completely switched to virtual autopsy. Most medical institutions have incorporated virtual autopsy for student demonstration or may be to compare the results generated with those of traditional autopsy. The All-India Institute of Medical Sciences (AIIMS) New Delhi, has taken up the initiative to introduce virtual autopsy measures in collaboration with the Indian Council of Medical Research (ICMR) for conducting forensic examinations in the COVID era as well as in the future.¹⁸

Along with these, there are certain limitations to virtual autopsy as well. It is unable to provide information about the status of contamination, surface texture and colour changes of the dead body. Also, presence of odour and appearance of the body are important parts of physical examination which are absent in case of virtual autopsies.¹⁷ It is also not very cost efficient, and requires thoroughly skilled technicians for handling body positioning and the imaging tools.

Digitalization of Medico-legal records is a step forward as it helps to sustain integrity of reports and also prevent manipulation. It also prevents any ambiguity that may arise while interpreting handwritten documents. Overall, it helps to ensure proper chain of custody throughout the investigation. In spite of having

several benefits, digitalization of the entire forensic network comprising police, medical experts, forensic experts and legal team, will require a lot of training, development and skilled individuals to handle such servers. Also, any default with the internet can lead to delay in processing of requests and sometimes sensitive information can be hacked also. It is also not a very cost-effective measure that can be implemented immediately.

Conclusion:

Post-mortem examinations have often been looked down as an unethical task. Many religions do not allow such examinations. Overall bringing a very prejudiced point of view for forensic medical examinations. With the onset of COVID-19 conducting such examinations became even more difficult due to its high rate of contamination. Also, subjecting trained forensic medicine practitioners to such health risks would be highly unacceptable. All these reasons prompted the use of alternative imaging techniques that would not require the medical professional to be in physical contact with the dead body. It also served as a tool for dignified management of the dead. As technology becomes more interwoven into all aspects of health care, the digitization of medicolegal services and forensics in our country is becoming extremely relevant. Though digitalization has certain drawbacks, these are surpassed by the benefits. By boosting accountability and efficiency of services given, digitalization will usher in a new age in the field of medicolegal practice in India.

For digitalization of the entire medico-legal process, an online portal should be launched throughout the country, and its access should be given to the specialized task forces within each state. Such task forces should be trained and skilled to effectively handle uploading of all documents, check entries and edits made to them, maintain their integrity and dispatch of documents till it reaches the court of law for the trials. This paper has given a review on the challenges to which the post-mortem examiners were susceptible during the pandemic, existing and developing imaging techniques and diagnostic tools. Also, the feasibility of virtual autopsy and digitalization of medico-legal records has been critically reviewed along with its scope during COVID and its future prospects.

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REVIEW ARTICLE

Importance of Diversity in Dental Pattern for Personal Identification: A Review

Mamta,¹ Mondal PR.²Ph.D. Scholar,¹ Professor.²

1-2. Department of Anthropology, University of Delhi, Delhi.

Abstract:

Forensic Odontology is a branch of forensic science that has the proficiency to establish a person's identity. The combination of virgin restored, unrestored, missing, filling, impacted, endodontic treatment, and decayed used as dental codes assigned to the specific tooth that encompass the unique dental pattern to determine person identification in single or mass fatality cases. The aim is to assess the accuracy of the diversity of dental patterns using radiographs and non-radiograph dental records and also to generate responsiveness among dentists about their role in human identification and the significance of sustaining complete accurate dental records. The published articles mostly exhibited a high diversity of dental patterns observed for full dentition ranging from 88.8% - 99.92%, for maxilla, 59%- 98.8%, and for mandible 82.00% -92.8% established by the various author depending on the population size. The frequency of virgin teeth was relatively found high in the young as compared to adults (6.67% - 54.90%), the filling of the tooth (7.00% - 11.45%), a crown (1.10%), and impacted third molar (5.33%) that can also be used as the discriminating criterion of education level, socio-economic status of the person. The conclusion demonstrates that the diversity of dental patterns may be a very substantial and valuable tool in human identification not solely in the occurrence of whole teeth, but also in the occurrence of only the maxillary and mandibular teeth records. The excellence, number, and presence or absence of dental treatment can be considered on the person's socioeconomic status and education level.

Keywords: Forensic odontology; Forensic dentistry; Dental patterns diversity; Dental records, Personal identification.

Introduction:

According to Keiser-Neilson (1970) "Forensic Odontology is that branch of dentistry which deals with the proper handling and examination of dental evidence and the proper evaluation and presentation of dental findings in the interest of justice."¹ In the current situation, Forensic Odontology has emerged as an integral part of a large international forensic education organization like the American Academy of Forensic Sciences (AAFS) and the International Association of Identification (IAI) with an aim is to identify the unidentified person(s) based on the individual characteristics of teeth, which is based on the principle that "neither two mouths nor teeth are identical" and mainly involves the comparison of an ante-mortem dental record for identification.² Identification of a person has become an elementary feature of human relationships, on moral, social, and legal grounds. It permits people to assist their rights and have their duties demanded from every civil and legal viewpoint. The principal attributes used for human identification in Forensic are Fingerprints, DNA, and Dentition.³

The most precise technique for human identification is fingerprinting, however, it is restricted to cases like disfigured, highly decomposed, severely burnt, or highly fragmented bodies in single or mass fatality cases. Simultaneously, DNA is the most specific human identification technique but entails extensive

setup and time.⁴

Teeth constitute a suitable strong box with unique morphological and characteristic features where other shreds of evidence lack, to be the hardest, strongest calcified, and well-protected structure in the human body that can withstand decomposition at high temperature⁵ with a hardness value of 270- 350 knoop hardness number for enamel and dentine. Hence, teeth are likely to be a line of evidence that usually turns out to be the most consistent comparative instrument.^{6,7}

Human dentition consists of incisors, canine, bicuspid, and molar teeth that differ in shape, size, interspace, and their arrangement in the mouth completely different among individual and possesses distinctive characteristics referred to as "tooth" class characteristics that set up the idea of identification, at the same time different characteristics like filling, missing, impaction, crowding, any dental pathology, etc., makes the dental pattern unique in each person that aid in the identification of missing person identity.^{8,9} On the other hand, oral jewelry has also been considered as an anthropological characteristic of identification to extract information of socio-economic eminence, religion, sex, and ethnicity.^{10,11} and are highly satisfactory and approved by the dentists and could aid in Forensic Dental identification.¹²

The comparative recognition is predicated on comparing antemortem and post-mortem dental records that involve dental charts, radiographs, clinical photographs, treatment notes, and study cast dental prostheses.¹³ Thus, maintaining ante-mortem dental records must be at minimal costs practical, and easily retrievable when required.¹⁴

The dental pattern is illustrated as "the combination of distinct codes designated; to specific tooth conditions namely virgin,

Corresponding Author**Dr. Prakash Ranjan Mondal**

Email : prmondal1@rediffmail.com

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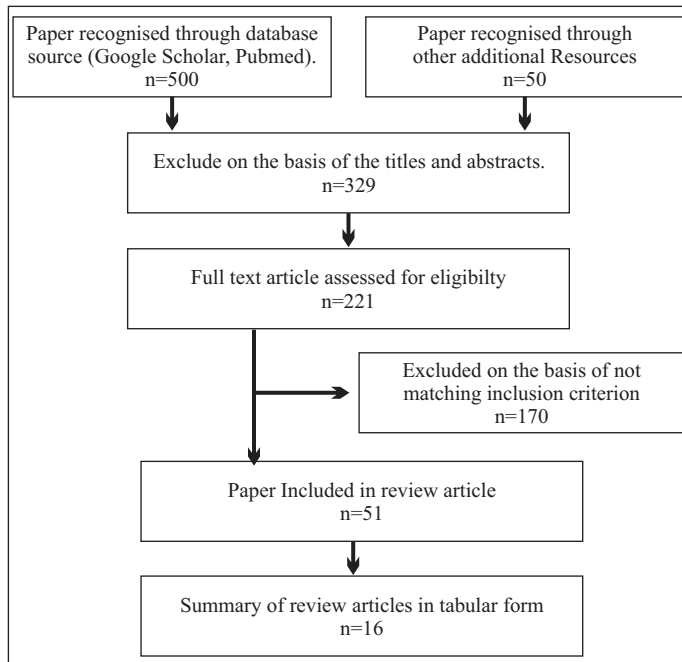


Figure 1. Selection strategy.

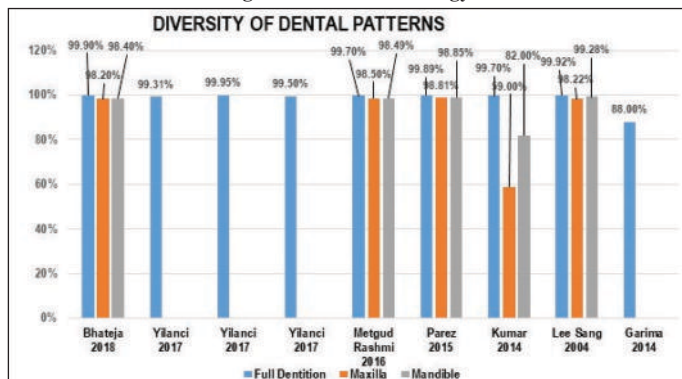


Figure 2. Diversity of dental patterns.

missing, filling and restored teeth on entire dentition, or groups of teeth.”¹⁵ The outcome of the observation is noted and charted in a non-radiographic configuration pattern as ante-mortem dental records.^{7,16}

The radiographs dispenses a great help in matching ante-mortem dental features and post-mortem dental features, as its outline, the complete perspective of the jaws and teeth, and other features in a single image.¹⁷ Excellent radiographs (film or digital) are advantageous for illuminating 'unrevealed dental details' along with tooth-color restorations that are easily undetected during post-mortem examination and disclose any fresh or longstanding trauma that could lead from identification from pins, wires, and plates that have been used by the dentist during treatment if they have manufacture's number or codes.¹⁸

“A dental record is a legal document that contains all subjective and objective information about the patient and is in the dentist's possession.”¹⁹ including written notes in the form of the patient's chief complaint, medical history, any drug allergy, clinical examination, diagnosis, dental charts (missing, filled, decayed,

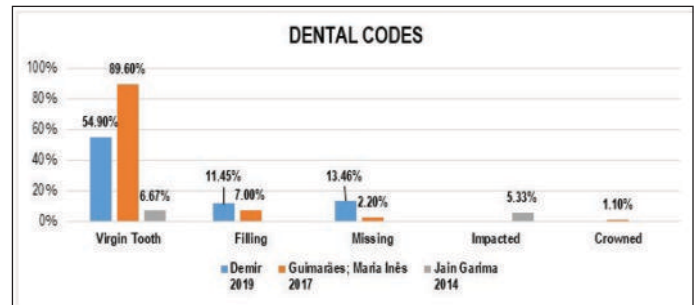


Figure 3. Dental codes.

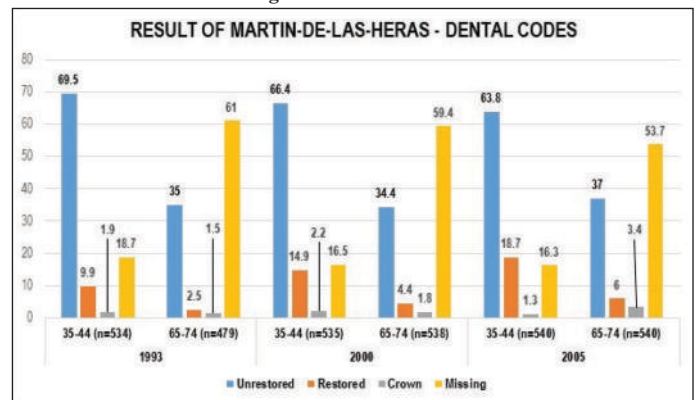


Figure 4. Result of martin-de-las-heras- dental codes.

Table 1: Inclusion and exclusion criteria.

Characteristic	Inclusion criteria	Exclusion criteria
Population	Any country aged > 18 years, Permanent tooth (major evaluation), deciduous tooth	Edentulous
Intervention	Studies with Good quality Radiograph complete and accurate radiographic and Non-Radiographic Dental Records, Records of edentulous and partially edentulous teeth showing a dental pattern	Cleft Lip/ Palate, complete edentulous, any other studies which defy inclusion criteria
Comparison	Studies on University, Population of same Country	Studies that defy inclusion criteria
Result	High dental pattern diversity perceived	Studies that report any dental anomalies and any other methods
Methodologica l study	Pilot Study, Cross-sectional, retrospective study, Longitudinal studies, Survey	Qualitative

root stump, impaction), the treatment planned, and subsequent follow-up, radiographs, clinical photographs, study models, referral notes or specialist reports, laboratory prescription, any other bits of information. It should be noted down more precisely and accurately, as any inaccuracy, inadequate records, fraudulency, poor quality of radiographs, and different charting classifications with different terms may leave the record pointless.²⁰

Materials and methods:

Study protocol: The search approach balances suggestions for high vulnerability versus viability and was directed by the literature concerning the search in the review as well as the outline of the review.

Table 2. Tabular summarisation of various studies.

Year	Author	Country	Population size	Parameters	Result
2020, January	Guimaraes et al.	Portuguese military population	1636 Dental data Portuguese Armed Forces	Data collection using Forensic Dental Symbols and Dental Encoder, Microsoft Excel, and SPSSV.23	The highest frequency observed was “unrestored” and less missing and high in the younger group <32 years. Although the statistical results are inconclusive it allows individual classification based on age.
2019, August	Demir et al.	Ankara University, Turkey	Randomly Selected 503 Nos. OPG	Codes set were V, M, C, DI, FC, E, SC, A, I, P, D, R, BL, U, DM, FR. Permanent teeth (major evaluation criteria), and deciduous teeth were considered.	Virgin tooth (54.9%), Missing (13.46%), and Filling (11.45%) were perceived. Virgin Tooth is more commonly found in the young age group (62.96%), No FR, low or primary educated with 50.62%, and highly educated people with 57.90% seen. Middle-age (40.17), and missing most commonly seen in 35.66% and Virgin with 30.51%
2018, August	Gorza et al.	Three Private Clinics,	12 Nos. OPG Showing complete Shedding, Permanent and Unrestored Teeth. Patients were selected as simulated PM radiographs, 24 more OPG with Mixed Dentition.	The Time-lapse between the AM and PM was between 3 and 18 years. The age of the individual of the AM radiograph ranged between 8 and 13 years. The selected radiograph was photographed by using a Nikon D90 Camera. A web-based survey done on Google form	The Accuracy of the methodology was 75.4%, the Sensitivity was 53.5% and the Specificity was 86.4%.
2018, April	Bhateja, et al.	D Y Patil Hospital, Pimpri Pune	Randomly Selected 300 Nos. OPG (male = 150, female+ 150)	The tooth was coded as V, X, I, D, R, T, F, P*, S. Population was categorized into six age groups years (20-29), (30-39) 40-49), (50-59), (60-69). And 70 years above.	The diversity of Dental Patterns observed for Full Dentition was 99.9%, Maxilla 98.2%, and Mandible 98.4%. Comparison between Maxilla and Mandible was observed highly significant.
2018, July - Sept.	Guimaraes et al.	Spanish & Portuguese Military personal	5136 Nos. Dental Records of Spanish and Portuguese Military Personnel	Dental Data were documented using Forensic Dental symbols for Dental Encoder	The frequency of unrestored first molar was lowest, with the highest frequency of unrestored teeth (>90%) in upper, lower anterior, and lower premolar teeth. The highest frequency of missing teeth for the third molar was also found (28%).
2017, February	Guimaraes et al.	Portuguese	595 Nos. Dental Records sample of the military population of 10 years after treatment. Analyzed 19040 teeth.	Information is collected through Forensic Dental Symbols into the Dental Encoder. It includes 33 Representative Dental Associations of five continents' feedback, as an extension of Spanish study.	The Unrestored (89.6%), Restored (7.0%), Missing (2.2%) and Crowned (1.1%).
2017, March	Yilanci et al.	Hacettepe University	Randomly Selected 250 Nos. OPG, 169 Nos. Radiographs were used for analysis aged between 15 to 84 years	V, M, D, R, F, C, B, P**, T, I, A, and others were given Dental Codes to the tooth.	The diversity of dental patterns for full dentition was 99.31%, 99.95%, and 99.5% Overall Intra and inter-observer agreements were 97.48% and 94.48%.
2016, May	Metgud et al.	Pacific Dental College & Hospital, Udaipur	Randomly Selected 300 Nos. OPG	V, R, M, I code given to tooth. Only Permanent Teeth, Dentulous, and Partially Dentulous teeth were included.	The diversity of dental patterns recorded for Full Dentition was 99.7%, Maxilla was 99.5% and Mandible was 99.49%.
2015, September	Deitos et al.	Brazilian adolescent	Clinical Data of 16,833 subjects in 2003 and 5,367 in 2010 representative sample of 15 -19 years as per WHO Parameters	H, D, F, M, and P were given Dental Codes to Tooth. Non- Erupted teeth, deciduous teeth, Teeth with Sealant or trauma not incorporated	The national and regional conditional diversity values preconceived for Complete and Partial dentition were 0.911 – 0.997, P > 0.005 are alike to the diversity patterns values of mitochondrial DNA.
2015, December	Perez	Lima, Peru, Peruvian Citizens	900 Nos. OPG, Retrospective study between 2013-2015	V, M, I, D, R, T, F, P. The diversity was calculated by Simpson's Diversity Index	The Diversity Reported in Full Dentition was 99.8%, in Maxilla 99.81%, and in Mandible 99.85%.
2014, February	Kumar et al.	AIIMS, New Delhi	Randomly Selected 300 Nos. OPG	V, R, M, and I were given codes to tooth and Data Analysed by using Statistical Package for Social Science (SPSS) version software.	The diversity of reported for Full Dentition was 99.7%, in Maxilla was 59.0% and in Mandible was 82.0%
2014, December	Jain et al.	AB Shetty MIDS, Mangalore, Karnataka	Randomly Selected 150 Nos. OPG	Win ID coding system consists of primary and secondary codes. (Table-3-4)	The Unique Dental Pattern observed was 88%. The most common pattern observed was Intact teeth (6.67%), Impacted or Missing Third Molar Teeth 5.33%. Maximum Variability was seen Maxilla > Mandible
2011, April	Biazevic et al.	Brazil	35,613 Nos. Individuals Records from the Brazilian National Oral Health	Data from the last 3 contemporary Spanish National Oral Health Survey years 1993, 2000, and 2005 age groups: 15-19, 35-44, and 65-85; D, M, P, I were given Codes to the tooth.	The Prevalence of healthy teeth is found more in young than adults. (Young > Adult)
2009, February	Martinde-Llas-Heras et al.	Spain	Data from 3166 Nos. Adult	Data extracted from the last 3 contemporary Spanish National oral Health Survey years 1993, 2000, and 2005.	Total diversity values were low and Heterogonous. Conditional Diversity (0.99) was obtained.

2007, June	Al et al.	School of Dental Science, University of Melbourne Australia	An Open disaster was simulated. 52 Nos. Fragmented Remains made of acrylic replicas 77 Nos. provisional victims, Mandibles (26), Maxillae(6), Skulls(17), Jaw Fragments (3). were exemplified	Compare Dental Characteristics on DAVID and WINID3 system and manual.	Manual matching of dental characteristics performed better than both programs (p<0.001) yielding 29 identification. Eleven and Six positive matches were found on DAVID and WINID3 programmes respectively. (p=0.185).
2004, July	Lee	Dental Hospital Yonsei	Randomly Selected 300 Nos. OPG	The tooth was code V X, I, D, R, T, F, P*. The permanent tooth was considered.	The Diversity of Dental Patterns observed for Full Dentition was 99.92%, and for Mandible was 99.28% higher than maxilla which was 98.22%.

Table 3. Categorization of dental codes.

Code	Name	Characteristics
V/H	Virgin/Higid	No evidence of caries, dental treatments, or any abnormality.
X, M	Missing	Congenital missing of a tooth or extracted tooth.
C, D	Caries and Defect	Defect, Decay cavity, tooth fracture or fallen out fillings
F	Filling	Any kind of restoration filled in the tooth cavity
T, E	Root canal/ Endodontic treatment	Root canal filled tooth by endodontic treatment
I	Impacted	Unerrupted or impacted tooth.
P	Pontic of fixed prosthesis	Parts of fixed dental prosthesis on teeth that supported Pontic
P*	Prosthesis	Tooth with Crown
S	Supernumerary tooth	Presence of Supernumerary tooth
FC	Dental filling with Caries	Filling and cavity together
SC	Single Crown	A restored tooth with a single unit crown
A	Abutment of Fixed Dental Prosthesis	Part of dental prosthesis on teeth that supported Pontics
D*	Deciduous Tooth	Presence of baby teeth in any dental arch for adults.
R	Residual Root	Presence of remained root tissue in the bone.
BL	Alveolar Bone	Loss of bone and connective tissue attachment to the root of the root of the tooth.
U	Unrestored Prepared Tooth	Prepared tooth without a crown
DM	Dental Mutilation	Dental modification, trimming or piercing.
FR	Fractured Root	Presence of fractured line at the Root.
B	Pontic	Bridge Pontic.
P**	Implant	Dental Implant
A	Dental Anomaly	Persistent Deciduous tooth with or without its permanent tooth is coded as a dental anomaly with the use of only one code.

Search strategy: The review was executed by adapting a manual search strategy on a Google scholar, PubMed–Medline search for the last 21 years (from 2000 to 2021) by using the key term: Forensic dentistry, Forensic odontology dental pattern diversity, dental records, and dental radiographs. The selection of studies was based on revising the titles and abstract to recognize the related publications from which the full text was subsequently attained.

Eligibility criteria: The selection of studies was based on revising the titles and abstract to recognize the related publications from which the full text was subsequently attained. The final inclusion supported inclusion and exclusion eligibility criteria outlined by the authors within the English language as given in Table 1.

Results:

Literature search and screening: The review paper for analysis

included database sources n= 500 and other additional sources n= 50. The established search series scrutinized n=221 studies. n=51 were preferable for inclusion after viewing the title/abstract and full text and removing duplicate articles (Figure 1)

Data extraction: Tabular summaries are tailored to the characteristics of the incorporated review to capture information relevant to our purpose. An overview of these studies encompassing year, author, country population size, parameter details, and study outcomes (Table 2) with categorization of dental codes (Table 3) Win ID Coding system; Primary Codes (Table 4), and Secondary Codes (Table 5).

Findings : Figure 2 illustrates the proportion of diversity of dental patterns established by various studies in several different countries. The high and significant diversity of dental patterns full mouth, maxilla, and mandible was observed that encourage an advantage in the process of Forensic identification of a person(s). Bhatija et al. (2018) observed dental diversity in 300 populations of Pune were 99.9%, 98.2%, 98.4% in full dentition, maxilla, and mandible from a panoramic radiograph.³ Yilanci et al. (2017) evaluated that dental diversity in 169 populations at Hacettepe University for full dentition was 99.31%, 99.95%, 99.95% when 4 and 6 base parameters and all 11 dental parameters were used on OPG.²² Metgud et al. (2016) evaluated dental pattern diversity in the population of 300 at Udaipur were 99.70% (full dentition), 98.50% (maxilla), and 98.49% (mandible)⁴ Perez et al. (2015) evaluated the diversity of dental patterns in 900 Peruvian populations 99.89 % (full dentition), 99.81% (maxilla), and 99.85% (mandible).²³ Kumar et al. (2014) evaluated the diversity of dental patterns in 300 Delhi, AIIMS population were 99.7% (full maxilla), 59.0% (maxilla), and 82.00% (mandible)²⁴ Lee et al.(2004) evaluated 300 populations at Yonsei University were 99.92% (full dentition), 98.22% (maxilla), 99.28% (mandible).²⁵ Jain et al. (2014) evaluated the diversity of dental patterns at mangalore in 300 populations was 88.8% unique.¹⁴ Gorza et al. (2018) observed the accuracy diversity of dental patterns was 75.4%, the sensitivity was 53.5%, and also the specificity was 86.4%.²⁶

Figure 3 illustrates the proportion of virgin, filled, missing, impacted, and crowned rely upon the oral condition of the mouth to establish the uniqueness of diversity of dental patterns and are often used as an ante mortem dental record for Forensic identification of a person(s). Demir et al. (2019) observed the frequency of teeth was virgin tooth with 54.98%, Filling with 11.45%, and missing with 13.46%. virgin tooth is more commonly found in the young age group (62.96%), no FR, low or primary educated with 50.62%, and highly educated people with

Win ID Coding system²¹ used as follows:

Table 4. Primary codes.

Code	Interpretation
M	“Mesial surface of the tooth is restored”
O	“Occlusal surface of the posterior tooth is restored”
D	“Distal Surface of the tooth is restored”
F	“Facial Surface of the tooth is restored”
L	“Lingual surface of the tooth”
I	“Inscial edge of the anterior tooth is restored”
U	“Tooth is unerupted”
V	“ Non-restored tooth”
X	“Tooth is missing-extracted”
J	“Tooth is missing post-mortem or the tooth's clinical crown is not present for examination. Also used for an avulsed tooth. The root or an open socket is present, but no other information is available”
/	“No information about tooth is available”

57.90% seen. middle-age with 40.17%. The most common dental diversity was missing Tooth seen in 35.66% and virgin tooth with 30.51 %.²⁷ Guimaraes et al. (2017) observed the unrestored (89.6%), Restored (7.0%), missing (2.2%), and crowned (1.1%).²⁸ Jain et al. (2014) observed the unique dental pattern observed was 88%. The most common pattern observed was intact teeth (6.67%), impacted or missing third molar teeth 5.33%. Maximum variability was seen in the maxilla than the mandible.¹⁴ Guimaraes et al. (2020) observed a very high frequency of unrestored and missing teeth in younger age group <32 than adult people. Although the outcome was statistically inconclusive, it acknowledges the individual classification based on age.²⁹ Deitos et al. (2015) observed clinical data of 16,833 subjects in 2003 and 5,367 in 2010 representative sample of 15 - 19 years as per WHO parameters in Brazil population conditional diversity value calculated for complete and partial dentition was 0.911 – 0.997 (p>0.005).³⁰

Figure 4 illustrates Martin-De-Las- Heras et al. (2009) categorized dental codes and dental patterns of six datasets according to the National Oral Health Survey for 1993, 2000, and 2005 year and comprised 2 adults age groups (35-44 years, 65-74 years) in 3166 Spanish population classified as unrestored, restored, crown, missing, edentulous, All unrestored, unique, and other Non-Unique patterns observed total and conditional diversity revealed total diversity was low and heterogeneous but conditional diversity was high and homogenous calculated. Once data were combined, the high diversity combined value was above 0.99 attained.³¹ Bizevic et al. (2011) observed the prevalence of healthy teeth is found more in young than adults in 35,613 numbers of Brazilian population records from National Oral Health (1993, 2000,2005, age group of 15-19,35-44, 65-85 years).³²

Al et al. (2007) simulated an open disaster and compared dental characteristics on DAVID & WINID3 system and manual. Manual matching of dental characteristics performed better in both programs (p<0.001).³³

Discussion:

The approach of differentiating living or deceased people from others is called identification which will become more essential in Forensic identification related to dubious deaths in single and

Table 5. Secondary codes.

Codes	Interpretation
A	“An anomaly is associated with this tooth. Specifies of the anomaly may be detailed in the comments section”
B	“ tooth is deciduous”
C	“Crown”
“Resin	filling material”
“ Gold	Restoration”
H	“Porcelain”
N	“Non-precious filling or crown material. Includes stainless steel”
P	“Pontic. The primary code must be X to indicate missing tooth”
R	“Root canal filled”
S	“ Silver amalgam”
“Denture	tooth. Primary code must be x to indicate missing tooth”
Z	“Temporary filling material. Also indicates gross caries (used sparingly)”

mass fatality instances for social, religious, humanitarian, ethical, and legal instances.^{34,35,17}

This review represents the contribution of dental identification and its significance in personal identification in single or mass fatality cases. Dental identification is a simple and powerful approach to recognizing people, established by reviewing ante-mortem and post-mortem records to categorize matching features for comparison.³⁶

Forensic dentistry plays a significant role in the identification of these individuals when all other means of identification fail. The distinctive nature of our dental structure and also the settlement of custom restorations confirm accuracy when techniques are appropriately employed. Dental identification takes two forms. First, comparative identification is employed to determine the person's identity by the ante-mortem dental records of a person. Second, post mortem dental profiling is formed by the Forensic Dentist, when ante-mortem dental records don't seem to be available.³⁷ Forensic Dentistry involves the processing, review, evaluation, and presentation of dental evidence to contribute scientific and objective data to legal processes.³⁸

The basis of this review is on the information related to distinctive features of dental diversity and their frequency found in the society that have been collected from earlier studies that were conducted in different time periods by different authors. This study also emphasizes generating awareness among dentists of their role in the personal identification of dentists in India. Forensic dental research, in particular, relies upon the availability of dental records, and consequently, dental records confirm to be a valuable tool in such cases.³⁹

Dental records serve as a very beneficial implement in Forensic Odontology as they can exhibit important information like name, age, sex, missing tooth, intact tooth, filled and impacted tooth, treatment notes, dental pathology, and so forth of deceased people or victims, can be acquired during a routine dental examination.¹⁹ The study conducted on the maintenance of dental records by Sengupta et al. (2014) and observed that the preservation of dental records was done by 86% of dentists and 36% were afraid of misapplication of records when calling for identification of victims.⁴⁰ According to the study by Preethi et al. (2011), 79% of

dentists preserved dental records while 12 % only kept complete dental records.⁴¹ The poor quality of dental records exhibited by the insufficiency of data, improper and outdated dental information, and not following the guidelines can completely deter forensic identification.²⁰ Astekar et al. (2011) observed that merely 38% of the dentist were conscious of sustaining dental records and 62% of the dentists did not preserve any kind of dental records.⁴²

Adam (2003) stated that dental diversity was enough for Forensic identity even in absence of a dental radiograph. He compared only missing restored and unrestored teeth on a simple dental chart Adam reported on the diversity of adult dental patterns using empirical observations of large reference data sets and showed the diversity using non- radiograph dental comparisons on dental charts.⁴³ Dental charts may be subjective, but dental radiographs are more objective and show relatively fewer errors when compared by post-mortem investigators for positive identification. So there is a clear need for the diversity of dental patterns in panoramic radiographs.²⁵

Keiser-Neilson (1980) has ascertained 12 well-matched characteristics between AM and PM dental records to determine positive identification; though this cannot be a common valid statement.⁴⁴ However, Buchner (1985) expressed that only a solely one tooth or jaw fragment may well be enough to substantiate a positive identification.⁴⁵

Madi et al. (2013) established a study on 2000 multinational populations exhibiting 1031 distinctive dental situations for each comprising tooth. Virgin teeth were most frequently found and the first molar was determined as the most amount of missing, filling, or restoring with the Crown. The comparison of the diversity of dental patterns was prepared on the data of dental records that were important in Forensic identification.²⁰

Silva et al. (2016) inspected the role of the endodontic dental radiograph in Forensic Dentistry as evidence in criminal cases. In the first examined cases, the mandibular left premolar was detected as a root canal-treated tooth in AM radiograph of the victim that was later confirmed in the PM radiograph. In the second case, Root canal treatment was perceived in the mandibular left first molar through AM dental radiograph, confirmed when the comparison is done with PM dental radiograph. This outcome suggests that even a single dental situation is important in terms of Forensic investigation.⁴⁶

Ante-mortem dental radiographs along with intraoral or extra-oral radiographs are extensively used in view that they are easily available and transferrable because of the recent advantage of digital radiography, permitting data to be transferred. The occurrence of dental diversities is closely associated with dental health status and relies on age, oral hygiene awareness, education, economic status, and the variations within the dental caries levels among countries.²³

The frequency of high diversity of dental patterns indicates the ample power of personal identification not solely supported full dentition but conjointly once when molar and premolars are available. The diversity of anterior teeth had low diversity in

contrast to full dentition or molar and premolars due to the lack of complicated anatomical structures in anterior teeth and the self-cleaning consequence of saliva.²⁵

Guimaraes, et al. (2018) observed in 5136 Spanish and Portuguese military populations highest frequency of the highest frequency of unrestored teeth (>90%) in upper, lower anterior, and lower premolar teeth. The highest frequency of missing teeth for the third molar was also found (28%).²⁸

Several Coding systems can be used to record dental findings like the "CAPMI" system, "Win Id", "Plass data DVI International software", "dental encoder", etc.⁴⁷⁻⁴⁹ and software like "The Dentist," "Densoft Programme," can be used to sustain dental records from the internet. Under Article 51A (h) of the constitution of India, there is an ethical responsibility on the doctor, to maintain and preserve medical, medico-legal, and legal documents in the best interests of social and professional justice.⁵⁰ The durability of the teeth and their associated tissues to peri and post-mortem assaults dispense extensive information for those who are interested in human identification.⁵¹

Conclusion:

The conclusion of this review demonstrates that the diversity of dental patterns may be a very substantial and valuable tool in human identification not solely in the occurrence of whole teeth, but also in the occurrence of only the maxillary and mandibular teeth records. Related to dental charts, dental radiographs are more precise and show relatively less prone to error. The accomplishment of Forensic identification through dental evidence in large part relies upon the availability of accurate and complete ante-mortem dental records. It is the accountability of dentists to preserve dental legal documents in the interest of social professional justice.

It is concluded that dental patterns using dental radiographs will be of great use in the future of Forensic odontology. It would thus be a suggestion to conduct furthermore studies using extensive data and include different other parameters to check more accurate results for identification purposes.

It was concluded that:

1. Ante-mortem dental records can be used as the most reliable and effective tool in Forensic investigation for both single and mass fatality cases when recorded accurately.
2. Virgin tooth can be measured to distinguish between younger adults (high frequency) and elders (low frequency) in terms of age.
3. Restorative and prosthetic procedures can be used as the discriminating criterion of educational level as the frequency of restoration and dental treatment increases with the education level.
4. The excellence, number, and presence or absence of dental treatment can be considered to the socioeconomic status of the person.

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SHORT COMMUNICATION**Forensic Medicine Expert in Department of Emergency Medicine : The Need of Hour****Mangeshkar A,¹ Nema P,² Tomar MS,³ Nigam M.⁴**Associate Professor,¹ Assistant Professor,² Senior Resident,³ Professor & Head.⁴

1,3. Department of Forensic Medicine, GMC, Datia.

2. Department of Forensic Medicine, SAIMS, Indore.

4. Department of Forensic Medicine, ABV GMC, Vidisha.

Abstract:

Emergency medicine is a new branch introduced by NMC in the gazette notification dated 14th February 2022. In India, since we lack specialized postgraduates in emergency medicine, postgraduates in General Medicine, Anaesthesia, Respiratory Medicine, General Surgery and Orthopedics are made eligible to work as faculty in this department. This is a welcome step as the casualties coming to the hospital with natural pathologies will be dealt by specialized doctors after introduction of this department in a tertiary care centre. However, the medicolegal cases reaching to the hospital in the form of casualties or otherwise still have to be dealt with less professional and unspecialized hands. Incorrect, incomplete, or inappropriately followed protocols in handling and reporting a Medico-legal case often delay legal proceedings and thus deprive a patient of his rights. The significance of critical cases in emergency medical services cannot be undermined especially in a densely populated country like India, where everyone is living with stress and competing to strive for the basic needs of life. Doctors in the Emergency department have to diagnose and treat a high volume of patients and are also responsible for preparing reports for unnatural cases like accidents, attempted suicides and homicides. Thus, any act of omission or commission in patient care as well as in preparing proper medicolegal reports and documentation by a doctor advances negligence and health risks of critically ill patients which is against the criminal justice system and hence liable for the breach of duty. This warrants the inclusion of Forensic Medicine experts in the Emergency Medicine department.

Keywords: Emergency medicine; Forensic medicine; Toxicology; Medico-legal cases; National medical commission.**Introduction:**

Forensic Medicine is a branch of Medical Science which deals with the application of medical knowledge to aid in the administration of justice in the court of law¹. Forensic medicine being a multi-disciplinary branch inculcates in its practice the key principles of Forensic Pathology, Forensic Psychiatry, Forensic Dentistry, Forensic Radiology and Forensic Toxicology etc. Toxicology is the Science dealing with properties, action, symptoms, toxicity, lethal dose, estimation, laws, treatment, and autopsy findings (cases of death) in relation to poison. The Emergency Medicine department is the point of first and most crucial contact of the patient in times of crisis not just to safeguard life but also to protect the rights and privileges of the injured for which he needs to be assured of the best medical care and the legal proceedings thereafter.

Medicolegal cases are cases of injury, illness, or any ailments where the attending doctor after eliciting history and examining the patient, thinks that some investigation by law enforcement agencies is essential to establish and fix responsibility for the case in accordance with the law of the land. Simply put, MLC includes – a medical case with legal implications or a legal case requiring

medical expertise. The increasing incidences of violation of civil rights; and the increasing complexity of household, agricultural or industrial toxicology and fatalities related to such exposure require greater aptitude and more skillful and scientific application of the principles of Forensic Pathology² and Forensic Toxicology. Thus to ensure the demand that the patient expects from the team of doctors under whose care he has submitted his consent is not just to be cured of the unpleasant illness but also be compensated for the unfortunate loss, due to an unexpected event, which should be documented and reported in a manner most prudent to ensure timely and appropriate justice. To make Emergency Medicine Department more robust and professionally sound, there is need of a consultant from Forensic Medicine department who with his expertise in medicolegal documentation, examination, evidence collection etc. along with knowledge of emergency care can effectively fill in the current lacunae in Emergency Medicine and consequently help in the betterment of the quality of care.

Present scenario of Casualty/Emergency Department: Any case reaching to the Casualty or Emergency department is first handled by MBBS graduate doctors or PG residents as the case may be, and are referred to specialized doctors depending on the condition of the patient. However all the medicolegal reports of the cases like Injury report, sexual assault survivors or accused examination report, drunkenness report, weapon examination report, medical certification of cause of death etc. are still handled by unspecialized MBBS doctors, who are overburdened by the influx of patients without any specialized training in medicolegal

Corresponding Author**Dr. Manish Nigam**

Email : jurimanish@gmail.com

Mobile No. : +91 98262 13412

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field.

On the other hand, doctors in the Department of Forensic medicine are kept devoid of involvement in emergency services and casualty though they are especially trained in dealing with all above mentioned medicolegal work which includes, all types of medicolegal report writing as per state and central government guidelines, management general and specific and identification of poisoning cases in emergency situations, snake bites or other animal bites, household, agricultural or industrial toxicology dealt under the specialty called Toxicology which forms a major bulk of emergency medicine cases.

The current trend in NMC: The National Medical Commission has been toiling hard to design and repeatedly redesign the curriculum of various departments in the medical education system to cope up with the changing dynamics of the health care system. In keeping up with the globally accepted standards in health care delivery system the National Medical Commission has done tremendous work in bringing up the competency based medical education system (CBME) to produce Indian Medical Graduates who are in tune with the global standards. In one such attempt to keep pace with rising need of Emergency Medicine Physicians to provide the best care in need of crisis the commission vide Gazette Notification of the National Medical Commission (Postgraduate Medical Education Board) New Delhi dated 14th February, 2022 in teachers eligibility qualifications the commission has brought in a welcoming concept by inclusion of other branches like General Medicine, Anesthesia, Respiratory Medicine, General Surgery and Orthopedics to be a part of the Emergency Medicine team. However various reports have shown that the percentage of cases that report to the casualty department have a huge proportion with Medicolegal implications in which trauma and poisoning are the major ones. WHO estimated that death due to envenomation is around 100000 annually. Approximately half of these deaths were reported in India.³ Also over the past decade, poisoning has become an increasing cause for concern not only in India but globally.⁴ It is repeatedly reported that poisoning is one of the most common modes of suicide in countries like India.⁵

Forensic Medicine- skills and curriculum: Professionally speaking Forensic Medicine and Toxicology (is the name of the subject and postgraduate degree in the majority of universities), a broad term used to describe a medical speciality which deals with the examination and diagnosis of individuals who have been injured because of external or unnatural causes such as poisoning, assault, suicide and other forms of violence, and apply findings to law (i.e. court cases). Such cases also warrant court attendance, answering queries to police investigating authorities etc. Forensic Medicine has in its course curriculum, the court procedures and detailed understanding of other legal and statutory provisions. More than 25% of the UG and PG curriculum in FMT is covered by Toxicology whereas Toxicology covers a small portion of the General Medicine curriculum, and almost negligible in any other clinical subjects like Anaesthesia, General Surgery, Orthopaedics etc. whatever the reason, practically speaking neither any physician or surgeon

would like to practice Toxicology nor would they be interested in the legal hassle thereof.

Toxicology is developing as a separate specialty/super specialty and many authors have classified Toxicology into Clinical Toxicology and Forensic Toxicology, with the understanding that Clinical toxicology would deal with the diagnosis and treatment part while Forensic Toxicology deals with the application of medical knowledge of Toxicology, to aid in the administration of justice. Forensic Pathology deals with Postmortem examination and Histopathology. Every such poisoning case involves one or the other legal hassle, investigational queries, and expert opinions by Forensic experts. So, this means better knowledge of every aspect of toxicology including diagnosis and treatment gives better application in justice.

The need of a Forensic Medicine expert in Emergency Medicine: The need for inclusion of a Forensic Medicine experts in the TEQ of NMC is to build a robust Emergency Medicine team which will not just be providing the accurate and timely diagnosis and treatment, after medical care, but also to have an overall approach to systematic documentation of the legal formalities for timely resolution of the aftermaths of the legal framework which will ensure health and well-being of the patient and his family which would also reduce the pendency of the court cases as a result of inappropriate documentation. Some documented evidences that speak in itself about the need of the Forensic Medicine expert in the Emergency Medicine unit/casualty are quoted below to understand the gravity of the need which is yet to be addressed.

1. The Ministry of Health And Family Welfare document states that a specialist doctor in Emergency Medicine department/casualty should guide his subordinate staff in history taking and examination of Medicolegal cases.⁶ This is possible only when a trained specialist is posted in areas of concern to handle such cases. In our country currently majority of the casualties are handled by MBBS graduates who do not have the required knowledge of amicably handling issues of medicolegal concern.
2. The Ministry of Home Affairs vide its website has officially published the charter of duties of a Medical Officer which states that doctors posted in the Emergency Medicine department/ Casualty are expected to timely intimate all cases of death, cases of surgical fatality, medico legal complications, dangerously ill cases, etc. to the Medical Superintendent.⁷ Which is again a task entrusted upon the an individual who does not have sufficient knowledge in handling issues of Medicolegal concern.
3. The standard operating procedure for casualty and trauma care in medical college hospitals published by the Health & Family Welfare department Government of Odisha in the year 2017 states that in all medico-legal matters, where the CMO is in need of expert advice, the faculty on call from the department of Forensic Medicine should be contacted and proper guidance obtained, it also mentions that the Emergency Medicine team works in Liaison with courts & police in medico legal cases.⁸

4. The State of Karnataka has officially published the duties of a senior specialist/specialist/G.D.M.O in its standard operating procedure for casualty which states that these categories of doctors mainly work in the casualty and attend emergencies to give medical aid in medico-legal and accident cases. They maintain accident register in proper order to keep good information of cases, issue wound certificates and other medico-legal certificates, assist courts when summons are served to give evidences in accident and medico legal cases.⁹

From the manual issued by the Ministry of Health and Family welfare and various standard operating procedure for duties and functioning of the casualty departments issued by the individual states it is evident that handling of medicolegal issues is an important task of the Emergency Medicine/Casualty team. Emergency department physicians often encounter medico-legal cases when patients initially present to the hospital, and thus there is a strong need for them to have robust medico-legal management and reporting system.¹⁰ Safely preserving Forensic evidences is a common issue faced by Emergency department physicians who provide the first line of management however untrained and inexperienced Emergency department physicians may fail to recognize such cases.¹¹ As per government Order¹² all the medical officers dealing with medicolegal cases should be assured workshop by department of Forensic Medicine.

Conclusion:

Summing up the need of expertise in functioning of an efficient Emergency Medicine Team, inclusion of a Forensic Medicine expert would be an apt solution as a Forensic Medicine expert has an intensive training in dealing with day to day medicolegal issues of the Emergency Medicine department/Casualty. The syllabus of MD Forensic Medicine & Toxicology curriculum itself contain training on handling of all the emergencies including road traffic accidents/trauma, management of poisoning, insect bite and all other common medicolegal cases. Forensic Medicine Expert and Toxicologists specialize in the prevention, evaluation, monitoring, management and treatment of injury and illness from exposure to drugs and chemicals, as well as biological and radiological agents. In medical colleges & tertiary care centers Emergency Medicine department run short of doctors and face medicolegal issue round the clock for which and the doctors are not trained enough to handle such situations. The solution of all such problems is that there must be a dedicated clinical Forensic unit in the Emergency Medicine department. Hence there should be separate faculty recruited for Emergency Medicine department to deal all medicolegal issues so that society and the public can be benefited.

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Avinash Waghmode	Professor & Head	BKL Walwalkar Rural Medical College, Chiplun Ratnagiri
Anand B Mugadlimath	Forensic Specialist	ICRC, Regional Delegation for India, Nepal, Bhutan & Maldives New Delhi
Ashok Kumar Samanta	Director Professor & HOD	ESI-PGIMSR & ESIC MCH, Rajajinagar, Bengaluru
AJ Patowary	Professor & Head	North Eastern Indira Gandhi Regional Institute of Health & Medical Sciences, Shillong
Bajrang K. Singh	Associate Professor	MGM MC, Indore
Chandan Bandyopadhyay	Associate Professor	Medical College Kolkata Government of West Bangal
Dhirendra Singh Yadav	Senior Scientific Officer/ Scientist-B	CFSL Pune
Harshwardhan Khartade	Associate Professor	Shyam Shah Medical College, Rewa
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Pragnesh Parmar	Additional Professor	AIIMS, Bibinagar
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Rajiv Joshi	Professor & Head	GGs Medical College, Faridkot
Soumeek Chowdhuri	Assistant Professor	Calcutta National Medical College, Kolkata
Sundaragiri Suraj	Assistant Professor	Gandhi Medical College, Secunderabad, Telangana
Sailesh Parate	Associate Professor	AIIMS, Rishikesh
Vikas Meshram	Associate Professor	AIIMS, Jodhpur

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