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From Editor's Desk

Respected seniors and dear colleagues,

Wish you all a very happy cold festive season, waiting for colourful days to come!!

I am delighted at this moment because we could release two additional supplementary issues this year through which we published almost 50 additional articles, and hence could clear the long waiting, bringing many authors a sense of relief. 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.

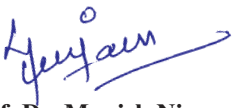
Probably this issue is the last one which was published independently by IAFM. Issue 3 and 4 of volume 46 (2024) will be published under SAGE international. This will entirely be a new beginning and a new experience for all of us, which we will surely relish, but shortcomings are bound to come, which our editorial team 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.

Dr. Siddhartha Das as Joint Editor; **Dr. Mandar Sane; Dr. Narendra Patel** as Associate editors; **Dr Vishal Seán Baveja** 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 46 issue 2 (suppl).

I honestly thank our reviewers, without whom we would not have come up with a quality issue as was desired. 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 all through.

Best wishes!

Sincerely



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EDITORIAL

Thanatochemistry and its application in forensic practice

Dr. Siddhartha Das

The practice of forensic medicine is evolving with time. It is moving from macroscopic autopsy room examination of the dead body to gradual involvement of various branches and ancillary investigative procedures which supplement or corroborate the autopsy findings. One such ancillary procedure is thanatochemistry or postmortem biochemistry. Thanatochemistry is the chemistry of death and the investigators involved in this, study the changes that undergoes in the chemical constitution of the human body after death. Coe defined forensic chemistry as one of the more important ancillary procedures for the forensic pathologist.[1]

Estimation of the postmortem interval (PMI) is one of the important primary objectives of a medicolegal autopsy. Easily observable autopsy features like rigor mortis and postmortem lividity are the practically employed methods for estimating the PMI. However, these postmortem changes are not very reliable in estimating an accurate PMI due to a wide variation in its onset and progression, which in turn is dependent on a variety of external and internal factors like environmental temperature, humidity, body condition, age etc. Biochemical investigations are used as ancillary investigative evidence that gives a quantitative measurement thus helping in determining a more accurate PMI in comparison to the physical changes mentioned earlier.[2] Postmortem biochemistry is also of great importance in investigating various natural causes of death like myocardial infarction, hypothermia, anaphylaxis-related deaths, diabetic ketoacidosis, alcoholic ketoacidosis, sepsis, rhabdomyolysis etc.[3]

The postmortem studies done by researchers involves the different body fluids like blood, vitreous humor (VH), cerebrospinal fluid (CSF), synovial fluid, pericardial fluid and urine. Most of the researches are however done with the antemortem samples and hence the postmortem reference values are not available for human subjects. Other demerits of a postmortem sample are the microbial activity following autolysis or decomposition that would affect the biochemical profile and, the passive diffusion that occurs after death due to a break in the cell barrier leading to an intermingling of intracellular and extracellular electrolytes. Moreover, serum or plasma obtained from live patients is better than haemolysed blood. Hence, antemortem samples give more accurate results as compared to the postmortem samples. But apart from blood and urine which can be collected from live patients, the other body fluids like VH and pericardial fluid can be available after the death of an individual only. Similarly, CSF and synovial fluid though can be collected in live patients but in many conditions their antemortem collection is preferably avoided. Since some of these body fluids are not accessible during life, extrapolated animal values are used as reference values for humans. Another problem is that the standard procedures of chemical analysis are calibrated for blood, serum or urine. When another fluid is used for analysis, the complete analytical procedure has to be calibrated for the alternative fluid.[4]

Most of the researchers have used blood, CSF or VH for studying thanatochemistry. Out of these three, VH is the preferred body fluid because it is a well-compartmented, protected and isolated fluid due to its anatomical location in the eye socket. It is relatively more stable in comparison to other body fluids and the energy metabolism continues for a relatively longer period, as compared to blood and CSF. The autolytic process is also slower when compared with that of blood and CSF. It is well preserved even in victims of severe head trauma owing to the protective effect of bones covering it all around. Numerous studies have been carried out about VH biochemistry and its importance is justified in evaluating the PMI.

The most commonly studied electrolyte for estimating the PMI is potassium. Though potassium value is found to increase with an increase in PMI but the researchers have proposed different regression equations for estimating the PMI from potassium value. The differences in the formulas proposed by the different authors are attributed to factors like health condition at the time of death, sample collection procedure, the analytical method used and various extrinsic factors like the ambient temperature. Temperature is considered the most important external factor which influences the rate of electrolyte changes. Studies have shown that the ambient and cold chamber temperature has an effect on the rate of electrolyte changes.[5-6] More such studies are recommended to understand the pathophysiological changes that takes place in the various biochemical parameters when the body is placed inside a cold chamber which is maintained at a much lower temperature as compared to the normal environmental temperature of that place. This will further help in estimating the PMI more precisely in cases where accurate information regarding the time of death is not available.

Apart from potassium, electrolytes like sodium, chloride, calcium, magnesium, ammonium, phosphates, sulphates have also been studied. Other biochemical markers like glucose, lactate, ketone bodies, amino acids (aspartate, glutamate, cystine, glycine, tryptophan), urea, creatine, creatinine, proteins (total proteins, albumin/globulin ratio), enzymes (2',3'-cyclic nucleotide 3'-phosphohydrolase (CNP), ALT, CK, LDH, CK-MB), oxypurines (uric acid, xanthine, hypoxanthine), monoamines (3,4-dihydroxyphenylacetic acid (DOPAC), homovanillic acid (HVA), 3-methoxy-4-hydroxyphenylglycol (MHPG) and 5-hydroxyindoleacetic acid (5-HIAA)), cholesterol, triglycerides, lipoproteins have been studied for its forensic application.[7,8]

Another forensic application of thanatochemistry is determination of the cause of death especially in the brought dead cases and where sufficient history or findings are not available. Biochemical markers like C-reactive protein (CRP), ferritin, interleukins (IL-6, 8, 10), S100 calcium binding protein B, neuron specific enolase, glial fibrillary acidic protein, brain-derived neurotrophic factor, lactate dehydrogenase, myelin basic protein, neurofilament light chain, neutrophil gelatinase-

associated lipocalin, tau protein etc. have been proposed for diagnosing traumatic brain injury. For detection of myocardial infarction markers like cardiac troponin I, CK-MB, atrial natriuretic peptide, brain natriuretic peptide has been used. Use of markers like tryptase, IgE, chymase, histamine, diamine oxidase for anaphylaxis deaths and CRP, IL-6, IL-1β, procalcitonin for septicaemia is recommended. Various biomarkers are constantly being explored for identifying and certifying deaths occurring as a consequence of drowning, hypothermia, hyperthermia, rhabdomyolysis etc.[3,7-9]

Postmortem biochemistry is indeed the way forward in medicolegal practice and definitely useful for routine casework. Owing to the postmortem pathophysiological demerits, it is advisable that thanatochemistry should be used in conjunction with autopsy, clinical and histopathological findings wherever available. More human studies should be done to get proper postmortem reference values instead of directly applying the animal study results to humans.[3] Issues like availability of equipments, manpower, interdepartmental collaboration should be kept in mind as these are essential for postmortem analysis of the samples.

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Dr. Siddhartha Das is associated with the speciality of Forensic Medicine and Toxicology for more than two decades. Presently he is working as Professor and a former Head of the department of Forensic Medicine & Toxicology at JIPMER, Puducherry. He is the current Joint Editor of Journal of Indian Academy of Forensic Medicine. He has around 60 research publications and an editorial board member in different international and national journals. His field of interest is Thanatochemistry, Forensic pathology and Forensic anthropology. He has been the Organizing Chairman of three national level CME/workshop. He is also a member of UGRMC (Under graduate research monitoring committee) of JIPMER.

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ORIGINAL ARTICLE

Amussat's Sign in Hanging – A Morphological and Histopathological Study

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Abstract:

Amussat's sign is typically a transverse laceration of the intimal layer of carotid arteries described in cases of hanging. Subtotal laceration of the carotid artery is not strictly specific for hanging and can be also caused by blunt neck trauma, extreme overstretching, or whiplash-injuries. The aim of this study is to find out the occurrence of Amussat's sign on morphological and on histopathological examination in cases of hanging. This is an observational cross-sectional study conducted in Tertiary care hospital during time period of January 2021 – June 2022 which consisted of 115 cases of hanging. Out of 115 cases of hanging, 93 (80.9%) cases were complete hanging. Males (n-78) were affected more than females (n-37). The most affected age group was 21-30 years contributing to 39.1%. Most common ligature material used was odhni (31.3%). Most common position of knot was at occipital region in 62.6% cases. Tear in carotid artery was seen in 14 (15.05%) cases on naked eye examination and all 14 cases were of complete hanging. On histopathological examination carotid intimal tear was seen in 73.3% (n-84) cases. Amussat's sign was mostly seen in anterior hanging cases on both gross (28.6%) and histopathological examination (85.7%). In present study Amussat's sign was present in 73.3% cases and most of them were identified by histopathological examination rather than naked eye examination and results shows incidence of carotid tear more in complete hanging.

Keywords: Hanging; Asphyxia; Carotid intimal tear; Amussat's sign.

Introduction:

Hanging has been the most common form of violent asphyxial death, be it suicidal, homicidal, or accidental. Hanging remains one of the most common methods of committing suicide. In India, suicide by hanging was the second most adopted means of committing suicide, i.e., 57.0% in the year 2021. In Maharashtra, hanging is the most popular method of suicide, followed by poison consumption.[1] Hanging is a form of violent asphyxial death produced by suspending the body with a ligature around the neck, the constricting force being the weight of the body or a part of the body's weight. [2] Apart from various common external and internal post-mortem findings, in cases of hanging carotid arteries, changes in the carotid arteries are also inevitable.

The most important signs in the diagnostics of hanging are internal neck injuries. Such vital findings are evidence of a pre-mortem origin of hanging and injury to carotid arteries as a result of hanging is one such basic diagnostic sign. The best known is the so-called Amussat's sign i.e., transverse laceration in the intimal layer of the carotid artery.[3] It must be emphasized that carotid tears are not specific for hanging only, but can also be caused by blunt neck trauma, extreme overstretching of neck or whiplash-injuries too.[4] Nonetheless, this sign has only been reported macroscopically, and only a few studies have been published to assess its true occurrence and any possible relationship with the position of the hanging mark.[5-7]

The present study, "Amussat's sign in compression of neck," makes a detailed autopsy examination and tries to compare and correlate established findings by previous authors, and an attempt is made to establish newer trends from the earlier studies. And a newer dimension, like the position of the knot and histopathological examination of the carotid artery, which corresponds to the ligature mark, has been added to this present study and highlights microscopic events. The objective of this paper is an attempt to find the morphological and histopathological changes in carotid artery in hanging cases. This study is also an attempt to find the changes in carotid artery in cases of faint ligature mark or partial hanging cases or where the ligature mark is barely visible and doubtful regarding hanging cases. In such cases, histopathological findings can help to strengthen the cause of death.

Material and method:

This is an observational cross-sectional study conducted in a tertiary care hospital, during the period of January 2021–June 2022. Sample size was taken by the total enumeration method, which consisted of 115 cases of hanging deaths out of 1247 autopsies. The decomposed and burned bodies, which allegedly died due to fatal neck compression, were excluded from the study. Detailed information regarding the demographic profile of the deceased, circumstances of death, type of ligature material, and whether it is a complete or partial hanging was collected from the inquest and relatives. This information was accompanied in some cases by a visit to the scene of the occurrence or by photographs taken at the scene of the occurrence. The standard autopsy protocol was followed, beginning with general and local external examination, and ending with general and local internal

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examination.

Based on the position of the knot, all cases were divided into four categories according to the position of the knot on the neck (I–IV) (Fig. 1). In cases of anterior hanging (I), the ligature knot was situated in the anterior midline, and the limit was the inner side of the sternocleidomastoid muscle. In cases of posterior hanging (II), the ligature knot was situated in the posterior midline, and the limit was the posterior aspect of the mastoid process. When the ligature knot was placed on the sides of the neck or head between the mentioned limits (on the right or on the left), then the category was right hanging (III) or left hanging (IV). Furthermore, individual cases were divided according to the completeness of the victim's suspension into two main subcategories: free body suspension and incomplete body suspension.

Ethical clearance was obtained from the institutional clinical ethics committee.

Dissection of neck: For a bloodless dissection of the neck, the thoraco-abdominal contents and the brain were removed before proceeding to the neck dissection. A block 12–20 cm high was placed under the shoulders to allow for minimal extension of the neck to aid dissection. After the evisceration, neck dissection was undertaken following the protocol of Prinsloo and Gordon. The neck is dissected layer by layer and carotid sheath was opened anteriorly to expose the internal jugular vein and carotid artery.

Table 1. Type of hanging depending upon degree of suspension.

Type of suspension	Frequency	Percent
Complete	93	80.9 %
Partial	22	19.1 %
Total	115	100 %

Table 2. Incidence of Amussat's sign on gross and histopathological examination in complete and partial hanging.

Amussat's sign	Gross examination		Histopathology examination	
	Complete (n=93)	Partial (n=22)	Complete (n=93)	Partial (n=22)
Present	14 (15.05%)	0	71 (76.3%)	8 (36.4%)
Absent	79 (84.95%)	22 (100%)	22 (23.7%)	14 (63.6%)

Table 3. Incidence of amussat's sign on gross and histopathological examination in complete and partial hanging according to different position of knot.

Position of knot	Carotid intimal tear on gross examination		Carotid intimal tear on histopathological examination.	
	Complete	Partial	Complete	Partial
Anterior (n=7)	2 (28.6%)	0 (0%)	5 (71.4%)	1 (14.3%)
Left lateral (n=25)	5 (20%)	0 (0%)	14 (56%)	3 (12%)
Right lateral (n=11)	3 (27.3%)	0 (0%)	9 (81.8%)	0 (0%)
Posterior (n=72)	4 (5.5%)	0 (0%)	43 (59.7%)	4 (5.6%)

The carotid artery was resected lower down at its origin and the internal and external carotid arteries were cut as distally as possible. Carotid arteries were opened longitudinally on the anterior surface for inspection of any intimal injuries or tears. Blunt forceps was used to handle the artery during dissection and care was taken to use as minimal handling as possible to avoid artefactual injuries. Appropriate tissue section of carotid arteries from neck beneath the ligature mark were dissected and preserved in 10% formalin solution for histopathological examination. Routine hematoxylin and eosin stain was used. Tissue samples were taken from 5 normal cases for comparison as control.

Results:

a. The analyzed group consisted of 115 cases of deaths due to fatal compression of neck and out of that 115 cases were of hanging; Out of 115 cases of hanging, there were 67.8% males (n-78) and 32.2% females (n-37).

b. The major age group affected in both the sexes in cases of hanging was in the range of 21-30 years contributing 39.2% (n-45) followed by 31-40 years contributing 23.4% (n-27) as shown in table no. 2. The least affected age group was 61- 70 years.

c. The commonest ligature material of choice was odhni (n-43, 37.4%) followed by nylon rope (n-36, 31.3%), followed by saree (n-20, 17.4%).

d. Out of 115 cases of hanging, Amussat's sign was seen in 79 (69.5%) cases in which 14 (12.17%) cases were identified by naked eye examination.

e. In 25 cases of left lateral hanging 17 cases had carotid tears in which 14 cases were complete hanging and three cases were partial hanging and, in most cases, tear restricts to left side only.

f. In 11 cases of right lateral hanging nine cases had carotid tears in which all cases were of complete hanging and in most cases, tear restricts to right carotid only.

g. In 72 cases of posterior hanging 47 cases had carotid tears in which 43 cases were complete hanging and four cases were partial hanging.

Discussion:

The present observational cross-sectional study was conducted between January 2021 to June 2022. A total of 1247 autopsies were conducted of which deaths due to hanging comprised 115 cases. In that males were more affected than females contributing to 67.8% (n=78) and 32.2% (n=37) respectively and most of the cases were within the age group of 21-30 years. The present study was conducted during the COVID-19 pandemic period, during which most of the people got stuck inside their houses, confined to closed spaces for indefinite periods of time, with fear, mental stress, anxiety, uncertainty, job loss, financial problems, family problems, intramarital problems, illnesses etc. which had a huge negative impact on mental health of public.

In present study the commonest choice of ligature material used was odhni due to its easy availability in the houses. The present study also indicated the fact that 80.9% of the hangings were complete. The present study showed 79 cases of carotid tear amongst 115 cases of hanging and most of them were identified by histological examination rather than by naked eye examination. Results shows incidence of carotid tear more common in complete hanging.

Amussat's sign was not seen on gross in cases of partial hanging. It is possible that in such cases the ligature does not produce intense pressure upon the area of the arteries of the neck. Intimal tears of the carotid artery were seen in more cases of lateral hanging on the same side of the suspension point. Factors like long drop and convulsive phase during the process of asphyxia on the ligature also contribute to this process.

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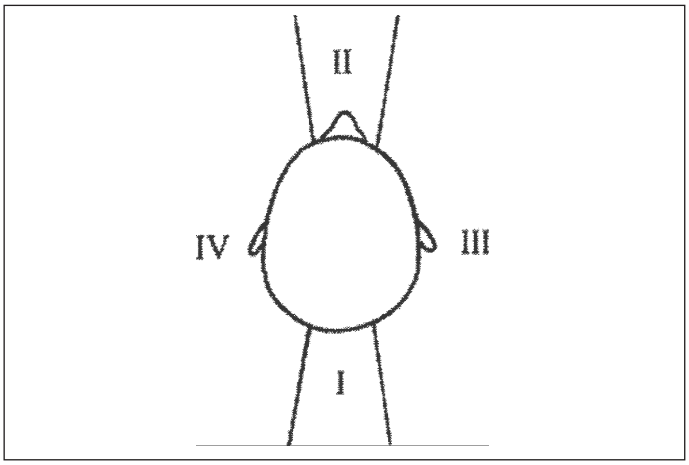

Figure 1. Subcategorization of cases according to the location of the knot into four groups.[14]

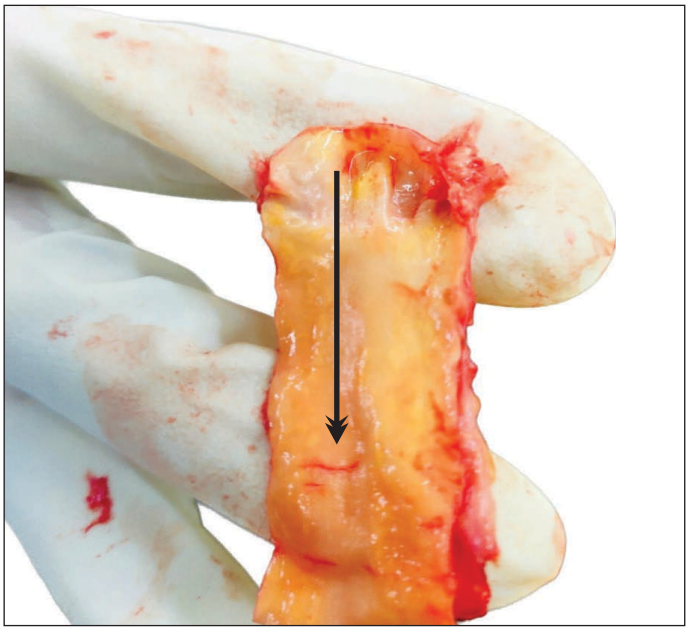

Figure 2. Amussat's sign on gross examination.

It is reasonable to speculate that the incidence of intimal tears in the carotid artery is associated not only to traction but also to direct pressure exerted by knot compression on the neck tissues. The section of the artery below the ligature is very likely to deform and become fixed to the deeper tissue structures of the neck as a result of the acting pressure of the ligature. The proximal section of the artery below the point of its fixation is then exposed to traction forces that lead to a forced, downward stretching of this part of the artery.[8] The most prevalent mechanism causing ruptures in the intimal layer of carotid arteries in hanging may involve a combination of forceful compression of the artery and its longitudinal stretching. The bilateral occurrence of intimal tears in the carotid arteries in anterior hanging instances, where a combination of the intense radial pressure of the tightening rope and powerful axial traction is invariably present, lends weight to this theory.[9,10]

Most of the autopsy studies published so far showed a state of relatively low frequency of occurrence of intimal ruptures in the

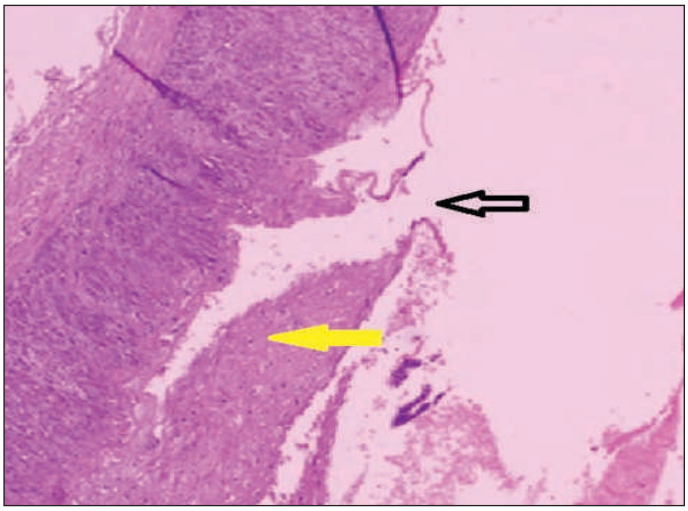

Figure 3. Photomicrograph showing carotid artery with tear in intima (black arrow) and media (yellow arrow) layers, H & E, 100X.

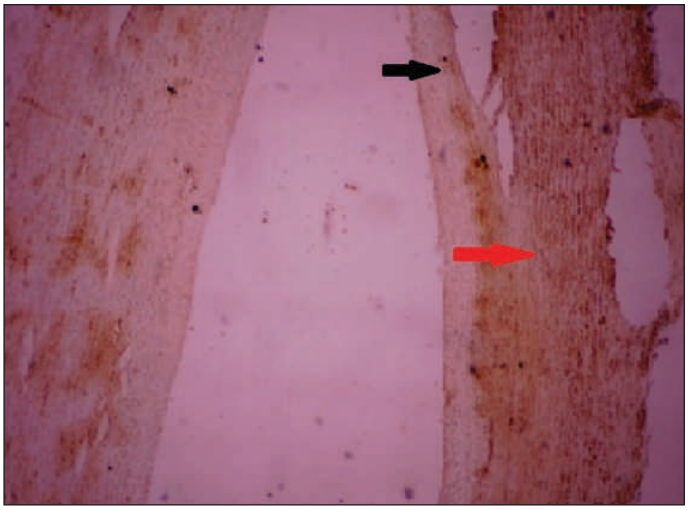

Figure 4. Photomicrograph showing tear in media layer (black arrow) and compression of muscle fibers of carotid artery (red arrow), IHC for smooth muscle actin, 40X.

walls of carotid arteries. In a study conducted by Jani and Gupta,[11] they found carotid tears in 47.8% cases. Nikolic et al.[5] documented injuries of the carotid arteries on the left side of the neck in 7.4 % of the cases and on the right side in 10.9 % of the cases in a retrospective study of 175 cases of hanging. Suarez-Penaranda et al.[6] found Amussat's sign in 9.1% of 228 cases of hanging, Jayprakash et al.[7] et al reported Amussat's sign in 1.1% out of 189 cases of hanging. Rao D[12] observed transverse tear in internal carotid artery in 52.27% cases out of 264 cases. Meera and Singh[13] observed in 23.81% cases of hanging and Hejna[14] in 16.1% cases of hanging.

In present study Amussat's sign was seen in 15.05% cases on gross in complete hanging which was quite similar to studies done by Petr Hejna[14] and S. Balusubramanian et al.[15] which showed incidence of Amussat's sign as 17.90% and 16.50% respectively. Whereas in partial hanging carotid tear was not seen in present study but it was seen in 13.7% cases and 6.69% cases in studies of Petr Hejna[14] and S. Balasubramanian et al.,[15]

respectively.

On histopathology examination Amussat's sign was seen in 76.34% (n=71) cases of complete hanging and in 36.40% (n=8) cases of partial hanging which was different from the findings of study conducted by S. Balasubramanian et al.[15] and D. Ghodake et al.[16] which showed 42.40% and 25.00% in complete hanging and 11.50% and 6.66% in partial hanging. However, in our study a statistically significant association was noted and it has been supported by similar studies conducted by Petr Hejna[14] and S. Balasubramanian et al.[15]

In present study Amussat's sign on gross examination was seen mostly in anterior hanging (28.6%) cases, followed by right lateral hanging (27.3%) cases, followed by left lateral hanging (20%) and least seen in posterior hanging (5.5%) cases. It was different from the study conducted by Petr Hejna[14] which showed Amussat's sign mostly present in right lateral hanging cases (28.57%) and it was not seen in anterior hanging cases.

In present study, Amussat's sign on histopathological examination was mostly seen in anterior hanging (85.7%) cases, followed by right lateral hanging (81.8%) cases, followed by left lateral hanging (68%) and least seen in posterior hanging (65.3%) cases. It was different from the studies conducted by S. Balusubramanian et al.[15] and D. Ghodake et al.[16] which showed Amussat's sign mostly in left lateral hanging (80.76%) cases and right lateral hanging (68.18%), respectively.

Conclusion:

1. Tear in carotid arteries is caused due to direct and indirect trauma in the form of crushing and gravitational pull.
2. Amussat's sign was more visible on histopathological examination (69.5%) as compared to gross examination (12.17%).
3. Amussat's sign was seen more in complete hanging (76.30%) as compared to partial hanging (36.4%).
4. Amussat's sign was most commonly seen in anterior hanging cases (85.7%) as compared to any other position of knot.

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ORIGINAL ARTICLE

Assessment of Non-Fatal Occupational Injuries at a Tertiary Care Hospital

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Abstract:

Occupational injuries are responsible for more lost time from work, productivity and working years of life than any other health conditions. The fatality due to occupational injuries are increasing but nonfatal injuries due to same cause are much more larger in number and most of them go without reporting. An effort has been made in this study to determine the pattern of nonfatal occupational related injuries. It is a cross sectional study. Data was collected from OPD and IPD patients of occupational related cases which had come to hospital. Qualitative color test for alcohol was performed. 50 cases of patients with non-fatal occupational injuries were studied. Majority of cases in agriculture occupation sector i.e., 29 cases (58%). 90% of cases were male and 10% of cases were female and age group between 18-27yrs (34%) followed by 30% of cases between 28-37 yrs and 24% between 38-47yrs. Majority of accidents occurred between 12pm-4pm and 4pm – 8pm i.e., 19 cases (38%) and 16 cases (32%) respectively. 60% of cases occurred in workers who had work experience of >5years, followed by 24% in 6 months 2 years of work experience. In majority of cases safety equipments were not available (72%) and 14% of cases had the habit of alcohol consumption and 8% of cases were tested positive for colour test of alcohol. Among cases, predominant type of injury was punctured wounds (36%), followed by laceration/avulsion (16%) and predominant body part affected were upper limbs (36% of cases) and lower limbs (30% of cases). Analysis of the data in our study revealed a number of factors that were strongly associated with occupational injury. Particular care should be exercised in educating the workers about workplace hazards, training and experience of workers employed in dangerous jobs, pre-recruitment medical check up and screening health examinations should be conducted regularly at work place.

Keywords: Occupational; Nonfatal; Injuries; Work place; Workers.

Introduction:

An occupational injury is any personal injury, physical damage to body tissues or death from an occupational accident. Occupational injuries are responsible for more lost time from work, productivity, and working years of life than any other health conditions.[1]

Injuries are the leading cause of morbidity and mortality among the workers. Thousands of people are killed annually in industrial accidents, and the number of disabling injuries is also a staggering figure. Many workers suffered job related injuries that resulted in lost work time, medical treatment, loss of consciousness, restriction of work or motion, or transfer to another job. Today injuries continue to claim the lives, damage the physical and psychological well being and consume the resources of workers and their families. The overall human, social, and financial toll of traumatic occupational injury is enormous, rivalling the burden imposed by such health threats as cancer and cardiovascular disease.[1] As with all injuries, a substantial share of those that occur on the job can be prevented. An improved understanding of the circumstances associated with occupational injuries should contribute to more effective preventive strategies.[2]

The past 20 years have witnessed the expansion of industries in India. Of the total employed population in India during 2001, 17.8% (i.e. 270 lakh) was in the organized sector (registrar general of India 2001). Among the 830 lakh engaged in the unorganized sector (i.e. 82.2%) agriculture was the major activity, followed by manufacturing, retail trade and other activities.[3]

It is estimated that 19 fatal and 1930 (1:100) non-fatal accident occurs annually per 1 lakh worker (Nag and Patel in 1998).[3] Verghese et al in 1990, in a cohort of 25,000 people from 9 villages of Haryana observed that the incidence rate of work related injuries to be 31% over 1 year period.[3] From a study of 2682 workers in Digboi, Assam, Sharma et al. 2001 reported that nearly 35% of total injuries occurred at workplace. An incidence of 3.6/1000 workers/ years was reported from Jaipur by Mathur and Sharma in 1998.[3] In a study by WHO in municipal areas of Delhi, it was seen that 2% of the total injuries were work related (WHO 2003 b).[3]

The fatality due to occupational injuries are increasing but nonfatal injuries due to same cause are much more larger in number and most of them goes without reporting. In this altered scenario there is very much a need for studying various patterns

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of nonfatal occupational injuries and attributed causative factors in order to form preventive strategies or to shape existing preventive strategies to minimize the occupational related injuries. An effort has been made in this study to determine the pattern of nonfatal occupational related injuries.

Material and Methods:

The present study of 50 cases of occupational injuries has been carried out in the Department of Forensic Medicine & Toxicology, during the period of December 2013 to November 2014. It is a cross sectional study, data was collected from OPD and IPD patients of occupational related cases which had come to Hospital. Information furnished by patients/relatives, examination findings, details of OPD and IPD records, MLC register and telephonic information from relatives and friends etc were obtained.

Table 1. Shows sector wise distribution of nonfatal cases.

Occupation	Frequency	Percent
Agriculture	29	58.0%
Construction	2	4.0%
Mining & Quarry	0	0.0%
Electrical	2	4.0%
Transport	3	6.0%
Metals & Non-metals	5	10.0%
Others	9	18.0%
Total	50	100.0

Table 2. Depicts time of occurrence of nonfatal cases.

Time of occurrence	Frequency	Percent
>12am to 4am	0	0.0%
>4am to 8am	6	12.0%
>8am to 12pm	8	16.0%
>12pm to 4pm	19	38.0%
>4pm to 8pm	16	32.0%
> 8pm to 12 am	1	2.0%
Total	50	100.0%

Table 3: Depicts work experience of nonfatal cases.

Experience	Frequency	Percent
<6months	4	8.0%
6months - 2 years	12	24.0%
>2years – 5 years	4	8%
> 5years	30	60.0%
Total	50	100.0%

Table 4. Depicts safety measures of nonfatal cases.

Safety measures	Frequency	Percent
Not available	36	72.0%
Available- Utilized	2	4.0%
Available- Not utilized	12	24.0%
Total	50	100.0%

Data was entered in Microsoft excel sheet and analyzed by using SPSS (Statistical Package for the Social Sciences) Software version 19. All categorical data was summarized in terms of frequency and percentage. Cases belonging to all ages above 14 years were included in the study and in cases where the history and details not available and vistor's to work place were excluded. The ethical clearance for the study was obtained from the Institutional Ethical committee. Informed consent was obtained from the patients/ relatives in the hospital.

Color test for alcohol: Oxidation of Alcohols: Alcohols undergo several types of chemical reactions. The most important reaction alcohols undergo is oxidation to carbonyl compounds. Primary alcohols are oxidized to aldehydes, which themselves are sensitive to oxidation to carboxylic acids. Oxidizing agents convert secondary alcohols to ketones, and tertiary alcohols lack the ability to undergo oxidation.[15]

Qualitative test:[16] Applicable to urine, stomach contents and scene residues.

Reagents: 1. Potassium dichromate solution (2%).

2. Conc. sulphuric acid.

Method: To one ml of distillate is added 0.2ml of 2% potassium dichromate solution, followed by 1ml of conc. sulphuric acid.

Result: The yellow colour of the dichromate changes to green or blue.

Sensitivity: 2mg.

The oxidising agent used in these reactions is potassium dichromate (VI) acidified with conc. sulphuric acid. If oxidation occurs, the orange solution containing the dichromate (VI) ions is reduced to a green solution containing chromium (III) ions.[17]

Socio-economic status: Modified B G Prasad's socio-economic status classification Jan-2014[18] is used (Class I: Rs 5410 & above, Class II: 2705 – 5409 Rs, Class III: 1623-2704 Rs, Class IV: 812-1622 Rs, Class V: <812 Rs).

Table 1: Shows majority of cases in agriculture occupation sector i.e., 29 cases (58%) followed by 9 cases (18%) which belongs to others. And also there were 5 cases (10%) of metals & non metals, 3 cases (6%) which are transportation related, 2 cases (4%) of construction and 2 cases (4%) of electrical.

Working schedule and work shift: It showed that in 27 cases (54%) accidents occurred among victims who were working on 8hrs schedule and 23 cases (46%) were working on 12hrs schedule. Work shift - 44 cases (88%) of occupational accidents occurred during morning shift and only 06 cases (12%) during night shift.

Pre-recruitment medical check up and regular medical check up at work place: Shows in 45 cases (90%) procedure of recruitment medical check up was not followed and only 5 cases (10%) have followed this procedure. Regular medical check up at work place - only in 12 cases (24%) of occupational victims had facility and undergone regular medical check up, whereas 38 cases (76%) didn't have such facility of regular medical check up at work place.

First aid treatment at work site: Shows that the facility of first aid was not available in majority of the cases (70%, 35 cases) and only 15 cases (30%) had undergone first aid treatment at work site.

Disabilities: Shows 4 cases of occupational injuries (8%) had vision problem and 2 cases (4%) had hearing problem.

Habits: Majority of the victims, 31 cases (62%) had no habits, 7 cases (14%) had the habit of alcohol consumption, 5 cases (10%) had the habit of smoking alone, 6 cases (12%) of the victims had the habit of alcohol with smoking, 1 case (2%) of the victims had

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Table 5. Shows distribution of nature of injury among nonfatal cases.

Nature of injury	Frequency	Percent
Abrasion	2	4.0
Laceration/Avulsion	8	16.0
Punctured wound	18	36.0
Burns (Dry & wet/Electrical burns/wounds)	7	14.0
Fracture of bone	5	10.0
Crush injury	5	10.0
Surgical Sutured wound	1	2.0
Infected wound	2	4.0
No visible injuries	2	4.0
Total	50	100.0

Table 6. Shows distribution based on body part affected among nonfatal cases.

Body part affected	Frequency	Percent
Head	2	4.0
Neck	1	2.0
Chest	0	0.0
Abdomen	1	2.0
Upper limbs	18	36.0
Lower limbs	15	30.0
Multiple Sites	11	22.0
Nil	2	4.0
Total	50	100.0

other habits and 4 cases (8%) were responded positive for colour test for alcohol.

Table 2: Shows nonfatal cases, majority of accidents occurred in afternoon and evening hours i.e., 19 cases (38%) and 16 cases (32%) respectively.

Table 3: Shows 30 cases (60%) of occupational injuries occurred in worker who had work experience of >5years, followed by 12 cases (24%) between 6 months-2 years of work experience.

Table 4: Shows in majority of cases safety measures/ equipments were not available i.e., 36 cases (72%) were deprived of safety equipments at the work place and in 12 cases (24%) safety equipments were available but not utilised.

Table 5: Shows among nonfatal cases, 18 cases (36%) were due to punctured wounds, 8 cases (16%) were due to laceration/ avulsion, 7 cases (14%) due to burns (dry burns/wet burns, electrical burns & wounds), 5 cases (10%) due to crush injury, 5 cases (10%) due to fracture of bone, 2 cases (4%) due to infected wound, 1 case (2%) due to surgical sutured wound and there were no visible injury in 2 cases (4%).

Table 6: Shows among non fatal cases, upper limbs sustained injuries in 18 cases (36%), lower limbs in 15 cases (30%), multiple sites in 11 cases (22%), head in 2 cases (4%), neck and abdomen in 1 case each (2%) and no external injury in 2 cases (4%). Simple and Grievous Injury: Among nonfatal cases, 33 cases (66%) sustained grievous injury and 17 cases (34%) sustained simple injury.

Discussion:

In the present study few salient interesting observations were recorded and these have been analyzed, discussed and compared with findings of similar studies. In the present study there was majority of male victims i.e. 90% in contrast to females of 10%. These findings are similar to the studies by Zine K U et al.[11] where males constituted 76.54% compared to female of 23.46% and Ergor A, Dermiral Y, Piyal Y B[5] in turkey where male outnumbered females. But according to Massachusetts occupational injuries and illnesses report, 2013[4] males were injured in 55.5% and females in 44.2% which is in contrast to our study where number of females is less. This discrepancy could be of a reason as our study is conducted in Hubballi city, where number of patients visited to the hospital are from the rural side, and in rural side it is still a practice, where males are the one who work outside whereas females will take care of the household work.

The age group of the victims in the current study ranged from 14 years to >68 years. The maximum number of occupational injuries occurred in the age group of 18 years to 27 years (34%), followed by 28 years to 37 years (30%) and 38 years to 47 years (24%). Similar findings were also found with the studies by Gururaj G,[3] report 2013[4] and Etiler N, Colak B, Bicer U and Barut N[6]. According to him[3] in his study observed that 25 to 30% of injuries occur in those 16-20 year of age, 30-45% in those of 21-35 years of age and about 30% in 36-45 years of age. Report 2013[4] revealed injuries and illness to workers in the 25-34 years was 23.1%, 45-54 years was 21.1% and 35-44 year-old age categories was 21% and according to them[6] in their study observed that, 38.2% occupational deaths occurred in the age group 25-34 years and 27.9% in 35-44 years. As adult and middle aged are the active working groups (18-45 years) in almost all occupation sectors, could be the reason for clustering of cases from 18-45 years.

In the present study, it was observed that majority of the victims were illiterates (68%), followed by 20% of cases had dropped out at their high school education. The socio-economic status showed classic crowding. The maximum number of cases occurred in Class IV (44%) and Class V (36%) of socio-economic status scale. This probably indicates the lack of knowledge, low purchasing power, limited application of safety measures, and compulsion to earn for livelihood.

In the current study, a high number of cases were from agriculture sector 58%, followed by others 18%, followed by metals & non metals 10%, which is followed by transportation 6%, construction 4% and electrical 4%. According to report, 2013[4] the major industries were Educational Services, Health Care and Social Assistance and Public Administration. Educational Services reported a total of 700 cases, and a TRC incidence rate of 2.4 cases per 100 FTEs. Health Care and Social Assistance had a total of 900 cases and a TRC rate of 7.7 cases per 100 FTEs. Public Administration accounted for 1,400 cases and an incidence rate of 2.7 cases. These findings are in contrast to our findings, where agriculture sector had highest percentage. This could be of reason as ours is the biggest tertiary care hospital in North Karnataka, the catchment area consisting of agriculture based villages, towns and rapidly urbanizing city with mushrooming of tall buildings.

In the present study it was also observed that in 90% of the cases procedure of pre-recruitment medical check up was not followed and in 76% of the cases, facility of regular medical check up at work place was not available. The findings are in accordance with the report[14] which states that an effective training and proper recruitment procedures can reduce number of injuries, death and

illness. Lack of these facilities had a clear impact on the outcome of accidents in our study.

Lingard H[13] in her study observed that the first aid facilities and first aid training had positive effect on occupational safety and health behaviours of the workers. First aid appeared to reduce 'self-other' bias, also appeared to reduce worker's willingness to accept prevailing level of occupational safety and health risks and helped to improve risk controlled behaviour. In our study, it was observed that 70% of the cases, first aid facility as well as first aid training were not available and also majority of cases in our study are agriculture workers, where they don't carry first aid to the work place.

Folkard S and Tuker P[7] in their study observed that, the risk was found to increase in an approximately linear fashion across three shifts showing an increased risk of 18.3% on the afternoon shifts and 30.4% on the night shifts. Similar findings were also observed in the present study that, number of occupational accidents was less in the morning hours (16%) as compared to afternoon (38%) and evening hours (32%) as shown in table 2. However, the risk decreased in the night hours (2%). This discrepancy was probably attributed to the fact that our study involved more number of agriculture sector victims (58%), who virtually come to rest in the night and also 88% victims were working on the morning shift.

In the current study it was also observed that, 54% of victims of occupational accidents were on 8 hours working schedule and 46% on 12 hours working schedule and 88% of victims were working in the morning shift compared to only 12% who were in the night shift. These findings are in accordance with the study conducted by Ergor A et al.[5] revealed that, 90.5% of victims were on 8 hr shift and only 4.5% were doing overtime work and 61.1% were on day shift, followed by 15.6% in the evening shift and 11.1% in the night shift.

In the present study it was observed that, crowding of accident at afternoon (>12pm to 4pm- 38%) and evening hours (>4pm to 8pm- 32%) was probably attributed to fatigability and decreased alertness with increase in hours of work. These findings are in accordance with study from Zineku et al.[11] observed that 34.6% of cases had sustained accident between 12pm to 6pm. It was also observed in our study that 16% of cases had accidents in morning hours between 8am to 12pm as shown in table 2, this could be attributed to agriculture sector, as in our study majority are agriculture workers, where they have the habit of getting up early and go to work in the early morning hours.

According to John Everett Park[9] approximately 50% of the employees had accident in first six months of employment followed by 23% in the next months and 3% subsequently. Benach J, Benarides FG, Jarque S[10] in their article revealed that, 58% of the accidents involve workers on the temporary contract and 49% affects workers with less than one year of service in the company. However, in our study it was observed that highest number of accidents occurred in victims having more than 5 years (60%) experience, followed by workers having 6months- 2 years of experience (24%) and then followed by workers having < 6 months experience (8%) as shown in table 3. This discrepancy was probably due to the fact that most of the victims of our study belong to the agriculture sector and construction sector. The agriculture sector is considered as a normal labour where experience wouldn't have much importance like other skilled works. Lack of concentration irrespective of work experience could have attributed to injuries in our study.

In the present study, it was observed that in 72% of the cases safety equipments were not available. Only in 4% of the cases equipments were utilized, however they couldn't prevent the accidents which can be attributed to equipment failure and 24% of cases in spite of safety equipments made available, it was not utilized, could be attributed to lack of knowledge and awareness about safety measures in workers.

According to study conducted by Alleyene BC, Stuart P, Copes R,[8] examined a unique set of data on 459 deaths occurring at work. The only illicit drug found was cannabis for which 10 workers tested positive. Forty workers tested positive for alcohol, 28 for prescription, and 22 for non prescription drugs. However in our study, 14% of cases had habit of alcohol consumption, 10% had the habit of smoking alone, 12% of the victims had the habit of alcohol with smoking and 2% of the victims had other habits. And it was also observed that 8% of cases responded positive for alcohol by colour test, which suggest patient/deceased had consumed alcohol prior to sustaining injury or death. Influence of alcohol causes blunting of reflexes and hence chances of sustaining injuries increases.

The present study revealed that, among nonfatal cases, 36% of cases had punctured wound, 16% of cases had laceration/avulsion, 14% of cases due to burns, 10% of cases due to crush injury, 10% of cases due to fracture as shown in table 5. These findings are in contrast to Kamalinia M et al.[12] In their study of 200 cases of occupational accidents, it was observed that, there were 37 deaths and 163 non fatal cases. Among non fatal cases, predominant type of injury was due to fractures of bone i.e. 88 cases (53.9%), followed by soft tissue injury of 70 cases (42.9%), 20 cases (12.2%) of amputation, 3 cases (1.8%) of burns and 11 cases (6.7%) of rupture. This could be due to difference in the type of occupation and place of work. In our study majority of punctured wounds sustained over upper and lower limbs are due to snake bite at work place. As snakes are existing in majority of agriculture fields, hence snake bites are well known complications of agriculture occupation and injuries over limbs indicating transient lack of concentration at work.

It was also observed by Kamalisia M et al.[12] in their study that predominant body parts affected were upper limbs (45.5%), followed by 24% of cases involving head and neck, 20% of cases due to lower limbs, 9% of cases due to spinal cord, 8% due to multiple sites and least was due to abdomen and thorax. Similar findings were also observed in the present study, among non fatal cases, upper limbs were affected in 36%, lower limbs in 30% and 22% cases due to multiple sites as shown in table 6. And in our study it was also observed that 66% cases were grievous in nature compared to 34% cases of simple injury.

Limitations of the study: 1. Since ours is a tertiary care hospital, majority of minor occupational related non-fatal injuries will not visit to tertiary centre and will be treated at the level of primary health centre. Hence burden of total occupational related injuries

cannot be assessed.

2. Since we have analysed a sensitive test for alcohol (colour test) and not quantified and not analysed for other substance of abuse.

Conclusion:

- Occupational accidents are unpredictable. As lack of qualification gets higher, unqualified workers are employed temporarily at lower wages.
- Analysis of the data in our study revealed a number of factors that were strongly associated with occupational injury. Some of these factors were intrinsic to the job, while others reflected personal or socio-economic conditions.
- In our study it was observed that, illiteracy among workers, lack of safety equipment (measures), unwillingness to utilize the available safety equipments, lack of first aid at work site, lack of regular medical facilities and pre-recruitment medical check up and training at work place were all responsible.
- Particular care should be exercised in educating the workers about workplace hazards and usage of safety measures, training and experience of workers employed in dangerous jobs, pre-recruitment medical check up and screening of new workers for vision problem, hearing problem, chronic diseases etc and health examinations should be conducted regularly at work place.
- In our study majority of agriculture workers sustained injuries like snake bites and by sharp weapons over the extremities. Hence we suggest use of gumboots and gloves for agriculture workers to prevent such incidents.
- Prevention of occupational accidents would protect human lives, prevent problems arising in families due to death and disability and loss of labour power, and contribute to the country's economy.
- Additionally, the occupational accident recording and reporting system is inadequate. Hence reporting and updating of the records is very important and should be made mandatory for planning any strategies.

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ORIGINAL ARTICLE

A Study on Pattern of Coup-contrecoup Head Injury in Autopsy Cases

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Abstract :

Head injuries constitute a significant number of cases brought to the casualty department of a hospital and also contribute majorly to deaths caused by transportation injuries. Understanding the mechanism and patterns of such injuries and their relation with the manner of infliction is of utmost importance to formulate preventive measures. This study was conducted to throw light on the dynamics and pattern of coup and contrecoup head injuries. A total of 263 cases fulfilling the inclusion criteria were studied prospectively with a male preponderance of 86%. Majority of the subjects were in the age range of 21 to 30 years (20.91%) followed by the age range of 41 to 50 years (17.87%). The most common pattern of injury was subdural haemorrhage (SDH) only followed by presence of both SDH and subarachnoid haemorrhage (SAH). Among 263 cases studied, At the time of impact, in 249 cases head was in a state of motion and in 14 cases, at rest. Statistical analysis concluded that proportion of contre-coup injury is more in cases where head was in motion during impact. Brain contusion was also seen more in cases of contrecoup injury than coup injury.

Keywords: Coup injury; Contrecoup injury; Motion; At rest; Impact; Road traffic accidents; Fall from height.

Introduction :

Of all regional injuries, those of the head and neck are the most common and most important in forensic practice.

Adelson (1974) gives these sound reasons for this dominance of head injuries:[1]

- The head is the target of choice in the great majority of assaults involving blunt trauma.
- When the victim is pushed or knocked to the ground, he often strikes his head.
- The brain and its coverings are vulnerable to degrees of blunt trauma that would rarely be lethal if applied to other areas.

A sound practical understanding of the neuropathology of trauma is more essential to the forensic pathologist than any other aspect of her subject, as head injuries provide the major contribution to death in assaults, falls and transportation accidents.

In head injury, a coup injury occurs under the site of impact with an object, and a contrecoup injury occurs on the side opposite the area that was hit. Coup and contrecoup injuries can occur individually or together. Coup and contrecoup injuries are considered focal brain injuries, those that occur in a particular spot in the brain, as opposed to diffuse injuries, which occur over a more widespread area. The exact mechanism for the injuries, especially contrecoup injuries, is a subject of much debate. In general, they involve an abrupt deceleration of the head, causing the brain to collide with the inside of the skull. It is likely that inertia is involved in the injuries, e.g. when the brain keeps moving after the skull is stopped by a fixed object or when the brain remains still after the skull is accelerated by an impact with a moving object. Additionally, movement of cerebrospinal fluid following a trauma may play a role in the injury.

Identification of the causes and modifiable factors behind these injuries is essential for better understanding to formulate preventive measures.

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Materials and methods:

Before starting the study, ethical clearance was taken from the ethical committee of the concerned institution. The study was conducted in the Police Morgue attached to the Department of Forensic Medicine and Toxicology for a period of eighteen months between 2017 and 2018. The study population included all cases with history of blunt trauma to head brought for autopsy at a Medical College and Hospital in eastern India. All decomposed bodies with softening and/or liquefaction of brain matter and bodies with gross disorganisation of skull & laceration of brain matter were excluded. A total of 263 cases were studied. The study design was descriptive, cross-sectional. After explaining the details of the study, required information was collected from the relatives using a pre-designed proforma. Police inquest papers, treatment sheets, injury reports and other relevant medicolegal documents were studied before proceeding for autopsy. After gathering information about the state of motion, position of the subjects and circumstances during the fatal incident, post mortem examination of the subjects were carried out according to the standard procedure. All injuries were carefully observed, examined and noted. The cranium was

Table 1. Showing frequency distribution of the sample according to cause of injury.

Cause of injury	Number of cases	Percentage
Road Traffic Accidents	172	65%
Fall from height	51	19%
Railway accidents	12	5%
Fall at home	20	8%
Roof fell on the subject	06	2%
Hit on the head by a blunt weapon	02	1%
Total	263	100%

Table 2. Showing distribution of cases with coup injury according to type of injury.

Type of injury (n=252)	No. of cases	Percentage
SDH	156	62%
SDH, SAH	66	26%
SDH, SAH, Contusion	15	6%
EDH, SDH	07	3%
EDH, SDH, SAH	05	2%
EDH, SDH, SAH, Contusion	03	1%

carefully examined for all injuries. Presence of skull fracture and scalp bruise or hematoma was noted. On dissection, the area of brain underneath the impact was examined for any injury (coup). Similarly, the area diametrically opposite to the site of impact was examined for presence of injury (contre-coup). Photographs were taken as necessary.All data were collected, compiled and subjected to suitable statistical analysis using appropriate methods. Results were presented using charts, tables, and diagrams as necessary.

Results:

During the study period, a total of 263 cases fulfilling the inclusion criteria were studied prospectively. Among 263 subjects studied, 37 (14%) were female and 226 (86%) were male. Majority of the subjects were in the age range of 21 to 30 years (20.91%) followed by the age range of 41 to 50 years (17.87%), 51 to 60 years (16.73%), 71 to 80 years (13.3%) , 31 to 40 years (12.92%), 61 to 70 years (8.36%), 11 to 20 years (7.60%) and 81 to 90 (2.28%). 65% cases were of road traffic accidents followed by cases of fall from height (19%) [Table 1]. Among 263 cases, 252 cases had coup injury, 238 cases had contre-coup injury and 227 cases had both. Among 263 total cases in the study population, majority(33.08%) had impact in the parieto-temporal region of the skull followed by occipital region (21.29%), fronto-parietal (17.87%) and frontal region (10.27%). Among 252 total cases with coup injury, the most common pattern of injury was subdural haemorrhage (SDH) only (seen in 156 cases) followed by presence of both SDH and subarachnoid haemorrhage (SAH) (seen in 66 cases). Brain contusion associated with meningeal bleed was present in 7.14% cases of coup injury. Extradural haemorrhage (EDH) associated with other types of meningeal bleed was seen in 5.95% cases of coup injury [Table 2]. Among 238 total cases with contre-coup injury, the most common pattern of injury was SDH only (seen in 137 cases) followed by presence of both SDH and SAH (seen in 55 cases). Brain contusion associated with meningeal bleed was present in 19.34% cases of contrecoup injury [Table 3]. Among 46 cases with contre-coup contusion, 20 cases i.e 43% included motorcycle riders (26% driving the motorcycle and 17% pillion riders).

Table 3. Showing distribution of cases with contre-coup injury according to type of injury.

Type of injury (n=238)	No. of cases	Percentage
SDH	137	57.56%
SDH, SAH	55	23.10%
SDH,SAH, Contusion	46	19.34%

Table 4. Showing distribution of sample according to state of motion of head during impact.

State of head during impact.	Number of cases
In motion	249
At rest	14
Total	263

Table 5. Showing distribution of cases with coup injury according to state of motion of head during impact.

State of head during impact.	Coup	No coup
At rest (n=14)	13	01
In motion (n=239	239	10

Table 6. Showing distribution of cases with contre-coup injury according to state of head during impact.

State of head during impact.	Contre-coup	No Contre-coup
At rest (n=14)	10 (71.42%)	4
In motion (n=249	228 (91.56%)	21

In 249 cases the head was in a state of motion at the time of impact whereas in 14 cases the head was at rest [Table 4]. Among 14 cases where the head was at rest during impact, 13 had coup injury. Among 249 cases where the head was in motion during impact, 239 had coup injury [Table 5]. Fisher's exact test was done with df=1 and specified significance level of 0.05, P value was 0.46 which is statistically not significant. Hence, we accept null hypothesis i.e there is no difference in rate of coup injury depending on state of motion of head during impact. Among 14 cases where the head was at rest during impact, 10 had contrecoup injury. Among 249 cases where the head was in motion during impact, 229 had contrecoup injury [Table 6]. Fisher's exact test was done with df=1 and specified significance level of 0.05, P value was 0.03 which is statistically significant. Hence, we reject null hypothesis i.e there is no difference in rate of contre-coup injury depending on state of head during impact. We accept alternate hypothesis and conclude that proportion of contre-coup injury is more in cases where head was in motion during impact.

Discussion:

In this study, a total of 263 cases were studied fulfilling the inclusion criteria, out of which, 226 cases were male (86%) and 37 were female. Amit M Patil et al.[2] in their study conducted from 1 November 2002 to 31 October 2004 at Topiwala National Medical College & BYL Nair Charitable Hospital, Mumbai found males were the most common victims. Similar findings were seen in other studies.[3-6] This can be easily explained since majority of drivers, pedestrians and construction workers working at heights are still males in our society. In 20 years and below age group, there were twenty cases. Maximum cases (55 cases) were found in the age group of 21-30 years age group. Similarly, Pathak A et al. in 2003 in their study[7] on autopsy finding of pattern of skull fractures and intra-cranial hemorrhages in cases of head trauma in department of Forensic Medicine, SMS Medial College, Jaipur found the age group 20-40 years covering the maximum number of incidences of head injury.

Frequency distribution of sample according to cause of injury shows maximum cases (172 in number) resulted from road traffic accidents followed by 51 cases resulting from fall from height. 12 cases were of railway accidents. 20 cases resulted from fall at home. In six cases, roof collapsed on the persons and two persons were hit on the head by a weapon. Accidents constitute a complex phenomenon of multiple causation. The etiological factors are classified into human and environmental factors.[8] The dominance of road traffic accidents can be explained by the lack of awareness and reluctance in obeying traffic rules among pedestrians, drivers and passengers. This makes the importance of formulating stringent traffic rules and strictly implementing them evident. Similarly, Pathak A et al. in their study[7] found the most common causative factor which was noted during the case study was the contribution of 66.84% (79 out of 120 cases) of the road traffic accidents followed by cases of fall from height covering 23.33% (28 out of 120 cases) and rest 10.83% included cases of assault and other traumas. Frequency distribution of cases with coup injury (n=252) according to type of injury (Table 2) shows SDH as the most common form of injury as seen in 156 cases. 66 cases had both SDH and SAH as coup injury. SDH, SAH and contusion of brain was present in 15 cases. EDH and SDH together was present in seven cases. Five cases had EDH, SDH and SAH. Only three cases had haemorrhage at all levels i.e EDH, SDH, SAH and contusion. Fifteen cases i.e 6% had EDH in total. Contusion of brain was seen in eighteen cases i.e. 7% cases.

Frequency distribution of cases with contre-coup injury (n=238) according to type of injury (Table 3) shows SDH as the most common form of injury as seen in 137 cases. 55 cases had both SDH and SAH as contre-coup injury. SDH, SAH and contusion of brain was present in 46 cases. Thus here, contusion of brain was seen in 46 cases i.e. 19% cases which is more than in case of coup injury.

Pathak A et al. in their study[7] also found SDH as the most common form of intracranial haemorrhage in 83.33% cases. Similar to our findings, they too observed EDH in 6.67% cases. Amit M Patil et alin their study [9] found a combination of SDH and SAH as the most common observation. SDH was the commonest form of intracranial haemorrhage in other studies also.[4,10-12]

Frequency distribution of sample according to state of head during motion shows during impact, in 249 cases the head and was in motion. In these 249 cases the moving head was brought to a sudden halt by the impact. The most common example here is cases of road traffic accidents where a pedestrian was hit by a car or motorcycle. In such circumstances, the primary impact was on the lower part of the body following which the person was thrown away by the force and the moving head then hit the road or some other structure. Similarly in cases of fall from height, the moving head is brought to a sudden halt as the person hits the ground. In 14 cases the head was at rest during impact. Such cases included incidents where the roof of the room collapsed on a person sitting or resting inside the room and also included two cases where a static person was hit on the head by a heavy blunt weapon. Since my sample included mostly cases of road traffic incidents and falls from height, most cases had the head in motion during impact.

Table 5 shows distribution of cases with coup injury according to state of motion of head during impact. It shows that out of 14 cases of head at rest during impact, 13 had coup injury while one case had no coup injury. Out of 249 cases where head was in motion during impact, 239 cases had coup injury and 10 cases had no coup injury. Fisher's exact test was done with degree of freedom=1 and specified significance level of 0.05. P value was 0.46 which is statistically not significant. Thus the null hypothesis had to be accepted i.e. there is no difference in rate of coup injury depending on state of head during impact.

Table 6 shows distribution of cases with contre-coup injury according to state of head during impact. It shows that out of 14 cases of head at rest during impact, 10 had contre-coup injury while four cases had no contre- coup injury. Out of 249 cases where head was in motion during impact, 228 cases had contre-coup injury and 21 cases had no contre-coup injury. Fisher's exact test was done with degree of freedom=1 and specified significance level of 0.05. P value was 0.03 which is statistically significant. Thus the null hypothesis had to be rejected. Alternate hypothesis was accepted i.e. proportion of contre-coup injury is more in cases where head was in motion during impact.

Conclusion:

It is to be kept in mind that this was purely an autopsy based study. Though antemortem factors were considered, yet a multi-disciplinary and multi-tier approach would have made it more accurate.

This study highlights the increasing incidence of road traffic accidents and also a significant number of fall from height cases. As seen in the study, in most of the cases, the head of the subject was in motion during impact which in turn increased the probability of the subject sustaining contrecoup injury. Brain contusion was seen more in cases of contrecoup injury than coup injury. Most of these cases included motorcyclists and pillion riders. Strict laws enforcing use of helmets will decrease number of such cases by reducing the chance and severity of head injury. Similarly, safety measures for construction workers need to be implemented.

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ORIGINAL ARTICLE

A Study on Injury Patterns among Motorcyclists Presenting to a Tertiary Care Hospital in South Kerala

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Abstract :

High traffic levels on the road and the low costs of procurement and usage make motorcycles attractive in India. However, motorcycle riders and passengers are more vulnerable to traffic accidents. The present study, which was conducted in a tertiary care hospital in South Kerala, focused on injury patterns related to motorcycle accidents, including the factors associated with such accidents. The results found that males (80%, 212) were more often victims of motorcycle accidents than females (20%, 53). The most affected age group was 20–39 years, at 41.5% (110). Most victims who came to the hospital had fractures (73.2%). Based on the fracture site, the head and neck areas were the most affected (48.5%). Based on external injury, the head and neck areas were again the most affected (63.9%).

Keywords: Road traffic accidents; Motorcycle; Injury pattern; Epidemiology.

Introduction :

A road traffic accident (RTA) is any injury due to crashes originating from, terminating with or involving a vehicle partially or entirely on a public road.[1] Mortality for ages 5–29 years is primarily caused by RTA injuries. Approximately 1.3 million lives are lost on the roads each year. RTA deaths among vulnerable road users, including pedestrians, cyclists and motorcyclists, account for more than half of the casualties.[2] According to World Road Statistics (2018), India ranked first in the number of RTA deaths across 199 countries. The WHO's Global Report on Road Safety (2018) observed that almost 11% of accident-related deaths in the world occur in India. Two-wheelers account for 35% of all RTA deaths on national highways.[3] With the expansion of road transport facilities, improved living conditions enabling more private vehicles and noncompliance with traffic rules, the frequency of RTAs has increased, particularly those with two-wheeler involvement.

Many people rely on motorcycles in this part of the country because they can get through busy roads quickly, it is economical and it satisfies vogue concepts. The hospital under study is located near a busy street; therefore, the study of motorcycle cases here should offer a good overview of what happens in such accidents in this area. In high-traffic areas, hospital settings must be fully aware of the relevant demographics and other variables considered in this study to prepare for delivering appropriate care at all times. Efficiency in providing care can be improved with knowledge of probable injury sites, the mechanism of an accident and associated factors. Studies showing the characteristics of injuries would help in clinical management. This study aims to provide an understanding of different areas of the body sustaining fractures, different types of damage and patterns to make the delivery of medical services better in trauma cases involving motorcycles.

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Material and methods:

This retrospective record-based study is part of the Indian Council of Medical Research-funded Short-term Student Project, which was conducted in a tertiary care centre in South Kerala. The primary means of private transport in that locale include cars and motorcycles. The target population was those affected by motorcycle-related trauma. This study reviewed cases of patients who presented to the emergency room of the institution following two-wheeler accidents. This study was carried out from August 2022 to October 2022. Proforma was used to collect relevant data. The records of cases satisfying the inclusion criteria were considered for the study, excluding other MLC cases arranged. The data was then entered into proforma, and patients were divided by injury type, including abrasions, contusions, lacerations, incised wounds, burns, puncture wounds, avulsions, penetrating wounds, etc. When different injuries occurred within the same region, they were recorded as combinations. However, fractures were considered separately. The entire body of each patient was assessed, and injuries and fractures in each area were marked. Data on documentation were recorded and then coded for analysis. The data were then compiled in a datasheet using Microsoft Excel (version 2013) and analysed using SPSS computer software version 16.0, which interpreted results in terms of percentage, mean and chi-square.

Result:

A total of 265 records were analysed for this study. Table 1 depicts the distribution of the study population based on gender. Males 212 (80%) outnumbered females 53 (20%).

Table 1: Distribution of study based on gender.

Gender	Frequency	Percentage
Male	212	80.0
Female	53	20.0
Total	265	100.0

Table 2: Distribution of study population based on age.

Gender	Frequency	Percentage
< 20 years	19	7.2
20–39 years	110	41.5
40–59 years	101	38.1
≥ 60 years	35	13.2
Total	265	100

Table 3: Distribution of study population based on fracture status.

Fracture	Frequency	Percentage
Present	194	73.2
Absent	71	26.8
Total	265	100.0

Table 4. Distribution of study population based on fracture site.

Fracture Site	Frequency	Percentage
Head & Neck	94	48.5
Upper Limb	60	30.9
Lower Limb	61	31.4
Thorax	20	10.3
Lumbar Region	9	4.6

Table 5. Distribution of study population based on external injury status.

External Injury site	Frequency	Percentage
Head & Neck	131	63.9
Lower Limb	70	34.1
Upper Limb	68	33.2
Abdomen	15	7.3
Thorax	10	4.9

The patients were categorised into different age groups. Table 2 depicts the distribution of the study population based on age. The age group 20–39 years was most affected (110 cases, 41.5%), followed by the age group 40–59 years (101 patients, 38.1%). Fractures were seen in 194 cases (73.2%). Table 3 shows the fracture statistics.

The fracture sites were determined by dividing the body into different regions, as depicted in Table 4. The head and neck regions were the most commonly affected (94 cases, 48.5%). Other sites were upper limbs (30.9%), lower limbs (31.4%), thorax (10.3%) and abdomen (4.6%). External injury distribution was also assessed region-wise. 77.4% of the reports had external injuries.

The different regions of the body and the pattern of injury mostly suffered are depicted in Table 7. Abrasion forms the most common single type of injury in both limbs separately. In 37.1% cases, abrasions were present in the lower limbs while in 52.9% cases abrasions were present in the upper limbs. Lacerations were next most common, accounting for 30% of the cases in the lower limb and 16.2% in the upper limb. Among the combination of wounds, both limbs sustained abrasions and lacerations mostly, with 11.4% of the cases in the lower limb and 5.9% of the cases in the upper limb. A penetrating wound was seen in 1 case in the lower limb. The limbs alone showed the presence of a puncture wound. The most frequently found single type injury in the head and neck region was laceration (54 cases, 41.2%), followed by a combination of abrasion and laceration in 24.4% cases. Friction burns due to RTAs were seen in the head, neck, upper limb, and abdomen regions. Avulsions were seen in all regions except the thorax and abdomen. Apart from cases where one type of injury is more frequent in a particular site, different combinations of injuries are seen in different parts of the same region. Abrasions were the most common injuries in the abdomen and thorax regions. Only abrasions or contusions as different types of injuries were seen in the thorax.

Table 6. Distribution of study population based on site & type of external injury.

External injury site	External injury type	Frequency	Percentage
Head & Neck	Laceration	54	41.2
	Abrasion + Laceration	32	24.4
	Abrasion	25	19.1
	Contusion	11	8.4
	Abrasion+Laceration+Contusion	2	1.5
	Laceration + Burns	2	1.5
	Laceration + avulsion	1	0.8
	Laceration + contusion	1	0.8
	Abrasion + Contusion	1	0.8
	Laceration + Avulsion + Abrasion + Burns	1	0.8
	Laceration + Avulsion + Abrasion	1	0.8
Lower Limb	Abrasion	26	37.1
	Laceration	21	30
	Abrasion + Laceration	8	11.4
	Contusion	6	8.6
	Avulsion	2	2.9
	Abrasion + Puncture wound	2	2.9
	Puncture Wound	1	1.4
	Avulsion + Abrasion	1	1.4
	Abrasion + Contusion	1	1.4
	Abrasion + Penetrating wound	1	1.4
	Avulsion + Puncture + Abrasion + Laceration	1	1.4
Upper limb	Abrasion	36	52.9
	Laceration	11	16.2
	Contusion	4	5.9
	Burns	4	5.9
	Abrasion + Laceration	4	5.9
	Laceration + Puncture wound	3	4.4
	Puncture wound	2	2.9
	Laceration + Avulsion	2	2.9
	Avulsion	1	1.5
	Abrasion + Contusion	1	1.5
Abdomen	Abrasion	10	66.7
	Laceration	3	20
	Contusion	1	6.7
	Burns	1	6.7
Thorax	Abrasion	7	70.0
	Contusion	3	30.0

Discussion:

Road accidents caused by motorised two-wheelers are the leading cause of disability and fatality. We analysed about 265

cases that met the inclusion criteria and found that more men (212, 80%) were killed or injured than women (53, 20%) similar to studies by, Dandona R and Mishra A (>80%),[4] Saumil P. Merchant et al. (86.3%),[5] Dileep Kumar R. et al. (87%),[6] and Rakesh Kakkar et al. 10 (80.5%).[7] The most commonly injured age group (110 cases, 41.5%) was 20–39, and the second most commonly injured age group was 40–59 (101 cases, 38.1 %). The age group of 20-39 was the most engaged riders; this could be the reason for such an outcome in our study. Because this age group represents the backbone of the Indian economy, when people in the age group become injured or disabled, it affects the economic prosperity and development of the country. Mashreky et al.[8] reported that the age group of 18–45 is the most vulnerable, which aligns with our findings.

In this study, 194 of the 265 cases (73.2%) were reported to have fractures. Among them, we found that the most typical sites of fracture were the head and neck (94 cases, 48.5%), followed by the lower limbs (61 cases, 31.4%) and upper limbs (60 cases, 30.9%), respectively. Another study by Ranjana Singh, Hemant Kumar Sing, et al.[9] in contrast, found that the most typical fracture site was the lower limb, followed by the upper limbs and skull bones.

There were 205 (77.4%) external injury cases in this study; the most common sites involved were the head and neck (131 cases, 63.9%), followed by the lower and upper limbs. The higher rate of head and neck injuries and fractures could be due to wearing a helmet but not tying the straps properly or by a lack of awareness that helmets are designed for individual safety and not simply as a cover to avoid legal prosecution. Another study by Arun Prakash K.S, Sanjeev K. et al.,[10] found that there was a higher rate of head and neck injuries followed by injuries of head, neck and lower limb and head, neck and upper limb.

Among injuries, laceration (54 cases, 41.2%) was the most common followed by abrasion & laceration in the head and neck. In the lower limb, abrasion (26, 37.1%) was the most common, followed by laceration. In the upper limb abrasion (36,52.9%) followed by laceration and in abdomen and thorax abrasion was the most common external injury.

Conclusion:

For medico-legal evaluation of injuries, one needs the skill to differentiate between blunt and sharp force trauma. Police enquiry is mainly based on eyewitness statements. However, although such statements must be considered, they cannot be indiscriminately taken as factual. Emotions such as sorrow and guilt frequently taint eyewitness accounts, resulting in distorted, exaggerated, and misleading information. In a few cases, no one witnessed the accident, and the victim was later found by the roadside. Therefore, it is necessary for the vehicular and roadside evidence to corroborate the injuries documented by the doctor. Only enforcing strict laws, educating people on road safety, creating safe road infrastructure, and ensuring good governance and post-crash response times can reduce the number of fatalities.

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

Conflict of interest: None to declare.

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ORIGINAL ARTICLE

Study of Suicide Cases in Bhopal Region: An Autopsy Study

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Abstract:

The act or incident of voluntarily and intentionally taking one's own life. Suicide is not a new phenomenon in human history; suicide is as old as mankind itself, and its origins may be traced all the way back to the dawn of civilization. The present study was conducted in the department of Forensic Medicine and Toxicology Gandhi Medical College, Bhopal, Madhya Pradesh on a total of 686 cases of suicide brought to the mortuary for post-mortem examination. Highest proportions of cases 243 (35.3%) were in their third decade of life, implying that suicide is most common in younger age group, followed by people in their fourth decade of life 160 (23.3%). Male victims predominated (68.6%). Present study predicts unemployment and poverty as being one of the important risk factors for suicide. Most of the victims belonged to the Hindu religion (93.6%). In my study maximum proportion of cases were married 490 (71.4%), When we look at the presence of any past illness, 19.4% cases were having some form of chronic physical and mental disorders at the time of committing suicides. Although seasonal variation is also significant, the present study reveals highest number of cases in summer season (75.7%). Most common mode of committing suicide was hanging 306 (44.61%), followed by poisoning 283 (41.25%). Least proportion i.e., 1 (0.15%) of deceased chooses firearms as mode of committing suicide.

Keywords: Autopsy; Suicide methods; Poisoning; Hanging.

Introduction:

The act or incident of voluntarily and intentionally taking one's own life. Suicide is not a new phenomenon in human history; suicide is as old as mankind itself, and its origins may be traced all the way back to the dawn of civilization. Suicide is linked to a wide range of factors in India, including poverty, low literacy, unemployment, family violence, the breakdown of the joint family system, unfulfilled romantic ideals, inter-generational conflicts, crop failure, rising cultivation costs, huge debt burden, unhappy marriages, harassment by in laws and husbands, dowry disputes, depression, chronic physical illness, alcoholism/drug addiction, and easy access to means of suicide, expected fear of failing in school/exams or performing below expectations, as well as anxiety of being unable to cope with the circumstance, harassment in the workplace or sexual harassment, people with impulsive personalities and those with a borderline personality.

Suicide, according to Durham, is "death resulting directly or indirectly from a positive or negative act of the victim himself, which he knows will create this result." Suicide is common, and no society or culture has been spared from it, albeit the toll varies by location. Suicide is a very common occurrence in today's world. In 2015, 828,000 people died by suicide around the world.[1]

Suicides in India surged to 230, 314 in 2016, accounting for 17% of all suicides worldwide. In both the 15–29 and 15–39 years age group, suicide was the most common cause of death.[2] In India, over 46,000 suicides occurred in the 15–29 and 30–44 age ranges in 2012, accounting for about 34% of all suicides. In India the National Crime Research Bureau (NCRB), 2010, in their annual report on Incidence and Rate of Suicides during the Decade (2000-2010) have reported that, more than one lac persons (1,34,599) in the country lost their lives by committing suicide during the year 2010.[3] Recognizing the pattern of suicide in a certain location not only aids in the early care of such cases, but also proposes implementing preventative actions at an earlier stage.

Developing suicide prevention programs requires determining the cause(s) of suicide and the factor(s) that caused the suicidal behavior. In India, community based preventive programs must be established with an awareness of the region's economic and cultural norms, with a focus on primary and secondary prevention of factors linked to suicide risk. Help agencies in society should be enhanced to support persons in interpersonal crisis, and mechanisms to limit access to pesticides and other suicide techniques must be developed.

The view that suicide cannot be prevented is commonly held view among health professionals. In light of these facts, and the severity of the problem and the lack of recent data, the current study attempted to conduct a complete and detailed analysis of suicides in terms of many epidemiological factors.

Materials and methods:

This is prospective study of suicidal deaths conducted at the mortuary of Gandhi medical college, Bhopal from January 2020 to September 2021. After ruling out exclusion criteria by general

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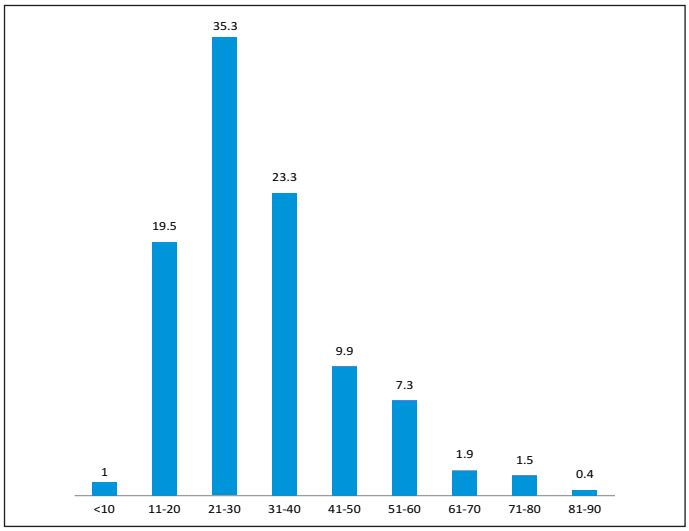

Figure 1. Distribution of cases according to age.

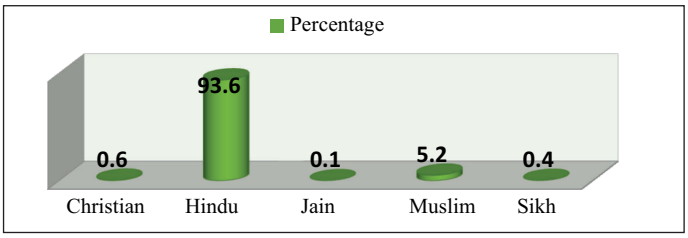

Figure 2. Proportional distribution of cases according to religion.

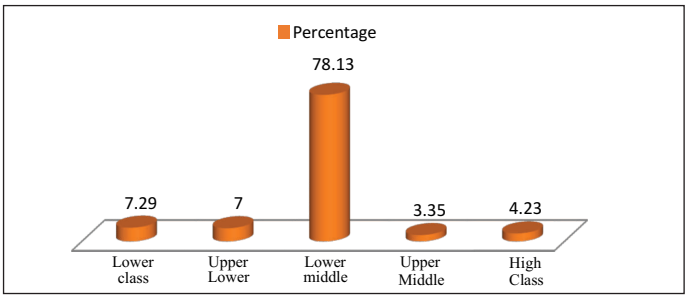

Figure 3. Distribution of deceased according to their socio-economic status.

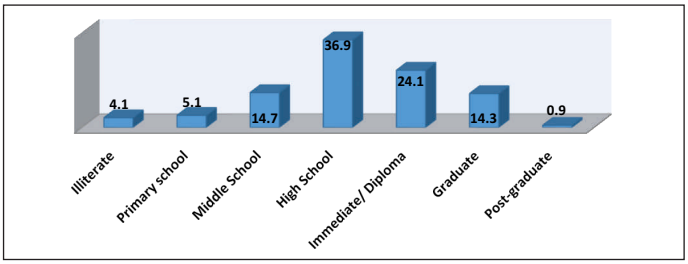

Figure 4. Proportional distribution of cases according to the education.

questions (age, religion, marital status, education, occupation, socio-economic status etc. who has apparently died by suicide?) from the closest persons or next of kin.

Material: A simple question paper sheet containing valid questions containing relevant information about the cases.

Limitations: The family members' hesitation to disclose reasons due to social stigma and not giving whole history is a limitation to this study.

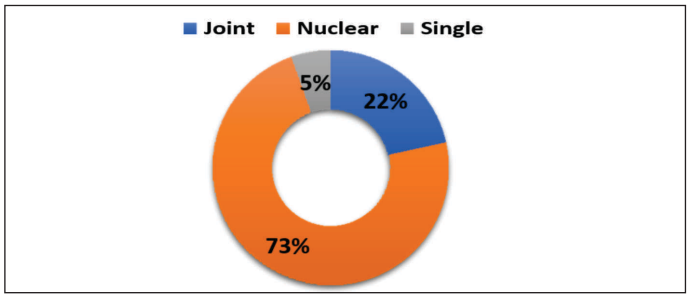

Figure 5. Distribution of cases according to the family type.

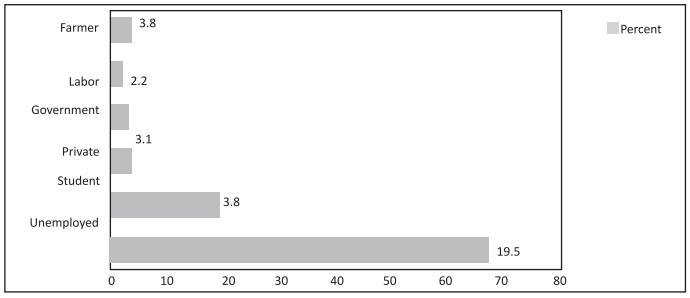

Figure 6. Proportional distribution according to occupation.

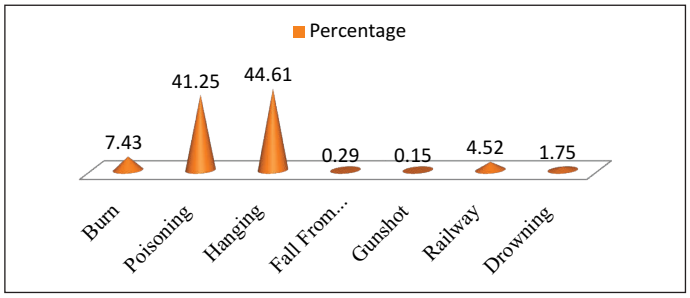

Figure 7. Distribution of cases according to means adopted for committing suicide.

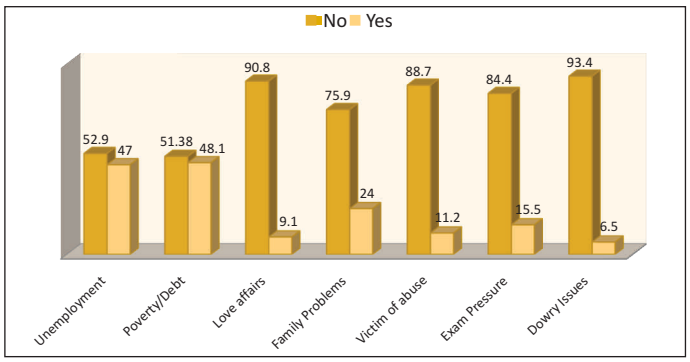

Figure 8. Proportional distribution according to causes of suicide among total cases.

Result and observations:

During the period from January 2020 to September 2021 a total of 686 cases were reported as suicidal deaths which were studied. Suicidal deaths constituted 15.3% of the total autopsies 4478 conducted during the study period in the department of forensic medicine and toxicology, Bhopal. Male predominate the study with the gender ratio of 2.2:1 showing that males are more prone to suicidal deaths. The maximum incidence of cases was seen in the third decade of life closely followed by fourth decade of life mainly younger age group was affected.

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Table 1. Distribution of cases according to age.

Age (in years)	Frequency	Percentage
<10	7	1.0
11-20	134	19.5
21-30	243	35.3
31-40	160	23.3
41-50	68	9.9
51-60	50	7.3
61-70	13	1.9
71-80	10	1.5
81-90	3	0.4
Total	686	100.0

Mean age ± SD of the cases in study 32± 13.9.

Table 2. Proportional distribution of cases according to religion.

Religion	Frequency	Percentage
Christian	4	0.6
Hindu	642	93.6
Jain	1	0.1
Muslim	36	5.2
Sikh	3	0.4
Total	688	100.0

Table 3. Distribution of deceased according to their socio-economic status.

SES	Frequency	Percentage
Lower class	50	7.29
Upper Lower	48	7.00
Lower middle	536	78.13
Upper Middle	23	3.35
High Class	29	4.23
Total	686	100

In present study majority of people committing suicide were Hindus followed by Muslims. Highest proportion of deceased belongs to lower middle socio-economic class. Majority of the deceased had education up to High school followed by those who had Immediate/Diploma, least proportion of deceased were postgraduates i.e., 0.9%. Majority of the suicide cases were literate i.e., 95.9%.

In present study majority of deceased who committed suicide were living in nuclear family 501 (73.03%), followed by joint family 148 (21.57%) and least number of them were those who were living alone 37(5%). In present study majority of the cases that committed suicide were unemployed (67.6%), followed by students (19.5%), then followed by farmers (3.8%), who were employed by private companies (3.8%), government employees (3.1%) and least proportion were labor (2.2%) by occupation. Maximum proportion of cases were married 490 (71.4%), followed by cases who were unmarried i.e., 187 (27.3%). Least proportion was comprised by cases that were separated i.e., 1 (0.1%). Most common mode of committing suicide was hanging 306 (44.61%), followed by poisoning 283 (41.25%). Least proportion i.e., 1 (0.15%) of deceased chooses firearms as mode of committing suicide. Majority of the suicide were committed in the summer season 519 (75.7%), followed by Rainy season 89 (13%), while least number of suicides were committed in winter season 78 (11.4%). April was the month with a greater number of mortality cases. Majority of the deceased did not leave suicide note i.e., 646 (94.16%). Majority of the deceased did not attempted suicide before. Majority proportion (80.6%) did not have any history of long-term illness. Main risk factors for committing suicide in males were unemployment followed by poverty/debt, exam pressure.

Main risk factors for committing suicide in females were family problem, abuse, dowry issues. Love affair was equally seen in both genders. Substance abuse, hopelessness, guilt, despair of life, panic attacks were most common symptoms associated with

Table 4. Proportional distribution of cases according to the education.

Education	Frequency	Percentage
Illiterate	28	4.1
Primary school	35	5.1
Middle School	101	14.7
High School	253	36.9
Immediate/ Diploma	165	24.1
Graduate	98	14.3
Post-graduate	6	0.9
Total	686	100.0

Table 5. Distribution of cases according to the family type.

Type of family	Frequency	Percentage
Joint	148	21.57
Nuclear	501	73.03
Single	37	5.39
Total	686	100.00

Table 6. Proportional distribution according to occupation.

Occupation	Frequency	Percentage
Unemployed	464	67.6
Student	134	19.5
Private	26	3.8
Government	21	3.1
Labor	15	2.2
Farmer	26	3.8
Total	686	100.0

Table 7. Distribution of cases according to means adopted for committing suicide.

Means adopted for committing suicide.	Frequency	Percentage
Burn	51	7.43
Poisoning	283	41.25
Hanging	306	44.61
Fall from Height	2	0.29
Firearm	1	0.15
Railway	31	4.52
Drowning	12	1.75
Total	686	100.00

Table 8. Correlation between gender and causes of suicide.

Cause of attempting suicide		Male	Female	Total	Chi-square	p-value
Unemployment	No	157	206	363	234.551a	.000*
	Yes	315	8	323		
Poverty/Debt	No	164	192	356	178.250a	.000*
	Yes	308	22	330		
Love affairs	No	431	192	623	.449a	.503
	Yes	41	22	63		
Family problems	No	403	118	521	73.715a	.000*
	Yes	69	96	165		
Victim of violence/abuse	No	466	143	609	150.427a	.000*
	Yes	6	71	77		
Exam pressure	No	409	170	579	5.819a	.016*
	Yes	63	44	107		
Dowry issues	No	472	169	641	106.220a	.000*
	Yes	0	45	45		

males which also shows statistical significance. The most common symptoms associated with females were emotional instability and regret to be born.

Discussion:

Suicide has a wide range of reasons and conditions that are difficult to classify and categories. Poisoning, hanging, drowning, and other methods of suicide are commonly used in India. Others are leaping from a great height, jumping in front of a moving train, etc. Suicide trends differ greatly depending on period, place, age group, sex, and race. The present study was conducted from January 2020 to September 2021 to assess the load of suicide related deaths.

In present study, the age group which is affected is mainly 21 to 30 years of age group and Mean age ± SD of the cases in study 32± 13.9. Highest proportions of cases 243 (35.3%) were in their third decade of life, implying that suicide is most common in younger age group, followed by people in their fourth decade of life 160 (23.3%). (Table-1) (Figure-1) Least proportion of patient belonged to elderly age group of 80-90 years i.e., 3 (0.4%) which is similar to other studies like Rastogi and kocheret et al.,[4] SC Gupta,[5] Charan K Shetty,[9] B S Chavan et al.,[10] Binaya K Bastia et al.,[11] J Prasad et al.,[15] Manjeet et al.,[12] Anil Rane et al.,[17] Sachidananda Mohanty et al.,[18] Binaya k Bastia et al.,[19] M arun et al.[23]

In our study majority of cases were Male 472 (68.6%) implying male have higher tendency to commit suicide. Female proportion was comparatively less i.e., 214 (31.1%). This is similar to studies of Suneet et al.,[6] P.N. Suresh et al.,[8] Charan K Shetty [9] Manjeet et al.,[12] J Prasad et al et al.,[15] Tanuj Kanchan et al.[20] Tanuj Kanchan et al.[21] Tanuj Kanchan et al.[22] M Arun et al.[23] In contrast with the studies like Rastogi and kocher et al.,[4] Vandhan Gajalakshmi[7] where female suicide are more than male suicide and in studies like Sachidananda Mohanty et al.[18] number of male suicide is equal to female suicides.

According to our study majority of cases who committed suicide were Hindu (93.6%), followed by Muslims (5.2%), Christians (0.6%), Sikh (0.4%) and least proportion were Jain (0.1%) (Table-2) (Figure-2). The findings are similar to P.N. Suresh et al.,[8] Charan K Shetty[9] Tanuj Kanchan et al.[20] In India, a major part of the population follows Hinduism as their religion.[23] Except for a few rare cases of Christians and Muslims, practically majority of the victims were Hindus.

From the present study the highest proportion of deceased belong to lower middle socio economic class i.e., 536 (78.13%), followed by Lower class 98 (14.29%) including both Lower class and Upper Lower class. Least proportion of deceased was from Upper-middle class i.e., 23 (3.35%) (Table-3) (Figure-3). The findings are different from studies like Sunil et al., [6] Anil Rane et al.,[17] Sachidananda Mohanty et al.[18] were highest proportion of deceased belong to lower socio-economic status. The socioeconomic disadvantage includes low income, unmanageable debt, lack of good housing conditions, and lack of educational qualifications, unemployment, and living in a socioeconomically deprived area. In present study majority i.e., 36.9% of the deceased had education up to High school followed by those who had Immediate/Diploma (24.1%). Least proportion of deceased was post graduates i.e., 0.9% (Table-4) (Figure-4). The findings were identical with the studies done by Ashish Srivastava et al [13] and Sachidananda Mohanty et al.[18] According to my study Majority of the suicide cases were literate i.e., 95.9% and only a small proportion of them were illiterate i.e., 4.1%. This is in contrast with the study conducted by Sachidananda Mohanty et al.[18] in which majority of cases committed suicide were illiterate and less educated. Majority of deceased who committed suicide were living in nuclear family type 501 (73.03%), followed by joint family 148 (21.57%) and least number of them were those who were living alone 37 (5%) (Table-5) (Figure-5). These results are consistent with the study done by Suneet et al.[6] Majority of the cases that committed suicide were unemployed (67.6%), followed by students (19.5%), then followed by Farmers (3.8%), who were employed by private companies (3.8%), government employees (3.1%) and least proportion were labor (2.2%) by occupation. My results are consistent with the studies done by Suneet et al,[6] P.N. Suresh et al,[8] Binaya K Bastia et al.,[19] in which unemployed males and students mainly commits suicide.

Majority of the cases that committed suicide were unemployed (67.6%), followed by students (19.5%), then followed by farmers (3.8%), who were employed by private companies (3.8%), government employees (3.1%) and least proportion were labor (2.2%) by occupation (Table-6) (Figure-6). My results are consistent with the studies done by Suneet et al.,[6] P.N. Suresh et al,[8] Binaya K Bastia et al.,[19] in which unemployed males and students mainly commits suicide.

In my study maximum proportion of cases were married 490 (71.4%), followed by cases who were unmarried i.e., 187 (27.3%). Least proportion was comprised by cases that were separated i.e.,1 (0.1%). 490 cases out of 686 cases were married that is similar to studies conducted in other parts of India [18, 23, 24] In fatal deliberate self-harm married people outnumbered unmarried people in studies done by Rastogi et al,[4] Suneet et al.,[6] P.N. Suresh et al. [8] Charan K Shetty et al., [9] Ashish Srivastava et al.[13] Shubangi et al., [16] Sachidananda Mohanty et al,[18] M arun et al.[23] According to study done by Binaya K Bastia et al.,[19] married females and unmarried males are more prone for suicide. The two main reasons for this are marital disharmony and financial burden. In western studies there is high incidence of suicide in unmarried people.

According to our study highest proportion comprised of people who choose mode of committing suicide as hanging 306 (44.61%), which was closely followed by people who committed suicide by poisoning 283 (41.25%). Least proportion i.e., 1(0.15%) of deceased chooses firearms as mode of committing suicide. (Table-7) (Figure-7) Our findings are similar to BS Chavan et al., [10] Manjeet et al.,[12] P.N. Suresh et al,[8] Tanuj Kanchan et al.,[21] J Prasad et al.,[15] Anil Rane et al.[17] Sachidananda Mohanty et al.[18] But in contrast to the studies done by Rastogi et al.,[4] Charan K Shetty et al.,[9] M Arun et al.[23] poisoning is the most common mode of suicide. Hanging is universally available and it is the most common method of suicide globally[18,23] in a study conducted by Alok Sinha et al.,[14] most common method of suicide was

firearm. The easy availability of weapons in many regions makes them potentially harmful, particularly among male teens and young adults.[25, 26] Majority of the deceased did not leave suicide note i.e., 646 (94.16%) while only 40 (5.83%) of them left a suicide note for their kin. These same finding witnessed in study of Sachidananda Mohanty et al.[18] in which out of 588 cases 5% people leave a suicide note behind. Leaving a suicide note means it was not a sudden thought the person was planning the suicide for a long time so majority of suicides were sudden and in anguish.

As reported by the family members majority i.e., 629 (91.69%) of the deceased did not attempted suicide before, while 57 (8.3%) had history of previous attempt at suicide. These people having history of previous attempts are a group of people that we can help and counsel. Majority proportion (80.6%) did not have any history of long-term illness, whereas on 19.4 % had history of past illness suffering from a variety of chronic physical and mental illnesses at the time of their deaths mainly hypertension, diabetes, lung, breast, and stomach cancers, as well as mental illnesses including schizophrenia, bipolar disorder, and depression. Findings consistent with the studies of Charan k Shetty et al.,[9] BS Chavan et al.[10] which 26.5% and 33.6% people having previous illness. In studies done by S.C. Gupta et al.,[5] 62 % people present with previous psychiatric problems in which 24% were suffering from depression, 14% from neurosis and 12% from schizophrenia. According to Manjeet et al[12] study and Ashish Srivastava et al[13] 52.5% and 54% people were suffering from depression respectively. In study by Tanuj Kanchan et al [22] 10.9% males and 27.8% females were in depression.

According to our study there was increased number of incidences of suicide during moths of April (25.7%), May (24.1%) and March (18.8%) this coincides with the time period of 1st and 2nd wave of Covid-19 in India. Least incidences were noted during the month of September i.e., 1.5%. Findings are similar to Tanuj Kanchan et al.[20] The COVID-19 epidemic has resulted in the imposition of severe restrictions that are having a significant impact on the global economy, including a rise in the global unemployment rate, and isolation. The month of April and May are post harvesting period and make it more prone for farmers and also exams in India are mainly held in these months.

In our study cause of death due to unemployment (66.7% among males and 3.7% in females), poverty/debt (65.2% among males and 10.2% in females) and exam pressure (13.3% among males and 20.5% in females) were mainly seen in the males which shows statistically significant association. Family problems (14.6% among males and 44.8% in females), Victim of abuse (1.2% in males and 33.1% among females) and Dowry issues (0% males and 21.0% Females) were mainly the risk factors of suicide in Females that shows statistically significant association (Table-8) (Figure-8).

Whereas, love affair was equally seen in both genders hence do not show any statistical significance. Unemployment is main reason in males for suicide this is similar to study done by Binya K Bastia et al.[19] Intense competition among school children, high expectation from parents and teachers, and inability to attain their goals are the main reasons for such suicides.[27] It may be due to ignorance of parents related to the problems of their child or may be due to lack of good communication with their children. There is no doubt that many dowry death instances go unreported, implying that the true number of dowry fatalities and atrocities is higher than the current data suggest. Approximately 15000 dowry deaths are estimated per year in which mostly are kitchen fires designed to look like accidents[28, 29] Mukherjee et al.[30] tried to figure out why dowry killings and other crimes against women differed so much across the country. They determined that the geographical concentration of dowry fatalities is in the northern region of India, based on NCRB data from three years (1995 to 1997). Women's age upon marriage has a significant impact on their family life. To avoid having to pay a large dowry and to relieve their daughters of their responsibilities, parents are marrying off their daughters as soon as possible. Young females are not able to cope with the harassment from the husband side and they think that there is no option rather than suicide.

According to our study we found there is substance abuse (29.6% among males and 0% in females), hopelessness (80.2% among males and 0.9% in females), guilt (73.7% among males and 0.9% in females), panic attack (7.2% among males and 0% in females) and despair with life (46.3% among males and 30.8% in females) was the most common symptoms associated with males which also shows statistical significance. The most common symptoms associated with females were emotional instability (0% males and 54.2% among females) and regret to be born (11.2% among males and 26.6% in females).

Whereas symptoms like isolation, self-criticism and talking about dying was equally seen in both the genders. Substance abuse is a slow methods and chronic method of self-intoxication and suicide. Substance abusers want to escape the reality. Drug abuse and drinking is more in males mainly because it is considered as male masculinity in our society. It is looked like a masculine role coping mechanism.

Conclusion:

Suicide is considered a public health issue that requires immediate attention in terms of prevention and additional study into the social and psychological aspects. The World Health Organization's (WHO) suicide prevention multisite intervention research on suicidal behavior (SUPRE-MISS) has indicated that it is feasible to prevent suicidal behavior to lessen the number of people who die by suicide by using a low-cost, quick intervention nations in development. To establish and implement a national plan that is cost-effective, appropriate, and relevant to community needs, collaboration, coordination, cooperation, and commitment are required. Suicide prevention in India is more of a social and public health goal than a standard mental health intervention. The moment has come for mental health professionals to take a proactive and leadership role in suicide prevention, saving thousands of young Indians' lives. Further it is concluded that psychological autopsy just like physical autopsy can be a useful tool to investigate the antecedent of death and revels the deceased contribution to their own death.

Conflict of Interest : The author has no conflict of interest to declare.

Source of funding: None.

Ethical clearance: the study was approved by Institutional Ethical Committee.

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ORIGINAL ARTICLE

Evaluation of Patterns of Comorbidities Among Patients Admitted for Elective and Emergency Surgery for Avoiding Medico-Legal Conflict

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Abstract:

Comorbidity, defined as several diseases in a patient connected through proven pathogenic mechanisms, necessitates identifying the diseases requiring primary and subsequent treatment. The comorbid condition may invite unnecessary conflict while treating surgically, which needs special pre and post-operative attention. The present study aims to evaluate the prevalence and the patterns of comorbidities among patients admitted for elective and emergency surgery to avoid medico-legal conflict. The present hospital-based prospective observational study was undertaken at the Department of Surgery, Gauhati Medical College and Hospital (GMCH), Guwahati, from June 1, 2018, to May 31, 2019. All patients admitted for elective or emergency surgery, with neither or at most two comorbid conditions fulfilling the inclusion-exclusion criteria, were included in the study. The data were analysed using SPSS V 21. A total of 309 cases were selected for the study. Most of the cases belonged to the age group 20-49 years, males (73%) and belonged to lower socioeconomic status (63.7%). Among females, chronic calculous cholecystitis (62.7%), while among males, hollow viscus perforation (35.4%) and unilateral and obstructed inguinal hernia (23.0%) were mainly reported. Almost 53% of the cases had comorbidity. Anaemia (18.1%), hypertension (16.9%) and type 2 diabetes mellitus (12.0%) mainly were reported comorbidities among females, while among males, type 2 diabetes mellitus (15.0%) and chronic obstructive pulmonary diseases (11.5%) were the most common. Comorbidities were prevalent among the study group. The adult age group is more prone to having one or more comorbidities. Controlling comorbidities in the preoperative phase is crucial in surgery for a better outcome.

Keywords: Comorbidity; Anaemia; Hypertension; Hollow viscus perforation; Type 2 diabetes mellitus.

Introduction:

Current medicine, which boasts a vast range of diagnostic methods and a variety of treatments, emphasises specification. To decide the starting point of treatment and identify the diseases requiring primary and subsequent treatment, it is necessary to evaluate the state of a patient who suffers from several diseases simultaneously. Some authors define comorbidity and multi-morbidity differently, defining the former as several diseases in a patient connected through proven pathogenetic mechanisms.[1]

Medicolegal implications are related not only to postoperative complications as events but also to general malpractice in terms of incorrect surgical indications or lack of basic requirements for surgical practice such as informed consent and failure to identify the comorbid condition. Various causes of comorbidities include anatomic proximity of diseased organs, precise pathogenetic mechanism of several diseases and terminable cause-effect relation between the diseases and one disease resulting from complications of another. Chronic infections, inflammations, involutional and systematic metabolic changes, iatrogenesis, social status, ecology and genetic susceptibility, etc., are the various factors for the development of comorbidity. A practitioner must follow principles while developing a clinical diagnosis for a comorbid patient. The essential premise is distinguishing between primary and secondary diseases and their consequences and concomitant disorders.[2,3] There are currently several generally accepted methods of evaluating comorbidity.[3] Despite the range of approaches for evaluating comorbidity, there must be a single commonly accepted method free of the shortcomings of the current methods' causes' disruption. At the same time, the practitioner is still determining its prognostic influence due to variation in the approach to a comorbid state analysis, rendering the commonly available systems of linked pathology evaluation unreasoned and hence unnecessary. Our healthcare system must increasingly address managing people with comorbidities, who are now the norm rather than the exception. This understanding is responsible for surgeons' rising

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Table 1. Demographic characteristics of the patients.

Characteristics	Subgroup	No. of cases (%)
Age	10-19	15 (4.85)
	20-29	71 (22.97)
	30-39	75 (24.27)
	40-49	60 (19.41)
	50-59	58 (18.77)
	60-69	27 (8.74)
	70-80	3 (0.97)
Sex	Male	226 (73.14)
	Female	83 (26.86)
Religion	Hindu	66 (21.36)
	Muslim	214 (69.25)
	Christian	18 (5.82)
	Buddhism	11 (3.56)
SES	Lower class	197 (63.75)
	Lower middle	102 (33.01)
	Upper middle	10 (3.24)

Table 2. Types of underlying diseases among cases.

Disease	Male	Female	Total
Acute appendicitis	7 (3.1)	5 (6.0)	12 (3.9)
Acute intestinal obstruction	25 (11.1)	20 (24.1)	45 (14.6)
Chronic calculous cholecystitis	28 (12.4)	52 (62.7)	80 (25.9)
Hollow viscus perforation	80 (35.4)	0	80 (25.9)
Obstructed inguinal hernia	22 (9.7)	0	22 (7.1)
Recurrent appendicitis	12 (5.3)	6 (7.2)	18 (5.8)
Unilateral inguinal hernia	52 (23.0)	0	52 (16.8)

Table 3. Types of underlying diseases among cases.

Comorbidity	Male	Female	
None	116 (51.3)	29 (34.9)	145 (46.9)
Anaemia	22 (9.7)	15 (18.1)	37 (12.0)
Chronic obstructive pulmonary disease	26 (11.5)	6 (7.2)	32 (10.4)
Coronary artery disease	2 (0.9)	5 (6.0)	7 (2.3)
Coronary artery disease: post CABG	2 (0.9%)	0 (0.0%)	2 (0.6)
Hypertension	22 (9.7)	14 (16.9)	36 (11.7)
Hypertension and type 2 diabetes mellitus	2 (0.9)	4 (4.8)	6 (1.9)
Type 2 diabetes mellitus	34 (15.0)	10 (12.0)	44 (14.2)

interest in the influence of comorbidity on various outcomes, including mortality, health-related quality of life, functioning, healthcare quality and postoperative outcome. Many a time the comorbid conditions of patients are overlooked resulting in inconveniences including the invitation of legal conflict. Therefore, the present study was undertaken at the Department of Surgery, GMCH, Guwahati to evaluate the prevalence and the patterns of comorbidities among patients admitted to the study hospital for elective and emergency surgery during the study period to prepare the cases for a better outcome, so that medicolegal conflict can be avoided.

Materials and methods:

The present hospital-based prospective observational study was undertaken at the Department of Surgery, Gauhati Medical College and Hospital (GMCH), Guwahati from June 1, 2018 to May 31, 2019. The study comprised all patients admitted to the Department of Surgery, GMCH, Guwahati for elective or emergency surgery during the study period. Institutional ethical committee clearance was obtained before the commencement of the study. Informed consent was taken from all patients or their

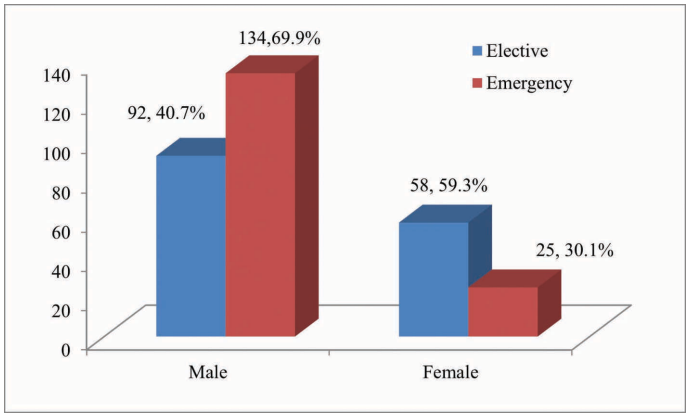

Figure 1. Type of surgery.

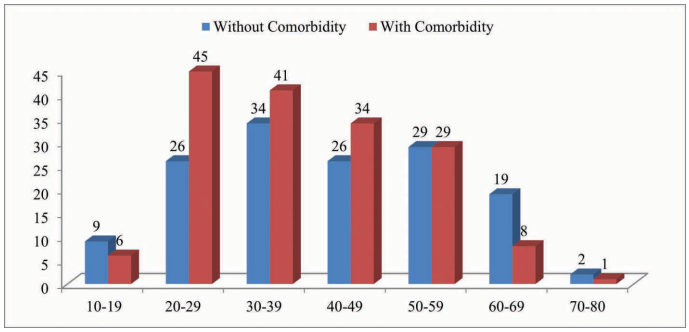

Figure 2. Age-wise distribution of cases with comorbidity.

attendees.

All patients admitted for elective or emergency surgery with none or, at most, two comorbid conditions were included in the study. Patients with more than two comorbid conditions, traumatic cases (blunt trauma and penetrating trauma) and conservatively managed cases were excluded. Patients above 80 years of age were also not included in the study.

A detailed history, including the comorbid conditions and any treatment undergone, was recorded. Preoperative investigations of the patients and additional investigations for comorbid conditions were also undertaken. Appropriate radiological and biochemical investigations were done according to the patient's comorbid condition. The data were recorded on a predesigned questionnaire.

Surgical interventions were undertaken after an adequate preoperative assessment and only after getting informed consent. The ethics committee of GMCH, Guwahati, Assam has approved this research work vide reference, MC/190/2007/Pt-1/IEC/105 dated 05/04/2018.

Statistical analysis: All the data were analysed using the IBM SPSS version 21 software. Data distributions were presented as counts, percentages (numerical summaries) and graphs.

Results:

Three hundred nine cases were selected for the study with a minimum age of 11 and a maximum of 78. The mean (±standard deviation) age was 39.9 (±14.0) years. Most cases belonged to the age group 20-49 years and 73% were males. Most cases (69%) were Muslims and belonged to lower socioeconomic status

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(63.7%), as shown in Table 1. Of the 309 cases, 51.5% were admitted for emergency surgery. Most female (69.9%) cases required elective surgery (Fig 1).

The majority, 26% of the total cases, suffered from chronic calculous cholecystitis and was primarily reported among females (62.7%). Hollow viscus perforation (35.4%) and unilateral and obstructed inguinal hernia (23.0%) were the most underlying diseases among males. Almost 15% of the cases suffered from acute intestinal obstruction (Table 2).

Almost 53% of the cases had been diagnosed with comorbidity. Anaemia (18.1%), hypertension (16.9%) and type 2 diabetes mellitus (12.0%) were the most prevalent comorbidity among females, while among males, type 2 diabetes mellitus (15.0%) and chronic obstructive pulmonary diseases (11.5%) were the most common comorbidity (Table 3). As seen from Fig 2, the highest percentage of cases with comorbidity were reported from those in the third (27.4%) and fourth (25%) decades of their lives. Only 5.5% of the comorbid cases belonged to the elderly age group above 60. Also, comorbidities were less reported among adolescents (3.7%).

Discussion:

Individuals with numerous coexisting conditions which are now the norm rather than the exception, require more attention in health care. This realisation has led to an increase in practitioners' and academics' interest in the influence of comorbidities on various outcomes, including mortality, health-related quality of life, functioning, and healthcare quality. Attempts to research the impact of comorbidity are hampered by a need for more agreement on how to define and quantify the notion.[4] The present time-bound hospital-based prospective study was conducted to determine the prevalent comorbid conditions among patients attending both the elective and emergency setup of Gauhati Medical College and Hospital.

Most participants (66.67 per cent) were in the age group of 20-49 years. The findings coincide with a recent study which estimated that almost 33% of all surgical procedures are required for the Indian population aged 30-49.[5.] Almost 73.1 % of cases were males, while 26.9% were females. Most cases (69.3%) were of Islam religion.

Most of the cases (63.8%) belonged to the Lower Class. Low socioeconomic status serves as a marker for impairment and more advanced disease. Health-related quality of life is highly dependent on the patient's socioeconomic status. Poor quality of life directly impacts perioperative morbid outcomes. Various studies have reported low socioeconomic status as a significant risk factor for adverse postoperative outcomes.[6-8] The comorbidity burden is also reported to be higher among low socioeconomic groups.[9,10]

Chronic calculous cholecystitis was the most reported underlying disease among females (62.7%) in the present study. Gall bladder diseases and calculous cholecystitis are documented as one of the most common lesions among women of the fertile age group.[11] Among male participants, hollow viscus perforation (35.4%) and unilateral and obstructed inguinal hernias (23.0%) were the most typical underlying conditions needing surgery in the present study. Several studies have reported hollow viscus injuries, perforation, and perforation peritonitis more prevalent in males than females.[12,13] Alcoholism and smoking habits among males may play a vital role in the increased risk of gastrointestinal perforation among males.[14] Out of the 309 cases included in the study, almost 53% had been diagnosed with comorbidities. Type 2 diabetes mellitus (14.2%) was one of the most common comorbid conditions among cases irrespective of gender. Patients undergoing surgery with diabetes mellitus have a higher risk of infection, postoperative complications, and in-hospital mortality.[15,16] Anaemia (18.1%) was the most prevalent comorbidity among females. Anaemia is the most everyday haematological condition affecting over one-third of the global population, primarily women, seriously affecting human health.[17-19] Preoperative anaemia is critical in postoperative outcomes, mortality and morbidity.[19,20]

Chronic obstructive pulmonary diseases (11.5%) were males' second most common comorbidity. Patients with chronic obstructive pulmonary diseases had a greater chance of acquiring postoperative morbidities, including pneumonia, respiratory failure, stroke, renal failure, and wound infection.[21,22] In the study, 11.7% of patients had preoperative hypertension (16.9%). Perioperative and postoperative hypertension increases cardiovascular and cerebrovascular activities. Persons with hypertension are at increased risk of haemorrhage and mortality. Thus, hypertensive patients must be treated before major elective surgeries.[23] It is a well-documented fact that hypertension is the most prevalent preventable medical cause for postponing surgery.[24]

The age-specific distribution of the cases shows that comorbidities are most prevalent in the adult age group of 20-59 years. Similar results were reported by Jay F. Piccirillo et al. in their study. They found that conditions like HIV/AIDS, obesity, and illicit drug abuse were more prevalent in younger patients. In contrast, conditions such as dementia and congestive heart failure increased in prevalence and severity across the age spectrum.[25]

Controlling comorbidities in the preoperative phase is crucial in surgery for a better outcome. Before performing elective surgery, a multidisciplinary strategy is required to prepare the case. This necessitates surgeons be well-versed in treating a wide range of comorbid diseases. It is critical to understand the initial management in case of a complication caused by the predominant comorbid condition. However, comorbid conditions cannot be treated in an emergency setting as they can in an elective setting. As a result, anaesthetists play an essential role in this area. Intraoperative communication between surgeons and anaesthetists must be seamless to address any issues resulting from the existing comorbidity. Postoperative care in intensive care units is required until the patient is stabilised.

Limitation: The present study is a hospital-based, time-bound study conducted at only one study hospital. Also, the findings presented here are part of a more extensive study. Only the preoperative observations to assess the spectrum of comorbidity among surgery patients were illustrated here. The intraoperative and postoperative outcomes of the study are not described.

Conclusion:

Comorbidities are prevalent among the study group. The adult age group is more prone to have one or more comorbidities. Anaemia and hypertension were the most common comorbid conditions among female patients. Male surgery patients had type 2 diabetes mellitus and chronic obstructive pulmonary diseases as the most prevalent comorbidity. Multidisciplinary strategy and preoperative optimisation are necessary for planning elective and emergency surgery among patients with comorbid conditions.

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ORIGINAL ARTICLE

Prevalence of Major Depressive Disorder in Survivors of Sexual assault Examined in a Medical College of West Bengal

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Abstract:

Rape is a heinous crime committed against women which has an impact on physical health as well as mental health. Post-traumatic stress disorder and major depressive disorders are commonly encountered by the survivors. This study tries to overview this and find out the prevalence of major depressive disorder in survivors of sexual assault. In general, developing countries are in dearth of data regarding this and the objectives of this study were to find the prevalence of major depressive disorder in adult and adolescent survivors of sexual assault. The study was based on a pre-validated Public Health Questionnaire and scoring was done accordingly. The instruments used were PHQ-9 and PHQ-A in English, Bengali and Hindi. The sample size of the study was 41, out of which 5 refused to give consent. Out of the 36 survivors, 21 (58.33%) were adults and 15 (41.66%) were adolescents. The legal cut-off of 18 years, as prevalent in India was used to classify the study population between adolescents and adults. In 15 adults and 12 adolescents, the perpetrator was known. In 6 adults and 3 adolescent the perpetrator was unknown. Multiple incidences of offence were committed in 24 (66.66%) subjects. Tentative diagnosis of depression was made in 15 (71.4%) adults and 6 (40%) adolescents. In adults, 40% suffered from mild form of major depression. In adolescents, 50% had minimal symptoms and 50% suffered from severe form of major depression. From the study, it can be concluded that Major Depressive Disorder is very much prevalent in the survivors of sexual assault. Interventional, longitudinal studies are required in this field for the proper follow-up and assessment of the survivors.

Keywords: Sexual assault survivor; Psychiatry; Depression; Prevalence.

Introduction:

Sexual assault is perhaps the most heinous crime against humanity which is not only against the body of the survivor but also against her mind. The term "Survivor" often refers to an individual who has survived a trauma and also used when discussing the effects of sexual violence.[1] Sexual violence is a public health problem throughout the world and more so in developing countries and is associated with long-lasting mental and physical morbidity.[2-5] Sexual victimization is associated with emotional, cognitive and behavioral effects.[6] Depression affects 264 million people worldwide[7] and as per the WHO Report "Depression and Other Common Mental Disorders - Global Health Estimates 2017", 4.5% of the population of India suffers from depressive disorders.[8] Survivors are at an increased risk of suffering from anxiety disorders, bulimia or anorexia, alcohol and substance abuse, stress disorders and depression.[9]

In developing countries like India, the total number of incidences of rape have increased from 36735 in 2014 to 38947 in 2016 with an increase of crime rate from 6.1% to 6.3%[10] which clearly shows that there is no decline in incidences of rape even after the enactment of Criminal Law Amendment Act 2013.

Patient Health Questionnaire (PHQ-9) is used for screening, diagnosing. monitoring and measuring the severity of depression.[11] This Patient Health Questionnaire has been modified and validated for children having age of 11 to 17 years and is known as Patient Health Questionnaire 9 modified for adolescents. (PHQ-A).[12] In this study we have used PHQ 9 and PHQ A and DSM IV criteria for diagnosis of Major Depressive Disorders[13] in the survivors who came for examination in the Department of Forensic and State Medicine. Although DSM 5 criteria are in circulation now, we have not used it as the differences are subtle and Structured Clinical Interview for DSM5 Research Version (SCID-5 RV) are not available for free[14] and the questionnaire are not multilingually validated. Thus, the rationale behind this study is to look at this aspect in these victims so that the health system can come up with new formulations to address the current deficiency.

Methodology:

The objectives of this study were to find the prevalence of Major Depressive Disorder in adult and adolescent survivors of sexual assault and to assess the severity in patients diagnosed with Major Depressive Disorder. A descriptive, cross-sectional, non-interventional study was conducted in the Department of Forensic and State Medicine in a Medical College of Kolkata for a period of 6 months based on pre-validated Public Health Questionnaire namely, PHQ-9 and PHQ-A in English, Bengali and Hindi and scoring was done accordingly. Appropriate

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statistical methods were used to analyze the data. Proper quality control and strict confidentiality was maintained through the study. Prior permission for the study was taken from the Institutional Ethics Committee and the certificate was dated 20th July 2020.

Results:

A total number of 41 survivors reported to the department during the study period of whom 5 refused to give consent for the study. Hence, total number of respondents in this study was 36 (Fig. 1). The age range was from 35 to 15 years of age. 21 of respondents were adult and 15 were adolescent. Majority of the respondents were Hindu by faith and preferred English as the language of response, details of which are mentioned in Table 1. Among the respondents, 24 were assaulted multiple times and boyfriend was the perpetrator in majority of the cases as further detailed in Table 2. Neither significant relationship exists between age of the survivor and relation of the perpetrator nor between the age of the survivor and the number of times she was assaulted. The median scores of PHQ-9 and PHQ-A are detailed in subsequent tables. A tentative diagnosis of depression was made in 21 respondents, 15 of which were adults and 6 were adolescents (Table 5). Severe major depression was diagnosed in 3 adults and none of the adolescents (Table 6). 3 of the adolescents attempted suicide at least once in a lifetime as shown in Fig. 2. All the respondents in whom a tentative diagnosis of depression was made were referred to Psychiatry Department, the distribution of whom are shown in Fig. 3.

Discussion:

Sexual assault not only involves physical intimidation and injuries, the psychological effects it imparts on the survivor are profound. They suffer from post-traumatic stress disorder, anxiety, major depressive disorders etc. In recent years, most of the studies have pointed out that mental health issues are a big challenge for the healthcare system with major depressive disorder (MDD) having the highest lifetime prevalence (almost 17%).[15]

A study conducted in USA showed that 25% of women claimed to have experienced sexual assault at some point of their college life.[16] A study also found that age was associated with depression which shows that sexual assault in a tender age helps to cope up better with the adversities than that in the elderly age group.[17] Australian studies have shown that women who have experienced even one incidence of sexual assault have higher anxiety levels than those who have not experienced any such incident.[18,19] Studies conducted in South Africa emphasizes that factors such as lower levels of education, poverty and poor living areas are associated with vulnerability of a survivor.[20] It is not clear that whether survivors who have experienced sexual assault both in childhood and as an adult are more vulnerable to experience mental health issues than those who have experienced assault only as adult.[21]

Studies have shown sexual assault is associated with long term physical and mental health issues, high-risk taking activities and premature death.[22-24] In USA, data from the National Women's Study shows lifetime incidence rate of PTSD in women suffering sexual violence to be 31% in comparison to 5% of non-victims of crime. Moreover, 30% of victims of rape suffered depression once in a lifetime.[25] Depression and PTSD may be results of common pathogenic mechanisms.[26] Resilience factors clustering like personal competence, strengthening effects of stress, trust in one's own instincts, social support and spirituality maybe underlying mechanisms.[27] Drug and alcohol facilitated sexual assault has been associated with history of past substance abuse.[28-31] However, not incapacitated but forceful rape was the strongest predictor of PTSD and depression.[32] According to another study, most of the victims who appear to be depressed within the first month are not likely to be classified so after a period of six months.[33] PTSD also occurs as an aftermath of sexual assault and identifying the vulnerable survivors at the earliest and directing appropriate therapies can reduce the disease burden.[26]

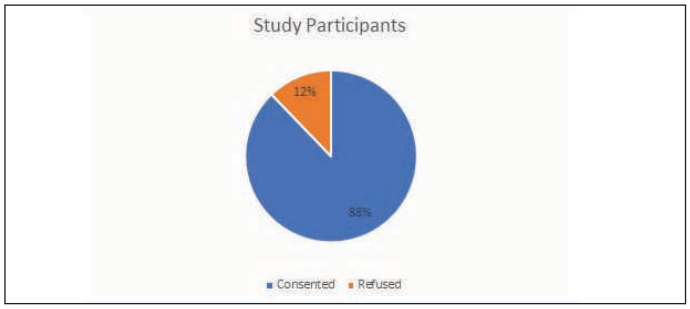

Figure 1.

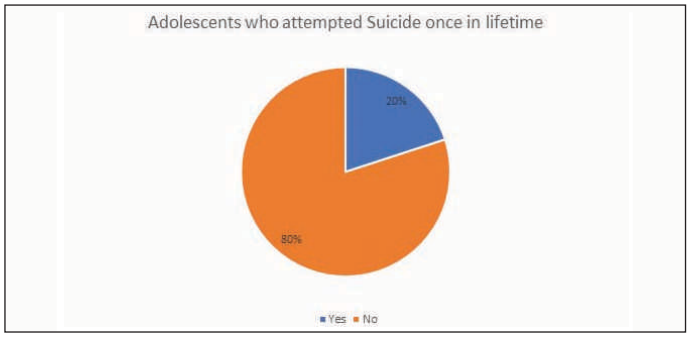

Figure 2.

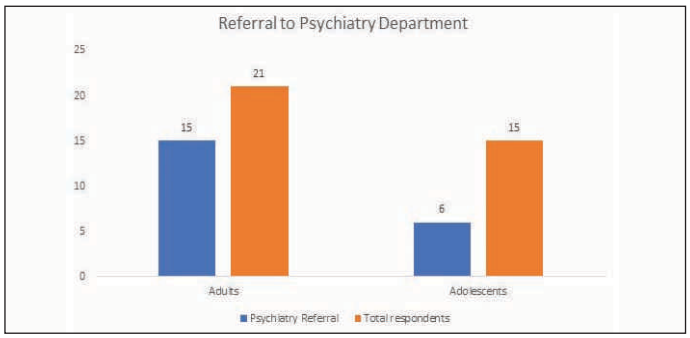

Figure 3.

A 17 min video was used as a tool of psychological intervention. The video consisted of information about the forensic examination and prevention of common trauma related reactions including substance abuse.[34] A briefer version of video intervention was tested in 2015 which helped to reduce anxiety symptoms at 2 month follow up. However, no effects were

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observed on PTSD symptoms.[35] Recently, pleasant imagery and relaxation instruction was used which also reduced substance abuse among survivors of sexual assault. General practitioners are also suited to identify, support, treat and/or appropriately refer women with a history of sexual violence as they are often the first point of contact.[22-24] Support groups are required in the society to provide guidance to the survivors and alleviating social anxiety which plays a significant role in healing process of the survivor.[37]

Research is required to find the risk factors for the development of psychiatric symptoms among survivors which may include, self-blame, substance use, perpetrator relationship and reduced help seeking behaviors. Future studies should include researches based on different ranges of behaviors including interpersonal violence and also tailor-made interventions based on rape experiences. Such longitudinal studies should aim at identifying important correlates of victimization and improving risk reduction and treatment outcomes among survivors.[38] Support groups play a pivotal role in alleviating the social anxiety of the survivors.[37] Structural interventions are key for reducing vulnerability of women enabling them to fulfill their social and economic development.

In this study, a total number of forty-one survivors fulfilled the criteria for inclusion in the study during the study period. Out of them 36 consented for the proposed study. Among the study participants, 21 were adult and 15 were adolescent. No sampling method was used as the condition studied is rare.

Table 1. Demographic characters of the respondents.

Age of respondent	Number of respondents	Religion of respondents			Language of response		
		Hinduism	Islam	Others	English	Hindi	Bengali
Adult	21	12	06	03	06	09	06
Adolescent	15	08	07	00	08	03	04
Total	36	20	13	03	14	12	10

Table 2. Number of times offences committed and survivor-perpetrator relationship.

Age of respondent	Number of times offences committed		Relationship between survivor and perpetrator			
	Single	Multiple	Close Relatives	Boyfriend	Neighbor	Unknown
Adult	09	12	06	06	03	06
Adolescent	03	12	03	06	03	03
Total	12	24	09	12	06	09

Table 3. Table showing median score of Questions 1 to 9 of PHQ-9 as reported by adults.

Questions	Score (Median)
Little interest or pleasure in doing things	2
Feeling down, depressed or hopeless	2
Trouble falling or staying asleep, or sleeping too much	2
Feeling tired or having little energy	2
Poor appetite and over eating	1
Feeling bad about yourself or that you are a failure or have let yourself or your family down	1
Trouble concentrating on things, such as reading the newspaper or watching the television	1
Moving or speaking so slowly that other people could have noticed, or the opposite – being so fidgety or restless that you have been moving around a lot more than usual	1
Thoughts that you would be better off dead, or of hurting yourself	0

Table 4. Table showing median score of Questions 1 to 9 of PHQ-A as reported by adolescents.

Questions	Score (Median)
Little interest or pleasure in doing things	0
Feeling down, depressed or hopeless	2
Trouble falling or staying asleep, or sleeping too much	2
Feeling tired or having little energy	1
Poor appetite and over eating	0
Feeling bad about yourself or that you are a failure or have let yourself or your family down	1
Trouble concentrating on things, such as reading the newspaper or watching the television	1
Moving or speaking so slowly that other people could have noticed, or the opposite – being so fidgety or restless that you have been moving around a lot more than usual	1
Thoughts that you would be better off dead, or of hurting yourself	0

Table 5. Prevalence of depression among respondents.

Study population	Depression		Total	Prevalence Percent
	Yes	No		
Adults	15	6	21	71.4 %
Adolescents	6	9	15	40 %
Total	21	15	36	

Table 6. Severity of depression among the respondents.

PHQ – 9 Score	Provisional Diagnosis	Number of adults (N= 15)	Number of adolescents (N= 6)
5 -9	Minimal symptoms	3	3
10-14	Major Depression, Mild	6	2
15-19	Major Depression, moderately severe	3	1
≥ 20	Major Depression, severe	3	0

The sample was divided into two groups- adults and adolescents. The median age of the adult group was 24 years and the median age of the adolescent group was 16 years. 67% of the study population was Hindu, 25% Muslim and 8% belonged to other religions. As per the census 2011, in the state of West Bengal 70.54% are Hindu and 27% Muslim.[39] So based on religion, the study sample was more or less a representative sample.

Most of the study sample preferred English as the mode of the response followed by Bengali and Hindi. The preference of English as mode of response other than vernacular could possibly be explained by the place of the study which is urban and good level of primary education in the state. The median gap between first incidence and lodging complaint in the adults is 5 months and for adolescents is 6 months. This is not very uncommon scenario in this country and some media reports even calculate that up to 85.2% of sexual violence is underreported.[40] Most of the studies conducted were 4 to 6 weeks after the incidence which is concurrent with this study as at least a gap of 4 weeks was present in between the study and the last incidence of sexual assault.

This study divided perpetrators into four categories – close relatives including husband and in-laws, boyfriend, neighbor and unknown. In 75% of the subjects the offender was known to the survivor which is lower than the National Crime Records Bureau data 2017 which puts the figure as 93%. Age of the survivor and her relationship with the perpetrator had no significant relationship. This is inconsistent with the common notion that non-adults are more susceptible to sexual assault by close

relatives. Possibly this inconsistency is because of less difference in median age of the two population.

In the study population, 75% were victims of sexual assault for multiple times. This possibly points out the vulnerability of our female population and possible intimidation faced by them in cases where the perpetrator is known. This is consistent with a study conducted in South Africa which also found more than half of the survivors were victimized for multiple times.[20] No significant relationship was obtained between age and number of times the survivor was subjected to rape.

The PHQ-9 and PHQ-A was used to make tentative diagnosis of major depressive disorder and also to classify its severity. The PHQ-A has a specific question about attempt to commit a suicide ever in the lifetime and 40% of the adolescent respondents replied affirmatively. In a study conducted in Brazil a suicide risk of 8.6% was assessed in the study population.[41] Possibly this indicates a very alarming situation. Further research and immediate intervention are required from the policymakers to avert any loss of life of the survivors.

In this study, a 71.4% prevalence of depression was recorded in the adult age group and 40% in the adolescent age group. Study from South Africa showed a prevalence of major depressive disorder in 84.3% of the study population.[42] A study in Australia found out 52.4% women suffering from depression after sexual assault.[43] Another study conducted in Brazil, found a prevalence of depression as 10%.[41] The prevalence of depression varies a lot according to countries and the methodology applied for diagnosis. The findings obtained in the study are more or less in concordance with previous studies.

Moderate to severe depression was found in 40% of the adult population and 50% of the adolescent population. In a study conducted in Sweden, 47% of the women were diagnosed to be suffering from moderate to severe depression.[17] This result is in concordance with the previous study.

This study shows that no significant difference exists for risk of development of major depressive disorder between adults and adolescents. Other studies had found that coping up with major depressive disorders is better in survivors who experienced sexual assault in a tender age.[17] This study was cross sectional and drawing out any such inference was beyond the scope of this study.

Conclusion:

A lot of empathy is required while dealing with survivors of sexual assault. Refusal of some survivors to participate in study possibly indicates requirement for better development of soft skills of the researcher. Sensitization regarding bad touch and good touch should be started from the very early formative years of children. Depressive disorder was present in both adults and adolescents indicating the need for screening of psychiatric illness during the clinical forensic examination. Survivors needed referral to Psychiatry Department which strengthens the idea of comprehensive care for survivors under one roof. In developing countries, with poor resources and both sexual assault and psychiatric illness being taboos, it is often under reported, if not unreported. This study is one of the pioneer studies in this part of the world and shows the importance for more comprehensive care for the vulnerable survivors.

Conflict of interest (if any): A part of this study was done as a part of Short Term Studentship under Indian Council of Medical Research (Ref. No. 2020 – 10475) for a period of two months during 2021 under the guidance of the corresponding author and the report was found to be satisfactory.

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ORIGINAL ARTICLE

Study of Perceptions toward Humanitarian Forensic: a novel - Humanly Approach

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Abstract :

Humanitarian Forensic Action, is a concept which has been brought by the International Committee of the Red Cross (ICRC), it refers to the applicability of forensic science and technology to address the needs of the victims of catastrophes for humanitarian, rather than criminal, purposes. Most of time Forensic Medicine and science is viewed in relation to crime, offence and justice involving victims or offenders. The concept of humanitarian forensic is predominantly focussed on dignified management of victims and grieved society. Forensic and forensic approaches are not much appreciated by community. There is a widely prevailing myth in the society that forensic is about investigation, crime, postmortem etc. People avoid taking help of forensic investigations unless it is absolutely essential. We started this project with the hypothesis that there are prevailing myths in community about forensic and lack of awareness about humanitarian forensics. We have collected 100 responses randomly in hospital settings. Out of which 62 respondents were male and 28 were female. Out of 100 respondents, 55 were from age group 20-30 years and with reasonably good education status. Validated 15 statements were asked for participant to respond on the Likert scale of 1-3 (agree, partially agree to disagree).

Keywords: Humanitarian; Forensics; Perceptions.

Introduction :

Humanitarian forensic action is the applicability of forensic science to humanitarian action.[1] During conflict, disasters, other conditions of violence, and consequences of migration there are sufferers of violence including deceased or missing individuals. In the arena of humanitarian relief, forensic science places great emphasis on the respectful handling of deceased individuals and the solving of unsolved cases. Individual identification should be given first attention since both relatives and the deceased have a right to have their identities restored after death and to know the situation of their departed loved ones.

The International Committee of the Red Cross (ICRC) outlines humanitarian action which is performed in a impartial, autonomous, fair and unrestricted manner with the aim of reducing suffering and preserving human dignity. In addition, it is bordered by International Humanitarian Law (IHL), a division of public international law that is relevant during armed conflicts.[1] According to the International Court of Justice, humanitarian action is described as actions taken by groups and individuals "to ensure respect for the human being" and "to prevent and alleviate human suffering wherever it may be found". The same guidelines also apply when dealing with humanitarian crises that are unrelated to armed conflicts, including natural disasters. and migration.[2]

Humanitarian forensics has always been a priority for the ICRC.

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The organization's forensic team has been promoting the phrase "humanitarian forensic action" in recent years to characterize its unique uses of forensic science. It places a strong emphasis on following the Geneva Conventions and other humanitarian law norms, as well as on "the dignified management of dead bodies".[3] In addition, the ICRC has provided investigator training in other nations and even helped establish a brand-new International Humanitarian Forensic Center in Gujarat., India.[4]

By and large, the recent initiatives to confirm the appropriate managing and identification of deaths due to COVID-19 globally, and the process initiated before five years to safeguard the dignity of the deceased in disasters, were observed. The humanitarian forensic actions involved an extensive forensic operation for the exploration and identification of warriors buried in an uninhabited isle on the South Atlantic. They are all related to a new field called humanitarian forensic action, which uses forensic science to aid humanitarian causes.

Forensic science has proven to be beneficial, even indispensable in the past few decades when it comes to performing some humanitarian duties.[5,6] Its innovative usage in this field first centered on preventing and ending the global problem of missing persons resulting from significant catastrophes, armed conflicts, and migration. However, recently, it has broadened the range of its activities to include supporting the appropriate and dignified handling of the dead, recording instances of torture and maltreatment, sexual offences and other exploitations during armed conflicts, and safeguarding susceptible populations, such as children and migrants.[7]

Academic centers are also interested in, research, and teaching the discipline. For instance, the International Center for Humanitarian Forensics was opened by the National Forensic Sciences University (NFSU) of India in June 2018, and the

University of Coimbra in Portugal opened its University Center for Human Rights and Humanitarian Forensic Research and Training in November 2019 - both institutions are committed to the advancement and development of this emerging field. This center, in which eminent academician from the Universities of Toronto, Milano, and Monash also participated, serving as a hub for global academic collaboration aimed at enhancing the significant role that forensic science plays in humanitarian efforts and the defense of human rights.[8]

Keeping this background in mind, we planned this study to obtain perception of general public of Gujarat State towards Humanitarian Forensic.

Objectives:

The project started with the hypothesis that there are prevailing myths in community about forensic and lack of awareness about humanitarian forensics. Therefore, we developed the research question - Is humanitarian forensics duly-recognized concept in the community?

The objectives of the research study are to collect perceptions of general public about varying aspects of humanitarian forensics with specific objectives to assess, analyze the perceptions and to prepare recommendations based upon the observations.

Methodology:

The present study of analyzing perception about Humanitarian Forensics was a questionnaire-based study. This questionnaire based cross sectional study was initiated after receiving the approval from the Institutional Ethical Committee, AIIMS, Rajkot. The study was carried out in hospital setting in which information was collected from those adults who were willing to participate and extended their consent. Consented participants were given a structured proforma which comprised of validated questionnaire in their language to ensure better understanding and minimize ambiguities. Study was commenced by developing a validated questionnaire with help from internal and external faculties working in the field of forensic medicine and forensic sciences. The questionnaire comprised of 10 close ended statements and two open ended questions. Data collected from the representative sample of general population who were vising hospital, OPD setting of AIIMS, Rajkot and PDU Medical (Government) College. The data collection was carried out under following heads: 1. Demographic details and 2. Perception about forensic and humanitarian forensics. For the study we have included those patients and relatives above 18 years of age visiting the hospitals with their consent. Participants with lesser age (below 18 years) and who were unable to understand and comprehend were excluded. Statistical analysis was done by using descriptive and analytical statistical methods using Microsoft office. The qualitative data from open ended questions was analyzed by an inductive, semantic approach of thematic analysis by analyzing the explicit content of the qualitative data of the study.

Results:

Total 100 participants responded completely to the study.

Demographic results:

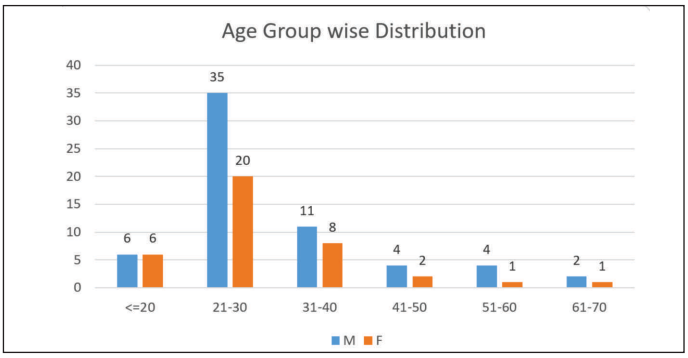

Figure 1. Age group wise distribution of participants.

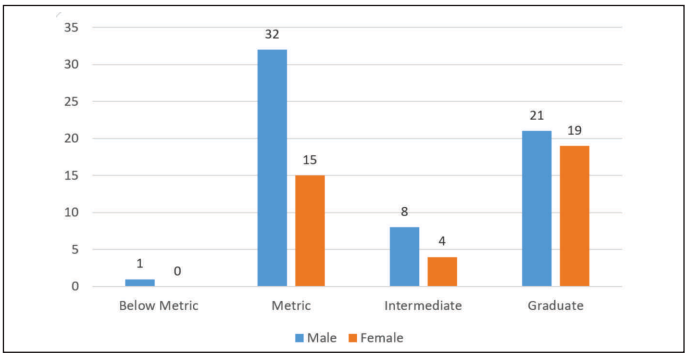

Figure 2. Education wise distribution of participants.

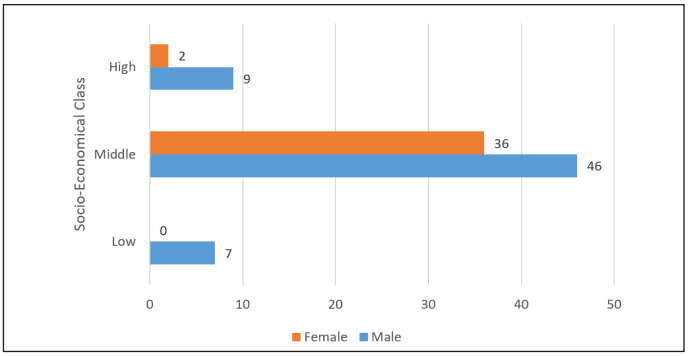

Figure 3. Socio-economic class distribution of participants.

Discussion:

In the humanitarian sector, uncertainty is more prevalent than ever. Anticipating and mitigating future crises is more important than trying to anticipate or stop them. Humanitarian actors' capacity to assist the victim of the following day will rely on their capacity to advance their tools of preparedness and quick response.[9] Climate change is continuously observed and has already resulted in an increased frequency and intensity of natural disasters [10-12]

In this context, the present study initiated to assess and evaluate perception of general population with regards to different aspects of Humanitarian forensics. We received response from 100 participants who were randomly selected, out of which 62 participants were male and 28 were female and 55% of the total were from age group 20-30 years of age. Most of them were educated to metric or intermediate level, even few were

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Following results has been obtained from the participants:

Total Participants: 100				
Sr. No.	Statements	Agree	Partially Agree	Dis-agree
1.	I know humanitarian forensics.	0	8	92
2.	I feel uncomfortable whenever see a dead body.	23	21	56
3.	A visit to postmortem room would make me annoyed.	25	22	53
4.	I feel uncomfortable whenever I trespass from mortuary or similar place.	25	21	54
5.	Forensic means investigation in crime.	53	3	44
6.	Forensic means postmortem examination.	59	1	40
7.	Forensic means court matter/ police involvement etc.	55	2	43
8.	I don't know role of forensic in disaster situation.	77	8	15
9.	I know meaning of dignified disposal of a dead body.	95	1	4
10.	I am not sure how community engagement can be useful in disaster management.	81	2	17
11.	I feel that something to be done for dead persons to maintain their dignity.	99	1	0
12.	I feel that something to be done for grieved families of disaster victims.	99	1	0
13.	I feel that there should be a specialty to help public in such cases.	99	1	0
14.	I feel that public awareness is important about humanitarian forensic aspect.	100	0	0
15.	I feel satisfied to know about humanitarian forensics.	99	1	0

graduates. They were predominantly (82%) from middle socioeconomic class and some were even from higher social strata. Therefore, the sampling was representative of the general population at large. We could not find any other study with the similar objectives to compare with the results of this study.

We collected response to 15 validated statements on the Likert's scale of 1-3 (agree, partially agree to disagree). In response to the statement, “I know humanitarian forensics” 92% expressed their lack of knowledge while 8% had heard the concept. The terminology is quite unpopular in the general population despite of their exposure to it. To fill up the gap in knowledge and action, developed nations have come out with the launch of the American Academy of Forensic Sciences (AAFS) and Humanitarian and Human Rights Resource Center (HHRRC). [13]

In response to their apprehension of seeing dead bodies and image of postmortem room, about 48% expressed agreement, statements to understand literal meaning of word forensics in layman terms, we observed that 58% were having either wrong concept or misconceptions. The population's stigma to the remains and post-mortem procedures were evident in this regard. Community awareness is highly essential for the introduction of humanitarian forensics together with the reduction of stigma in the society.

Out of total, 77% agreed to the statement that they won't know the role forensic in disaster situations. Most of them wished to have dignified disposal of a dead bodies but 'how' part was remained unanswered. The humanitarian aspects of forensic are generally built up over the years to improve the involvement of forensic services to the humanity and population at large. Therefore, the understanding of the humanitarian forensic field should necessarily reach the grass root level for its better utility.

In the opinion of 81% participants, role of community engagement is not certain in the practice of humanitarian forensic but at the same all were in agreement that something needs to be done to maintain dignity of a dead person and also were expecting some support system for the grieved families. Out of all, 99% expressed the need of a distinctive specialty for larger interest and public awareness for the same. After the questionnaire they were made aware about the concept of humanitarian forensics and 99% of them expressed their satisfaction and gratitude. Knowing perception of general population helps to understand their psychological aspects. Psychosocial action is not limited to providing emotional support; rather, it encompasses the concepts of the individual as a right-holder, promoting autonomy in decision-making, validating behavior, and creating individual and group histories. For the sake of families and communities, forensics and psychosocial sciences must collaborate in a complementary manner, according to this framework.[14] Additionally, psychosocial work can enhance the quality of the antemortem data by accounting for the impact that stress, traumatic experiences, and culture have on individuals' recollections.[14] Knowledge and awareness among the community is an important aspect for community engagement in mass disasters. A similar study by Julia Rosenberg et al highlighted opportunities for engagement and collaboration with health providers, including and beyond the Child Abuse Pediatrician work force.[15]

Conclusion:

This research study will be a novel in itself. The project is highly relevant in forensic context. This will be adding a new dimension to prevailing myths in the society. Increasing awareness and knowing perceptions will also be helpful in preparing recommendations for future strategies. Recommendations were prepared based upon their perceptions and awareness regarding the humanitarian forensics as follows. General awareness regarding the humanly approach towards the forensic is required among the community which can be acquired by various measures i.e. community awareness programs. Government at state and central level, local public authorities, hospital administration, NGOs, etc. can participate for improvement in knowledge of stakeholders. Humanitarian aspects are and shall be in demand in near future where war like situations may happen or in cases of mass disaster or mass migrations.

The primary goals of forensic humanitarian action are to preserve human dignity and lessen suffering, with the victims and their families at the center. Contrarily, psychosocial action is founded on the notion that every person has rights, promotes autonomy in making decisions, affirms behavior, and involves the reconstruction and development of both individual and societal histories. It goes beyond providing emotional support alone. According to this paradigm, forensics and psychosocial sciences - both geared toward the same goal - must collaborate in a complementary manner to support relatives and societies. The ultimate humanitarian goal of forensic investigations can only be achieved under specific circumstances. The three basic pillars of

forensic action with a psychosocial perspective are coordination, information, and respect. Based on this, forensic investigations will be able to aid in the victims' healing process, and the psychological and psychosocial assistance to the victims can help to strengthen the investigations themselves.

Ethical approval:

The research project has been approved by the Institutional Ethics Committee, All India Institute of Medical Sciences, Rajkot, Gujarat vide letter no. AIIMS.Rajkot/ IEC/ 29/ 2022 dated 04.08.2022.

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ORIGINAL ARTICLE

Palatal Rugae : New Pathway Leading Towards Familial Hierarchy

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Abstract :

In the era of various technical and methodological advances, human identification becomes a herculean task especially in mass disasters cases where in the pile of flesh; one has to distinguish among own and others. Similar to fingerprint, palatal rugae also vary from person to person and may help to find the links between generations similar to DNA. This study aimed to carry out a comparative evaluation of palatal rugae, finger prints and lip prints in 3 consecutive generations. For this, photograph of palatal rugae, ink pad, dark coloured lipstick, white paper and cellophane tape were used. Participants were explained about the study and its purpose, their written consents was obtained. Photographs of palatal rugae were obtained by adjusting proper position, light and intraoral mirror. Fingerprints of hand fingers and thumbs were recorded on white paper using ink while lip prints were recorded by using cellophane tape and lipstick. With the help magnifying glass and marking pencil all the patterns were traced and analysed for repetition. Statistical analysis was done by using SPSS 20.0 version. Patterns of finger prints (66.7%) and palatal rugae (73.3%) showed repetition with maternal side while lip prints patterns showed more similarity (63.6%) with paternal side. Thus it can be concluded that palatal rugae & fingerprints are inherited as a maternal trait while lip prints tend to have a paternal influence.

Keywords: Forensic science; Palatal rugae; Finger prints; Lip prints.

Introduction :

For human identification fingerprints are considered as an ideal method as fingerprints neither change their pattern nor show similarity with others. Similarly, lip prints as well as shapes of palatal rugae also show individialistic patterns. That is why; dental identification is one of the most commonly used scientific methods in natural disasters.[1,2] Fingerprints are the patterns of raised papillary ridges like loop, arch, whorl etc. present on fingertips of hand as well as on foot. Their analysis have been the gold standard for human identification since ancient times and is getting converted to modern form with the recent technical advances like in field of biometric devices or digital finger print analysis. In cases where fingerprint analysis is not possible such as earthquack or road traffic accidents etc then identification of palatal rugae pattern becomes the procedure of choice.[2,3,4] It is also supported by Cheiloscopy, in which lip prints are used to identify the involvement of particular individual especially at crime scenes.[5]

In this study; we aimed to carry out a comparative evaluation of palatal rugae, finger prints and lip prints in 3 consecutive generations, in order to identify if these have any inheritance pattern.

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Material and methods:

For recording patterns, intraoral mirror, DSLR camera, ink pad, dark coloured lipstick, cellophane tape, drawing sheet and scissor were used. Analysis of patterns was done by using magnifying glass and marking pencil (Figure 1).

15 families having 3 consecutive generations (total of 80 participants) were selected. Participants were explained about the study and its purpose, their consents were obtained. Photographs of palatal rugae were recorded by professional photographer with DSLR camera (Canon EOS 60D) by maintaining proper position of individual, light and intraoral mirror (Figure 2).[2] Participants were asked to wash their hands and press their fingers one by one on ink pad with little pressure and then placing the same on white paper sheet. fingerprints of all fingers and thumbs of both the hands were recorded (Figure 3).[1,3,4] While for recording lip prints participants were asked to colour their lips with dark colour lip stick then a piece of cellophane tape was taken and placed on lips; obtained lip prints were paste on white paper sheet (Figure 4).[1,5] After recording all details; different patterns were analysed with the help of magnifying glass and marking pencil and compared for repetition between generations. The data was analysed using SPSS (Statistical Package for Social Sciences) 20.0 version. The association between the variables was assessed using Chi-square test. P value <0.05 was considered statistically significant.

Result:

For analysis of lip prints Tsuchihashi's classification (1974),[1] for finger prints Henry's classification[4] and for palatal rugae classification of Thomas and Kotze (1983)[6] were used (Figure 5).

Figure 1. Materials required for collection of different prints & patterns.

Figure 2. Recording pattern of palatal rugae.

Figure 3. Recording finger prints.

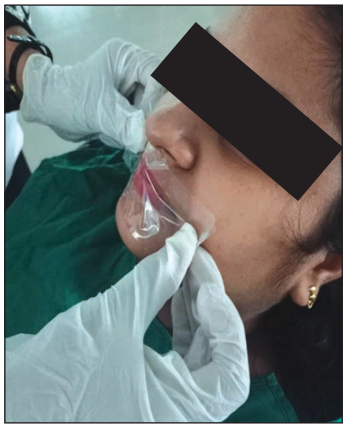

Figure 4. Recording lip prints.

On analysis, it was found that the pattern of palatal rugae and finger prints have more similarity with maternal side i.e. 73.3% and 66.7% respectively while repetition of lip print pattern show paternal dominance (63.6%) (Chart 1).

33.3% lip prints were found to be repeated in 2 consecutive generations and 40% in alternate generation. In siblings, around 20% lip print pattern were repeated while 26.6% lip print show no repetition at all. Around 60% patterns of finger prints were repeated in all 3 generations, 73.3% repetition was found in 2

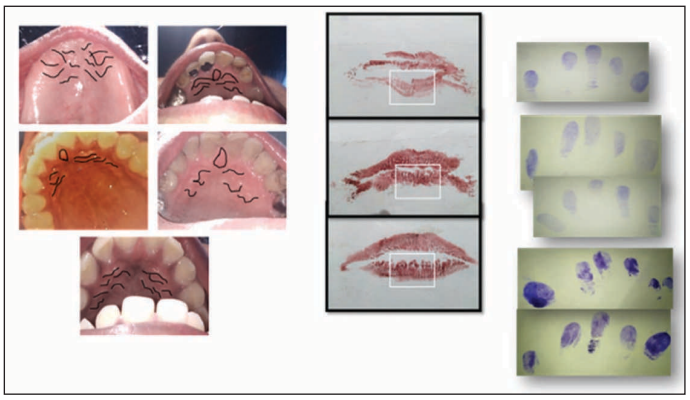

Figure 5. Analysis of different patterns.

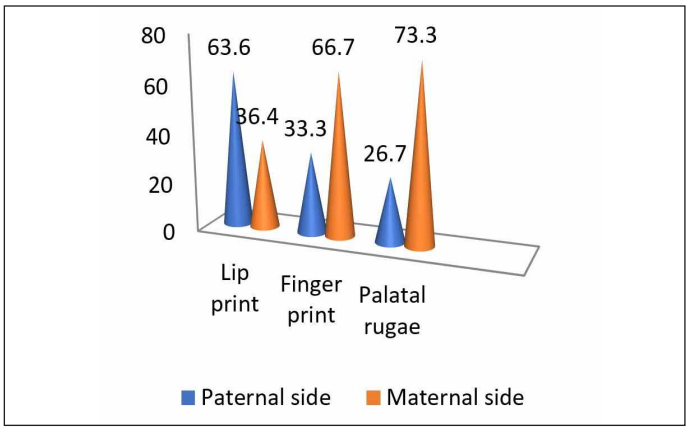

Chart 1. Comparison of frequency of repetition of lip print, finger print and palatal ruage on maternal & paternal side.

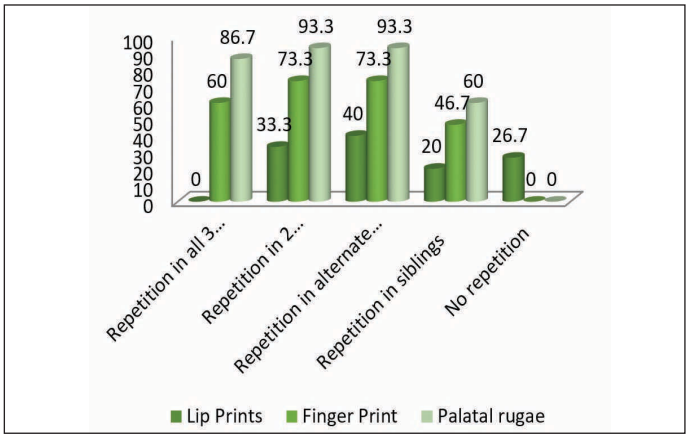

Chart 2. Comparison of repetition of palatal rugae, fingerprint & lip print pattern.

consecutive generations as well as in alternate generation while in siblings, 46.7% patterns were repeated. Pattern of palatal rugae showed maximum (86.7%) repetition in all 3 generations, 93.3% repetition was found in 2 consecutive generations as well as in alternate generation; along with this siblings showed repetition of 60% palatal rugae pattern (Chart 2).

During analysis of different patterns Type 1 (40%) lip print, Loop type (12.1%) finger print and Curved (10.2%) type palatal rugae was more commonly found while Type V lip print (3.7%) Arch pattern of finger prints (2.1%) and Bifurcated palatal rugae

(3.4%) were found to be least common.

Discussion:

In our study we found 86.6% repetition in pattern of primary palatal rugae, 60% repetition of fingerprints among all three generations of family; 40% repetition of pattern of lip prints in alternative generations and 33.3% repetition in 2 consecutive generations. Mala et al in 2017 conducted a study to correlate repetition of fingerprints, lip prints and palatal rugae in 3 consecutive generations of a family. They found that palatal rugae showed 10% repetition, and fingerprints (especially thumbprints) showed 30% repetition amongst the 3 generations while lip prints showed 20% repetition amongst alternate generations.[1]

In our study palatal rugae pattern showed 73.3% resemblance with maternal and 26.7% resemblance with paternal lineage. Contrary to this; Burhanuddin et al in 2017 found palatal rugae pattern based on lineage and concluded that pattern of palatal rugae of a child showed 25% resemblance with father while 15% with mother.[6]

Type 1 (40%) lip prints were common in our study while Abarnalingam et al in 2019 found Type 2 lip prints more commonly followed by Type 3.[7] This could be attributed to geographical & racial diversity of study population.

In our study, loop pattern of finger prints were commonly (12.1%) found. These findings were similar to Hassan Solhi et al who in 2010 found maximum number (54%) of loop pattern in fingerprints.[4] Among the pattern of palatal rugae; curved (10.2%) type of rugae was a common finding in our study. Contrary to this Abarnalingam et al in 2019[7] and Rani S. Thabitha et al in 2015[8] found wavy type of palatal rugae more commonly followed by curved type; in their respective studies. This could again be attributed to variation in the study population.

Conclusion:

Although palatal rugae, finger print and lip print patterns are unique for every individual but there can be repetition of patterns in consecutive generations. Palatal rugae and finger print pattern show more similarities with maternal side while lip print pattern have more similarities with paternal side. Among different patterns of palatal rugae, fingerprints and lip prints curved type , loop pattern and type I lip prints were more commonly found respectively while bifurcated rugae, arch pattern and type V pattern were least common.

Hence, it can be concluded that these patterns are genetically transferred and rugoscopy, dactyloscopy and cheiloscopy can also be used for identifying link between generations.

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Conflict of interest : The authors declare no conflicts of interest.

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ORIGINAL ARTICLE

An Autopsy Based Retrospective Analysis of the Profile of Poisoning Cases at a Tertiary Health Care Centre in Central India Region

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Abstract :

Acute poisoning is a crucial medical emergency and has remained one of the commonest causes of unnatural deaths. The earlier the initial resuscitations, gastric decontamination and use of specific antidotes, the better the outcome. The aim of this study was to characterize the poisoning cases admitted to the tertiary care health centre in Vidisha district. All cases brought for autopsy between the period January 2022 to December 2023 were evaluated retrospectively. We reviewed data obtained from the medical records as well as the data entries made in the pre-structured formats filled at the time of performing autopsy. It was found that 38% of all medico-legal deaths were due to poisoning. Males constituted 71.27% cases. Maximum victims, 31.38% belonged to the 21-30 years age group. 65.95% of the total victims were found to be married. The place of incidence was found to be indoors in 82% cases and history of addiction was provided in 20% cases. About 39% cases were brought alive to the hospital and the survival period in about 55% of the brought alive cases was less than 24 hours. By means of this study, poisoning has been recognised as one of the most common cause of suicidal mortality. Strengthening of peripheral health centres by means of better treatment modalities along with better access for psychological support and regulation on sale of agricultural poisons can help in curbing the mortality caused as a result of poisoning.

Keywords: Poisons; Agricultural poisons; Mortality; Suicide; Poison information centre.

Introduction :

A forensic autopsy is an examination conducted post mortem to address medicolegal objectives.[1] Poisoning is a serious public health issue in developing countries. Information about poisoning may be helpful for poisoning prevention and hospital treatment, aiding in the development of measures that lower the morbidity and mortality associated with poisoning.[2] Pesticide poisoning is the most prevalent means of suicide, in low and middle-income nations.[3] Various studies done across the world show that poisoning patterns have kept abreast with the developments in the pharmacological and agricultural sciences in that particular geography. Poisoning is not any less a problem in the developed countries as over-the-counter and prescription drugs were found to be the most common agents used as a poison such as Acetaminophen which was found as the most poisoning agent in USA among reproductive-aged women in USA.[4] The drugs prescribed by doctors have been employed in cases of self-poisoning in UK.[5] In India, as agriculture is the main occupation, insecticides and other agrochemical fertilizers are used to a greater extent and the poisoning with such products is more common.[6] The periodic study of the epidemiology of such deaths is important to as to ascertain the pattern of poisoning in in a specific region.

There are many differences with respect to the pattern and cause of acute poisoning between geographical regions, even within the same country. The knowledge of the general pattern of poisoning in a particular region would help to identify the risk factors and allow early diagnosis and management of such cases, which in turn should result in reduction of morbidity and mortality.[7] Studies such as this help in the effective and efficient planning helping the amendments in the current policies and/or introduction of new means. The solutions that may arise to mitigate the problem are bi-pronged. Primarily, the intention is to prepare the medical facilities for dealing such cases in a more efficient way reducing the morbidity and consequent mortality rates and secondarily to implement such measures that help in reducing the number of instances wherein there are deaths consequent of poisoning.

Materials and methods:

This is a retrospective study in which all the cases with an alleged history of death as a result of consumption of poisonous substance that were brought to the mortuary of Atal Bihari Vajpayee Government Medical College, Vidisha for autopsy between the period January 2022 to December 2023 were studied. The data from medical records as well as pre-structured formats filled at the time of conducting autopsy, consisting of the demographic profile and postmortem findings were carefully compiled, studied and tabulated in a pre-designed format. This study was approved

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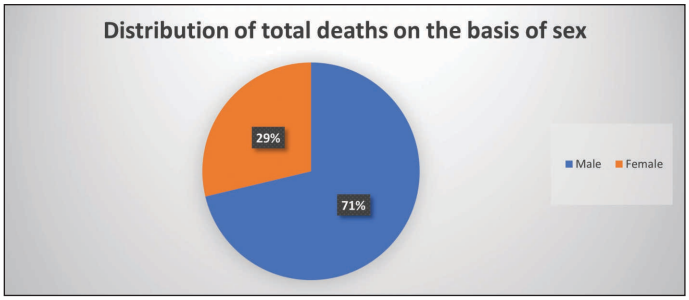

Figure 1: Distribution of total deaths on the basis of sex.

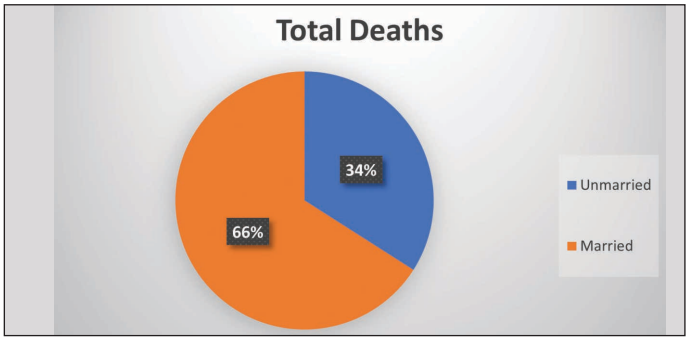

Figure 2. Distribution of total deaths on the basis of marital status.

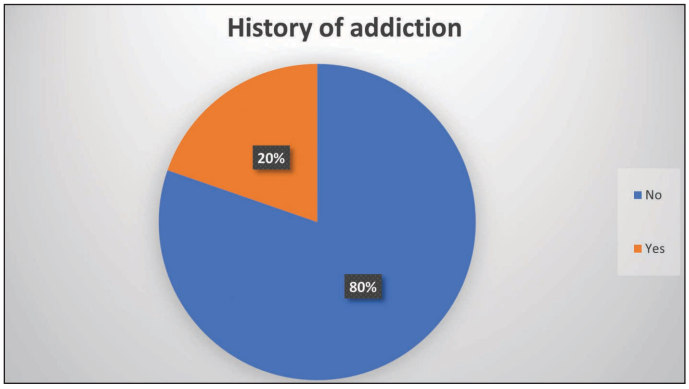

Figure 3. Distribution of total deaths on the basis of history of addiction.

by the Institutional Ethics Committee.

Observation and results:

A total of 494 cases were brought to the mortuary for autopsy during the study period, out of which 188 (38.05%) cases were brought with the alleged history of consumption of poisonous substance. The maximum number of deaths occurred in the month of October (23; 12.23%), closely followed by September and November respectively. The month wise distribution of deaths is depicted in Table 1. In Table 2, the age wise distribution of deaths depicts that the maximum number of cases were found to be of the age group 21-30 years (59; 31.38%) followed by 31-40 years (41; 21.80%). The male sex was found to comprise the maximum number of cases (134; 71.27%) while females comprised of 28.72% cases as is depicted in the Figure 1. Females of the age group 11-20 years (18; 33.33%) were predominantly involved followed by 21-30 years (15; 27.77%). Among all the deceased, majority had marital status married (124; 65.95%) and the remaining were unmarried (64; 34.04) as is depicted in Figure 2. History of addiction was provided in 20% cases whereas in remaining 80% cases there was no such history, as is depicted in

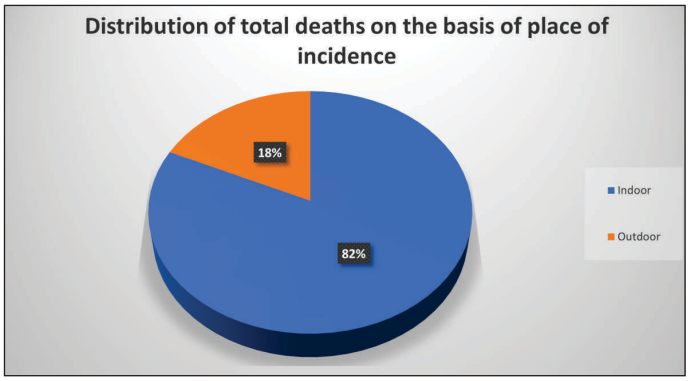

Figure 4: Distribution of total deaths on the basis of place of incidence.

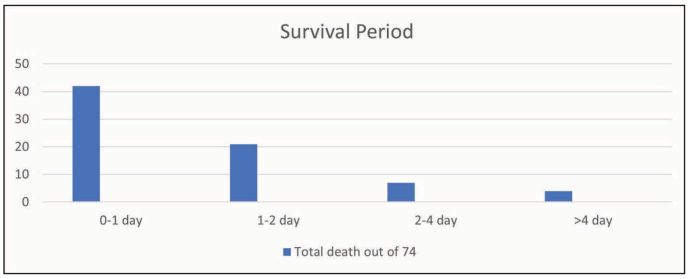

Figure 5: Distribution of total deaths on the basis of survival period.

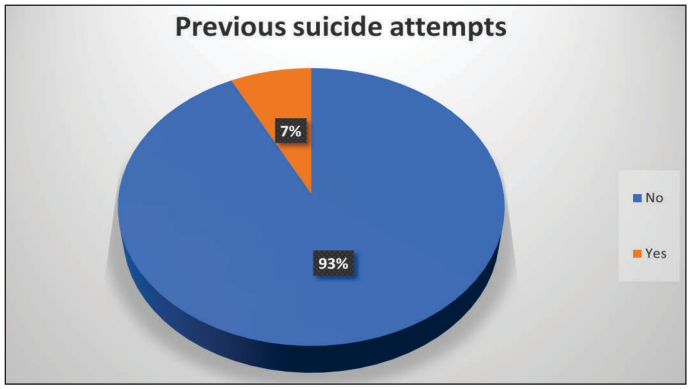

Figure 6: Distribution of total deaths on the basis of previous suicide attempt.

the figure 3. Figure 4 depicts the place of incidence, it was found to be indoors in maximum cases (82%) whereas in the remaining cases it was outdoors. Among all the cases, (74; 39.36%) of the total cases were brought alive to the hospital while the remaining were brought dead. Among the patients who were brought alive, maximum number (41; 55.40%) of cases survived for a period of 0-1 day which is depicted in Figure 5. Gastric lavage was done in most of the cases. In none of the cases the relatives were carrying the sample of poison with them.

Discussion:

Age is a very prominent factor in any epidemiological study as it outlines the population that is at risk. In this study, the age group 21-30 years has been found to have the maximum number of incidences of poisoning irrespective of manner and sexes. This can be attributed to multiple reasons ranging from facing competition in exams or in jobs. A lot of people get married in this age bracket which can also eventually add up to the stress if it does not work out well. This finding has been found to be matching with other studies conducted like that of Patil A,

Table 1. Monthly distribution of deaths.

S No.	Month	Total Deaths (2022+2023)
1	January	12 (6.3%)
2	February	6 (3.1%)
3	March	16 (8.5%)
4	April	14 (7.4%)
5	May	11 (5.8%)
6	June	18 (9.5%)
7	July	15 (7.9%)
8	August	16 (8.5%)
9	September	20 (10.6%)
10	October	23 (12.2%)
11	November	22 (11.7%)
12	December	15 (7.9%)
	Total	188

Table 2. Distribution of death on the basis of age.

S No.	Age	Total Deaths (2022+2023)
1	0-10	1 (0.5%)
2	11-20	34 (18%)
3	21-30	59 (31.3%)
4	31-40	41 (21.8%)
5	41-50	31 (16.5%)
6	51-60	18 (9.5%)
7	61-70	2 (1.06%)
8	71-80	2 (1.06%)
	Total	188

Marigoudar RM, Jatti VB[8] (21-30 - 34.4%, 31-40 – 19.7%); Pawar V and others[9] (20-29 years – 45.62%, 10-19 years – 28.81%); Bannur V et al.[10] (21-30 years – 31.4%, 11-20 years – 17.2%); Verma P et al.[11] (21-30 years – 40.83%, 31-40 years – 22.50%); Jain AK et al.

In some studies the most commonly involved age group was found to be 11-20 years (36.7%) like in one study conducted by Patel NS et al.[12] Similarly, in a study conducted by Kochar A,[13] the most prevalent age group was found to be 31-40 years (36%) which is the second most commonly involved age group in our study.

In our study the most commonly involved sex was males, which can be attributed to various factors. Farming happens to be the most common occupation in the region in which this study has been conducted as a result of which pesticides are widely available and most of farming related activites being male-dominated makes the males more susceptible. Also, other factors like stress, unpredictability of income, liabilities etc. can be contributing factors in suicidal poisoning cases. The finding of male predominance in death is concurrent with several other findings like a study conducted by Kumar SV et al.[14] (52.15% males and 47.84% females); Singh S, Sharma BK and Wahi PL,[15] Singh S et al.,[16] Sharma BR et al.[17]

While there is uniformity in the higher involvement of male sex in cases of poisoning, there are studies in other countries where the involvement of female sex has also been found to be higher like in a study conducted by Chelkeba L et al.[18]

In this study, among various other epidemiological factors, the marital status has also been studied. It has been found that maximum number of victims of poisoning were married. This can be attributed to the stress factor which naturally add up when a person is married, such as looking after the household expenses in cases where the spouse is not earning, the conflicts, emotional turmoil, planning in the interest of the entire family's future and looking after ageing parents etc. Similar findings have been reported by several other authors in their studies like Parekh U, Gupta S,[19] Datir S et al.[20]

Conclusion:

Poisoning has been recognised as a very common cause of death, mostly suicidal followed by accidental deaths. Furthermore, agriculture is a prevalent source of earning livelihood in the India, more so in and around the geography of the institution where the study has been conducted. As a result, most common variety of poisonous substance used are insecticide and pesticide compounds.

The approach to reduce the instances of poisoning is multi-dimensional and requires a strategy which is multi-sectoral. There exists a legal framework for the regulation of such compounds both in terms of safety as well as sale in the open market but the actual and optimal implementation of the same still has a long way to go.

Based on the sizable instances of suicidal poisoning cases, there is clearly a lacuna in terms of psychological help that if fulfilled will surely and steadily help in the reduction of the cases of suicidal poisoning.

Also, for the betterment in the quality of treatment being offered to the patients, there is a very good scope of strengthening the backup to the peripheral health care centres like PHCs, CHCs etc by introducing a Poison Information Centre (PIC) at the medical college level in the same district. Additionally, the establishment of toxicological laboratories for detection of poisons at all medical colleges can go a long way in prompt diagnosis and accurate treatment of the patients. Availability of the antidotes of the commonly encountered poisons should be ensured in all the facilities so as to provide prompt treatment.

Health programs conducted by the health care centres can also surely help in spreading awareness about poisoning and thus helping in preventing the instances of accidental and suicidal poisoning.

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ORIGINAL ARTICLE

Evaluation of Inkjet Ink and Substrate Degradation in Media with Varying pH Levels

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Abstract:

Forensic questioned document is a very important field. Forensic document expert (FDE) are generally well versed with the characteristics related to paper, ink and other writing media that helps in evaluating the case. Despite to possess great knowledge and experienced, a forensic document examiner may deals with the lot of challenges. Documents reach the forensic document examiner in different and various conditions. The documents can be torn, shredded, burnt, chemically destroy, engrave in soil or even soaked in some liquid. The document may be thrown in ponds, water tanks etc. by the criminal in order to hide the original document. During a document comes in contact with any liquid lots of destructive will happen to it. Many techniques are attempted and proposed for examination of water soaked documents and if required the restoration of content. Therefore, the present study has been attempted to evaluate the impact of soaking in different liquid medium on the different paper surfaces and printed content. The printed document soaked in liquids having different pH (Acidic, basic, neutral) were studied so as to determine the effect on printing ink and substrate. The change in characteristics of the paper and ink were noted and facilitated in estimating the age of the soaked document. The samples were examined using Olympus Stereomicroscope and under Ultra-violet light.

Keywords: Bond paper; Glossy paper; Soaked document; UV light; Stereomicroscope; Inkjet printer; Questioned documents.

Introduction:

A document is a material which contains some symbols, numbers or any other writing which gives some meaning, information to some persons or it can be considered as evidence in the course of investigation. It may be paper, wall, stone, metal, glass and wooden piece etc.[1] For the document a writing material and writing media is compulsory. Document is very important in day to day life. We almost every day come across a number of documents.[1] We write and sign daily in our personal and in professional life. In the modern age where credit cards and online purchasing are ubiquitous, identity theft are a common concern . Alteration or fabrication of the document is increasing day by day which may adversely affect the modern society. Criminals are not dim to realise the importance of documents. Modes and methods for falsification of document have been exploited to an extent by criminal class.[2] For the Forensic Document Expert, it is a very challenging task to examine different types of documents like books, wills, letters, suicidal notes, cheques and bills etc which are severely damaged by the criminals to conceal the writings or authenticity of the documents. With the changing technology in the field of forensic science, criminals are adopting new and different techniques to commit a crime. In such cases criminals destruct the documents by burning, tearing, chopping, engraving, soaking the documents. It is very important to examine the document which determines the authenticity and integrity of the document.

Researchers have used liquid nitrogen, freeze drying, vacuum freeze dehydration and stereo microscopy to attempt and successfully repair and decode various texts.[3-8] Ink feathering, lateral spreading, transference to adjacent or facing paper, change in shine and other phenomena have all been researched in saturated ballpoint pen writings and gel pen writings.[9-10] Less research on the inspection of soaked documents has been documented, according to the literature review.

The purpose of the current study was to gain a conceptual understanding of the impact of soaking inkjet printed documents on a variety of substrates in various mediums, such as acidic, neutral and basic solutions at different intervals. The printed matter on the documents were attempted to be deciphered using a Stereo microscope and UV light. The project provides a wonderful outcome for the understanding developed regarding various features of printed matter on various types of sheets soaked in various forms of liquid media.

Materials and Methods:

The current study was conducted to analyze the different brands of inkjet printer ink on Bond paper, Glossy paper and A4 sized paper soaked in three pHs of liquids at three different intervals, after the approval by Institutional ethics committee. The samples of printed documents were prepared with three different brands of inkjet printer (Table no.1) on three distinct types of paper. White normal printing paper of the JK Copier brand in an A4 size (21 cm x 29.7 cm) with a 80 GSM weight and Super White JK Excel Brand in bond paper with same size (90 GSM) and White Oddy Snap Shot inkjet ID paper brand in glossy paper with same size

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Table 1. Brands of Printer chosen for the study.

S.No.	Brands of Printer
1.	Canon G2010
2.	Epson L805
3.	Epson 3780

(180 GSM) were the substrate chosen for the investigation.

For the investigation, three distinct types of liquid mediums—acidic (pH 3), neutral (pH 7) and alkaline (pH 13)-were created by soaking the printed documents prepared on the three variety of substrates. The regular tap water, with a pH of 7,

Table 2. Showing phenomenon observed in printed document immersed in acidic medium (HCl) on A4 paper, bond paper and glossy paper at different intervals.

S. No.	Brands of Printer	Type of paper	Time Interval after a week	Time Interval after fifteen days	Time Interval after a month
1	Canon G2010	A4 Plain Paper	No Change in Ink and Paper	Ink fades away Paper turns yellow Absorbed HCl spots are seen. Ink is completely absorbed by paper	Ink is spread and slightly faded Paper turns greenish yellow Black greasy layer is seen on paper HCl spots are seen Paper is degraded
		Bond Paper	No Change in Ink and Paper	Ink starts to fade away and is spread Ink is completely absorbed by paper	Ink is completely spread and absorbed Some portion of Ink is faded away and fragmented Paper turns pale yellow Paper starts degrading HCl spots are seen on paper Ink traces and some content is are seen under UV visible light
		Glossy Paper	No Change in Ink and Paper	Ink is slightly separated No change in Paper Plastic layer separated HCl spots are seen	Ink is spread Yellowishness in Paper increases Plastic layer separated Paper degraded HCl spots are seen
2	Epson L805	A4 Plain Paper	No Change in Ink and Paper	Paper turns yellow Ink is completely absorbed by the paper Ink is spreaded HCl spots are seen	Ink is completely faded away A blackish greasy layer is deposited over Paper Paper turns greenish yellow Content is not seen on paper Paper is degraded
		Bond Paper	No Change in Ink and Paper	Blue ink completely fade away and magenta is spreaded Ink is completely absorbed by paper	HCl spots are seen Ink spreading increased Ink is completely absorbed by the paper Content is visualized under uv light Paper is slightly degraded
		Glossy Paper	No Change in Ink and Paper	Ink start to spread Plasticated layer starts separating HCl absorbed Paper are seen on paper	Ink spreading increases Plastic layer separation continous Paper degradation started Yellowishness in Paper increases HCl spots are seen.
3	Epson 3780	A4 Plain Paper	No Change in Ink and Paper	Paper turns yellow Ink is completely fragmented HCl spots are seen	Paper turns more yellow and slight green in color Ageing is increasing Ink is more fragmented HCl spots are seen Paper is more degraded Rottening is seen in paper
		Bond Paper	No Change in Ink and Paper	Ink is fragmented HCl spots are seen Paper turns pale yellow	Ink fragmentation increases Yellowness in Paper increases Paper turns more older aged HCl spots are seen Crystalline particles are observed
		Glossy Paper	No Change in Ink and Paper	Upper layer slightly separated Ink is fragmented	Upper layer separated Paper degraded Ink fragmented Paper turns pale yellow HCl spots are seen

Table3. Showing phenomenon observed in printed document immersed in alkaline medium (NaOH) on A4 paper, bond paper and glossy paper at different intervals.

S. No.	Brands of Printer	Type of paper	Time Interval after a week	Time Interval after fifteen days	Time Interval after a month
1	Canon G2010	A4 Plain Paper	No Change in Ink and Paper	Ink is fragmented and start spreading Laid marks are seen Absorption spots are seen Ink is completely absorbed by the paper Paper is degraded	Laid marks are started to fade away Paper degradation continues Ink is fully absorbed by paper NaOH spots are seen Ink is spreaded and only black ink is fragmented Ink traces are seen under UV light
		Bond Paper	No Change in Ink and Paper	Laid marks are seen Ink start separating Ink is completely absorbed by paper Wet spots are seen.	Ink spreaded/ faded/ fragmented Laid marks disappeared Ink completely absorbed NaOH spots are seen on paper Paper is degraded Ink traces and some printed portion is visible under uv light
		Glossy Paper	No Change in Ink and Paper	Ink is slightly faded Laid marks are seen NaOH spots are seen on paper. Plasticated layer start separating Ink is completely absorbed by paper	Ink is spreaded Laid marks slightly fade away NaOH spots are seen Paper is degraded Plasticated layer is separating continuously Crystalline particles are observed
2	Epson L805	A4 Plain Paper	No Change in Ink and Paper	Ink is spreaded and fade away NaOH spots are seen Ink is completely absorbed by paper	Paper degradation continues Ink spreading increases Ink is faded away more NaOH spots are seen Ink is absorbed in paper too.
		Bond Paper	No Change in Ink and Paper	Ink is completely absorbed, spread and faded away	Ink is not seen as it was completely faded away from Paper NaOH spots are seen Paper is slightly degraded Ink is completely absorbed by paper Some portion of ink is visible under UV light
		Glossy Paper	No Change in Ink and Paper	Ink is slightly spreaded	Paper degradation and plastic layer separation is started Ink is slightly absorbed in paper
3	Epson 3780	A4 Plain Paper	No Change in Ink and Paper	Ink is fragmented Spots of NaOH are seen	Ink fragmentation increases NaOH spots are seen Paper starts to degrade
		Bond Paper	No Change in Ink and Paper	Ink is fragmented NaOH spots are seen on paper	Ink fragmentation increases Paper is slightly degraded NaOH spots are seen
		Glossy Paper	No Change in Ink and Paper	Plastic layer seperated Ink is fragmented	Ink fragmentation increases Plasticated layer separated Dullness in Paper increases Crystalline particles are observed

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was chosen as the study's neutral medium. By incorporating concentrated Sodium Hydroxide (NaOH) with a pH 13.53 and concentrated Hydrogen Chloride (HCl) with a pH of 1. Before soaking the samples, the pH of each solution-acidic (pH 3), neutral (pH 7) and alkaline (pH 13.53)-was determined using a pH meter.

As the samples were prepared by using three different brands of inkjet printer on three substrates which was soaked in three different mediums made the total number of samples twenty seven. The twenty seven samples were soaked at different time interval that is one week, fifteen days and one month that made the total number of samples eighty one.

Before soaking, the samples were examined and observed under the visible light and UV radiations. One booklet from each brand

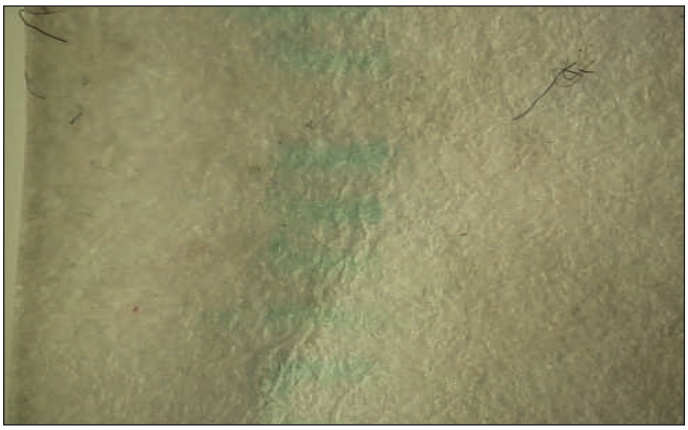

Figure 1. Change in color of inkjet printer ink and texture of paper after immersion in acidic medium for fifteen days.

Figure 2. Change in the texture of glossy paper after immersion in acidic medium for fifteen days.

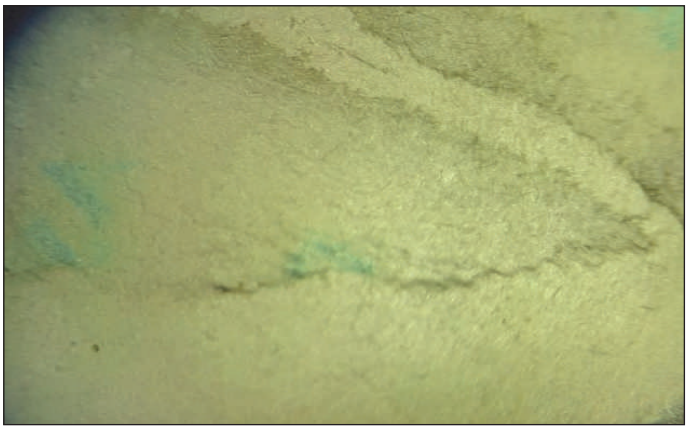

Figure 3. Change in the texture of A4 plain paper after immersion in acidic medium for one month.

Figure 4. Change in the texture of bond paper and spreading ink after immersion in neutral medium for fifteen days.

Figure 5. Fading of ink on bond paper after immersion in neutral medium for one month.

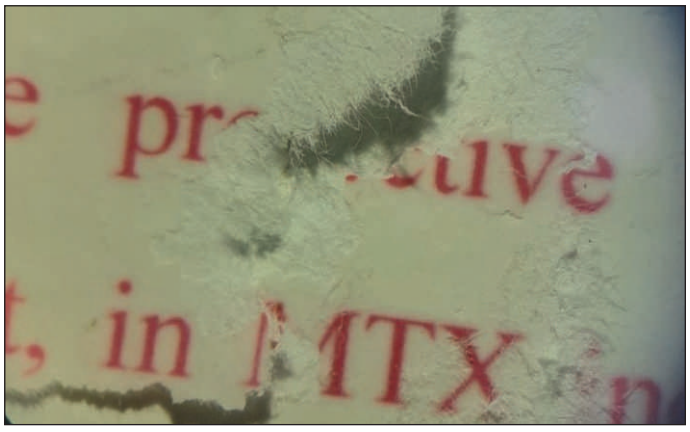

Figure 6. Plastic layer of the glossy paper separated after immersion in neutral medium for one month.

of printer, prepared on three different substrates selected for the study and preserved as control samples. After one week, fifteen days and a month, one booklet from each medium-acidic (pH 1), neutral (pH 7) and alkaline (pH 13)-was removed, observed in visible light and examined under a stereomicroscope and UV radiation. The outcomes of printed documents soaked in varied pH liquids at different time intervals were noted (Table 2-4). Blank samples were also prepared and analyzed in the same way and preserve as standard samples.

Results and Discussion:

The findings of printed document samples prepared on three different substrates that is A4 size plain paper, glossy paper and bond paper soaked in different liquids having varied pH that is acidic, neutral and basic for three different intervals have been evaluated (Table 2-4) and has following characteristic features.

Printed Documents in acidic medium at different time intervals: The outcomes of printed documents soaked in acidic medium that is in hydrochloric acid after one week, fifteen days and one month were analyzed (Table no.2). It was observed that no spreading of ink, fading of ink, transfer of ink on subsequent paper or facing paper or no changes seen in the texture of A4 plain paper, bond paper and glossy paper soaked in acidic medium after one week. While spreading, changing and fading of inkjet ink, spots of HCl and transfer of ink seen after fifteen days of soaking on A4 plain paper (Figure 1), bond paper and glossy paper whereas changes in color and texture of A4 plain and degradation of transparent film on the glossy paper seen after fifteen days (Figure 2). Similarly after one month, change in the texture of A4 plain paper and glossy paper was clearer this shows the aging of the document. So, as the time interval increases more prominent characteristics were observed.

Printed documents in neutral medium at different time intervals:

The outcomes of printed documents soaked in neutral medium that is in tap water (pH 7) after one week, fifteen days and one month were analyzed (Table no.4). It was observed that no spreading of ink, fading of ink, transfer of ink on subsequent paper or facing paper or no changes seen in the texture of A4 plain paper, bond papers and glossy paper soaked in neutral medium

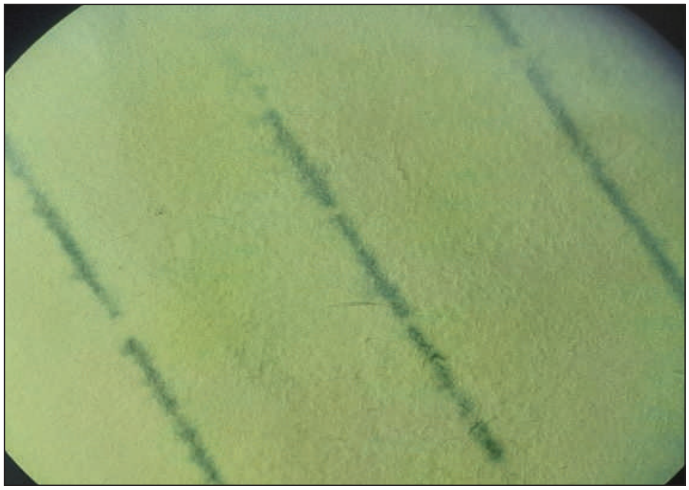

Figure 7. Line marks are present on paper after immersion in alkaline medium for fifteen days.

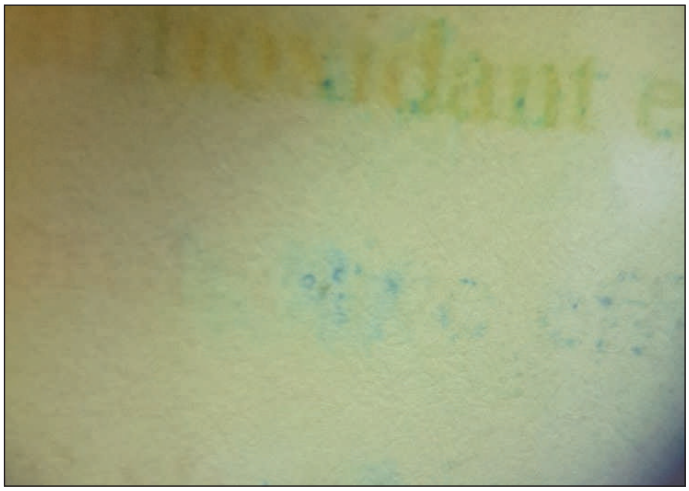

Figure 8. Spreading and transferring of ink after immersion in alkaline medium for one month.

Figure 9. Ink completed fade after immersion in alkaline medium for one month.

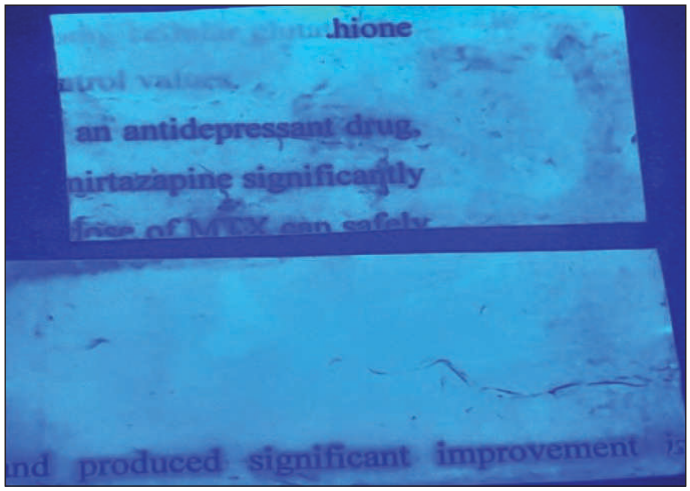

Figure 10. Change in texture of glossy paper and spreading of ink after immersion in acidic medium for one month under UV radiations.

Table 4. Showing phenomenon observed in printed document immersed in neutral medium (tap water) on A4 paper, bond paper and glossy paper at different intervals.

S. No.	Brands of Printer	Type of paper	Time Interval after a week	Time Interval after fifteen days	Time Interval after a month
1	Canon G2010	A4 Plain Paper	No Change in Ink and Paper	Ink is spreaded and destroyed Wet spots are seen Ink is completely absorbed by paper	Ink is spreaded and faded Ink is completely absorbed by the paper Water spots are seen Crystalline particles are observed Ink is slightly fragmented too
		Bond Paper	No Change in Ink and Paper	Ink is fragmented Water spots are seen	Paper turns slight yellow Ink is slightly fragmented, slightly spread and slightly faded away on paper Paper is degraded Some content is seen under UV light Ink is completely absorbed by paper Water spots are seen Ink traces are also observed under UV Light
		Glossy Paper	No Change in Ink and Paper	Plastic layer starts separating No change in ink	Plastic layer separated Ink fade away Paper degraded Ink is slightly spread
2	Epson L805	A4 Plain Paper	No Change in Ink and Paper	Ink is faded, spreaded and completely absorbed by the paper Water spots are seen	Ink is completely faded and spreaded away from Paper Paper is slightly degraded Water spots are seen Ink traces can be visualized under UV light
		Bond Paper	No Change in Ink and Paper	Paper turns yellow Ink is completely absorbed by the paper Ink is spreaded HCl spots are seen	Ink is completely faded away A blackish greasy layer is deposited over Paper Paper turns greenish yellow Content is not seen on paper Paper is degraded
		Glossy Paper	No Change in Ink and Paper	Spreading of ink increases Paper absorbed Water Plastic layer starts separating	Ink spreading continous Water spots are seen Paper degradation and plastic layer separation continues
3	Epson 3780	A4 Plain Paper	No Change in Ink and Paper	Ink is fragmented	Ink fragmentation increases Paper is degraded Crystalline particles are observed
		Bond Paper	No Change in Ink and Paper	Ink is fragmented Ink starts to separate in spots Water spots are seen on paper	Paper is slightly degraded Ink fragmentation increases Water spots are seen on paper Crystalline particles are observed over the paper
		Glossy Paper	No Change in Ink and Paper	Upper plastic layer separated Ink is fragmented	Plasticated layer completely separated Ink more fragmented Paper is degraded

after one week. Whereas after fifteen days ink starts to fade and spreading of ink takes place while the paper turns yellow in A4 plain paper and bond paper, plastic layer starts separating in glossy paper shows significant feature of aging. Similarly after one month plastic layer of the glossy paper gets completely fading of ink can be observed (Figure 3-6).

Printed documents in basic medium at different time intervals: The outcomes of printed documents soaked in neutral medium that is in tap water (pH 13.5) after one week, fifteen days and one month were analyzed (Table no.3). It was observed that no spreading of ink, fading of ink, transfer of ink on subsequent paper or facing paper or no changes seen in the texture of A4 plain paper, bond paper and glossy paper soaked in neutral medium after one week. After fifteen days line marks are seen on the A4 plain paper, bond paper and glossy paper while spreading of ink and fading of ink started. Similarly, ink got completely faded and visible under UV light (Figure 7-9).

Development of the disappeared content under UV light: It was observed that more prominent feature of spreading of inkjet printer ink and changes in the texture were studied under UV light but ink does not produce fluorescence under UV light.

Similarly the blind samples were examined to estimate the changing effect on the three types of substrates in three liquid aqueous medium with varied pHs. 100% accurate results were obtained under different phenomena in different time intervals with three different substrates and matched with the preserved samples.

Conclusion:

It was concluded that study on inkjet printer ink on three different types of substrates soaked in three liquid mediums with varied pHs produced highly consistent results. The study can be successfully applied for the forensic analysis where printed documents are found in soaked condition. The current study has a one-month time limit, but it can be extended to a longer period of time and it can also explore different written or printed materials with a comparable study.

Conflict of Interest: None

Financial Assistance: None

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ORIGINAL ARTICLE

A Study of Road Traffic Orthopedic Injuries at Tertiary Health Care Centre of Central India: Haddon Matrix approach

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Abstract :

Road accidents continue to remain the leading cause of deaths, disabilities and hospitalization in India, as it is home to the second largest road network in the world. This massive network serves as the nation's lifeline, transporting the majority of all goods within the country, and it is the preferred option for mobilizing the country's passenger traffic. A cross sectional study was conducted amongst ward admitted patients in the Department of Orthopedics for one year. The data was collected using a pre-designed and pilot-tested questionnaire by interviewing patients. Multi-variate logistic regression was used to find the co-relationship of various factors responsible for causing trauma. The study included 560 patients; almost 70% were young adult males. The factors causing trauma were over speeding (Odds Ratio -0.97, P<0.05), driving in an inebriated state (Odds Ratio -0.77,P=0.001), ignoring traffic rules (Odds Ratio -0.44, P=0.03) and not using safety devices (Odds Ratio -2.2, P=0.02). In most of the patients, head-on collisions, especially on straight roads, were the cause of trauma. However, distracted driving, poor weather conditions were not associated with trauma. The factors causing causalities on the road need to be identified. It is expected that with increasing freight and passenger traffic, the incidence of trauma will increase. There is a dire need to inculcate standard road etiquettes in drivers. Also, on the part of stake holders, the condition of vehicles and the maintenance of roads can prevent causalities.

Keywords: Road traffic injuries; Orthopedic trauma; Haddon matrix; Multivariate analysis.

Introduction :

Road transport is the most cost-effective mode of transportation in India, both for freight and passengers, considering its level of penetration in populated areas. Exposure to adverse traffic conditions is high in India because of the unprecedented rate of motorization and growing urbanization, fueled by a high rate of economic growth. As a result, incidents of road accidents, traffic injuries, and fatalities have remained unacceptably high. Road traffic injuries are the leading cause of death globally and the principal cause of death in the age group of 15 to 49 years. [(1)] During the calendar year 2021, road crashes in India claimed about 1.5 lakh lives and caused injuries to more than 3.8 lakh people.[1] Because road accidents are the result of the interplay of multiple factors, multi-prong measures are needed to reduce the number of accidents and fatalities. Therefore, the Ministry of Road Transport and Highways has initiated a proactive policy approach towards road safety by incorporating the participation of all stakeholders across the country. A total of 4,12,432 road accidents have been reported by States and Union Territories (UTs) during the calendar year 2021, claiming 1,53,972 lives and causing injuries to 3,84,448 people.[1] In India, the state of Tamil Nadu accounts for the maximum number of road traffic accidents, i.e., 13.5% with 10 % fatalities, followed by 11.8% accidents and 8.2 % fatalities in Madhya Pradesh.[1] Road safety cannot be undermined if we want to achieve goals of sustainable development, prosperity, and growth. Road safety is imperative for a happy, healthy, and prosperous life, for an individual as well as that of the nation. With rising motorization and an expanding road network, travel risks and traffic exposure grow at a much faster rate, as the growth of registered vehicles always out numbers population growth and the construction of new roads. Today, road traffic injuries are one of the leading causes of deaths, disabilities, and hospitalizations, with severe socio-economic costs across the world.

Road accidents are multi-causal and are often the result of the interplay of various factors like human error, the road environment and vehicular conditions. Hence, the Haddon matrix, which is a "phase-factor matrix," is likely to facilitate an assessment of the factors that contribute to injury occurrence and severity. It helps in evaluating contributing factors and using its assessment to design prevention strategies.[2] It combines public health concepts of host-agent-environment as targets of change with the concepts of primary, secondary, and tertiary prevention.[3,4]

Present study uses the Haddon matrix to understand contributing factors, responsible for causing Orthopedic injuries. It accounts for 13% of disability adjusted life years (DALY), and adverse

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Tables-1

	N(560)	%
Age (In Years)		
<18	67	11.9
18-30	230	41.09
31-45	174	31.04
45-60	64	11.5
>60	25	4.47
Distribution of patients on the basis of Type of road of accident		
Highway	174	31.0
Roads in town	185	33.1
Roads connecting village to highways.	201	35.9
Distribution of patients on the basis of road condition at the site of accident		
Straight road	139	24.8
Curved road	81	14.4
Bridge road	109	19.4
Poorly maintained road	63	11.3
Under construction road	66	11.8
Well constructed road with fast traffic	102	18.3
Distribution of patients on the basis of type of impact		
Hit & run	122	21.8
Head on collision	165	29.4
Hit from side	150	26.7
Slipping/Skidding	123	22.1
Distribution of patients on the basis of their position at the time of impact		
Pedestrian	130	23.3
Bicycle rider/Two wheel rider	190	33.9
Light vehicle	44	7.8
Heavy vehicles	53	9.5
Pilon/Co Passenger	143	25.5
Distribution of patients on the basis of status of driving licence		
Valid licence available	259	46.2
Learners licence available	94	16.7
Without Licence	208	37.1

impact on quality of life.[5] Minor injuries do not have a significant effect on life. But major injuries or impairments cause significant disabilities that may require significant palliation and rehabilitation. The study area is apex health care institutes with the availability of facilities to manage Orthopedic traumas. The findings of the study are expected to help in understanding the pattern of road traffic accidents in central India and taking adequate measures to prevent them.

Material and methods:

A cross sectional study was conducted amongst ward admitted patients of the Department of Orthopedics at Gandhi Medical College, Bhopal. Prior approval was taken from institutional ethics committee (IEC). The participants were selected by non-random opportunity sampling from July 2022 to April 2023. A sample size of 560 was calculated by prevalence of 21%, based on previous 6 months data of all road traffic accident patients being treated at Gandhi Medical College & Hamidia Hospital casualty ward, only 21 % required admission at the Orthopedic ward, at a 95 % confidence interval, a margin of error of 5%, and a design effect of 2. Seriously injured patients with a morbid prognosis were excluded. Informed consent was obtained from participants. A pre-designed, pilot-tested questionnaire was used for data collection. The question pertaining to probable cause of accident was elicited. The data collected was compiled and analyzed using MS-Excel 2020.The data was interpreted as proportions and percentages. Multivariate logistic regressions were used to co-relate various epidemiological factors with the probability of trauma.

Table 2. Multi variate logistic regression factors causing accident (N-560).

Factors causing accident	OR	95%CI	Pvalue
Over-speeding	0.97	0.96-0.98	0.04
Inebriated state	0.77	0.67-0.88	<0.001
Wrong side driving	1.55	1.14-2.09	0.006
Not using safety devices	2.2	0.98-1.96	0.02
Ignoring traffic rules	0.44	0.21-0.93	0.03
Distracted driver	1.07	0.80-1.42	0.656
Harsh weather conditions	1.01	0.75-1.37	0.93
Poor road conditions	0.71	0.67-0.08	0.06
Over loaded vehicle	0.83	0.48-1.42	0.49
Vehicular factors	1.05	0.72-1.53	0.08
Naive driver	0.66	0.50-0.86	0.004

Result:

In total, 560 patients participated in this study. The study included 79.6% (446) male patients. Out of 114 female patients, only 8.75% (49) were drivers.

Discussion:

It was observed that a majority of accident victims were young adult males (18-45 years). This is similar to global trends.[6] In the current study, most of the female patients were Pillion riders or co-passengers. (Table-1) It was found that most of the patients were injured on rural roads connecting with the highways, likely reason was that it was less crowded, hence drivers indulged in over speeding. Higher number of incidents occurred on comparatively straight roads, In India, there is a rising trend of accidents occurring on straight roads. The likely reason is that vehicle speeds tend to be high on straight roads in open areas, which corroborates the high percentage of road accidents.[1]

Although road features such as sharp curves, potholes, and steep gradient tend to be accident prone,[1] but poor road conditions did not significantly cause accidents in current study. We found that 18.3% of patients were injured while walking or standing on a footpath. Also, some of these patients suffered head on collisions from over-speeding vehicles. They were unable to recall any faults on their behalf. A large number of patients in the study were two wheel riders, followed by pedestrians, (Table-1) This is similar to global trends and as stated by the Academy of Family Physicians that pedestrians and cyclists are the most common victims of road traffic accidents.[6,7]

Pillion riders are at risk of injury, especially when not using safety devices, i.e., helmets, seat belts, and riding an overloaded vehicle. The 22.1% of patients who were driving or riding skid or slipped vehicles were over speeding on an accident-prone road. In this study, 37.1% of patents did not have a valid driving licence to drive. It is because most of the patients were co passengers. In the current study, over speeding was found to be significantly associated with accidents. (Table-1) As concluded by the WHO,

increase in average speed is directly related both to the likelihood of a crash occurring and to the severity of the consequences of the crash.[6]

The study found a significant association between accidents and driving in an inebriated state. (Table-2) As the WHO states, driving under the influence of alcohol and any psychoactive substance or drug increases the risk of a crash that results in death or serious injuries. As the risk of a road traffic crash starts at low levels of blood alcohol concentration (BAC) and increases significantly.[6] In the case of drunk driving, the risk of incurring a road traffic crash is increased to differing degrees depending on the psychoactive drug used. The study found that there is a significant risk of injury among patients who do not use safety devices such as helmets and seat belts. (Table-2) This is similar to the observation by the WHO that correct helmet use can lead to a 42% reduction in the risk of fatal injuries and a 69% reduction in the risk of head injuries. Wearing a seatbelt reduces the risk of death among drivers and front seat occupants by 45–50% and the risk of death and serious injuries among rear seat occupants by 25%.[6] There is a significant association between accidents and not following traffic rules. (Table-2) The drivers do not take road safety rules seriously and display erratic behavior on the road. Regarding these rules, WHO concludes that, if traffic laws are not enforced or are perceived as not being enforced, it is likely they will not be complied with and therefore will have very little chance of influencing behavior. Also, a significant factor responsible for causing accidents was a novice driver with poor dexterity and underdeveloped driving reflexes. In some cases, they were underage drivers with no driving licence who had started driving recently. The study was unable to find a significant association between trauma and distracted driving and mental condition of drivers. There is an insignificant association between accidents and overloading of vehicles. This is likely, that overloading is not acknowledged as a potential cause of trauma.

Conclusion:

Road accidents have become a leading cause of fatalities and injuries globally, with India being the leading country in this regard. The huge loss of life and attendant economic losses are highly avoidable and require urgent measures to be adopted for effective mitigation. The study used the Haddon matrix approach to understand factors causing Orthopedic trauma. This study is likely to help identify factors that cause trauma on roads.

The study gives an insight into the Indian scenario, which needs to be acknowledged. Hence, taking into consideration the factors mentioned in the study, appropriate measures can be taken in accident prone areas to make road travel safe for all.

Recommendations: The current study draws attention to the importance of formal training, re-training, and sensitization on avoidable risky behaviors being imparted to professional and non-professional drivers in a systematic manner and being a part of curricular education. The traffic rules should be followed strictly, with inclusion of adequate punitive actions. There should be stringent actions to prevent overloading. Inebriated driving should not be tolerated.

The use of safety devices should be strictly observed. Also, distracted driving should not be ignored. All individuals should be sensitized regarding the adverse outcomes of distracted driving.

Roads should be built with a proper long-term vision of town and country planning or keeping in mind futuristic visions to accommodate more vehicles down the lane in the next few decades. Well-maintained signals, signage, and marking (including lane marking) with proper traffic signals are required. Further, wherever possible, two-way traffic should be separated with sufficiently high dividers to reduce face-to-face collisions. Policymakers need to ensure safe footpaths on all arterial roads, along with subways and foot bridges, wherever necessary, particularly near busy junctions. Further comfortable, reliable, and cost-effective public transport service should be ensured for all levels of citizens, which will demotivate the public to use personal vehicles.

Limitation- The study was unable to elicit instances in which the driver was at fault, as in most of the situations, the drivers did not believe that trauma was due to their fault.

Conflict of interest- no.

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ORIGINAL ARTICLE

Analytical Study of Deaths Due to Suicidal Burns Based on Postmortem Examination

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Abstract:

Heat is a form of energy which when transferred to the body causes thermal injury in the form of burns or scalds, the former due to dry heat and the latter due to moist heat. According to WHO, an estimated 1,80,000 deaths every year are caused by burns, the vast majority occur in low/middle-income countries and almost two-thirds occur in African and South-East Asia regions. According to World Health Statistics 2019, India's suicide rate stood at 17.8 suicides per 1,00,000 people, much higher than the global suicide rate of 10.5. The present study focuses on suicidal deaths due to burns to know the magnitude of the problem in our society, to identify which group of society is more vulnerable to this method of suicide and to investigate the outcome of self-inflicted burns and what measures can be taken to reduce the count. An observational study of 100 postmortem cases conducted during a period of 18 months i.e. from January 2019 to June 2020 conducted in Gandhi Medical College/hospital mortuary, Secunderabad, Telangana. The main sources of data are inquest reports, first investigation reports, postmortem reports, hospital case sheets, and death summaries (in treated cases and hospital deaths). The present study concluded that maximum deaths due to suicidal burns occurred in the age group of 31-40 years (35%) associated with equal preponderance of male (50%) and female (50%) groups. Victims whose total body surface area involved was less survived better. By providing proper timely counseling to the vulnerable population, the rate of suicides can be curbed to some extent. Also creating public awareness about the adverse effects of chronic alcoholism, if not all, few social problems can be avoided. As the rural population's preponderance is more in deaths due to suicidal burns, most of them succumb by the time they reach the hospital or health care centers. The delay in hospitalization enhances the complications of burn injuries. Providing adequate health care facilities, counseling centers for the vulnerable section of population and expansion of tertiary medical care all over the country to treat burns victims could be a major step to prevent deaths due to suicidal burns.

Keywords: Suicide; Burns; Degree of burns; Socioeconomic status; Period of survival; Total body surface area; Self-immolation; Kerosene; Soot.

Introduction:

"FIRE", as a noun, comes from the English "fyr" and the Greek "Pyr". Though the existence of fire in nature in the form of lightning, volcanoes, etc has been since times unknown, we human beings tend to say that fire was invented by Homo erectus some 1,000,000 years ago.

This concept has wide scholarly support. Fire is an element of nature which is also worshipped in various cultures according to different mythological stories. Heat is a form of energy which, when transferred to the body causes thermal injury in the form of burns or scalds, the former due to dry heat and the latter due to moist heat. According to WHO, an estimated 1,80,000 deaths every year are caused by burns the vast majority occur in low/middle-income countries and almost two-thirds occur in African and South-East Asia regions. According to World Health Statistics 2019, India's suicide rate stood at 17.8 suicides per 1,00,000 people, much higher than the global suicide rate of 10.5.[1]

Despite the advances in treatment modalities in medicine and surgical fields, the prognosis of burns cases is poor. This may also be attributed to the severity of burns, any other comorbid conditions, incompetency in treatment, poor hygiene, and nourishment. However, deaths due to self-immolation have been increasing over the years in our society.

The present study focuses on suicidal deaths due to burns to know the magnitude of the problem in our society, to identify which group of society is more vulnerable to this method of suicide, and to investigate the outcome of self-inflicted burns and what measures can be taken to reduce the count.

Methods and methodology:

The present study aims to study the socio-demographic pattern and precipitating events causing deaths due to suicidal burns, to identify the proportion of the percentage of burns to mortality, and to identify the areas of intervention to prevent such deaths.

An observational study of 100 postmortem cases was conducted during a period of 18 months i.e. from January 2019 to June 2020 in Gandhi Medical College/hospital mortuary, Secunderabad, Telangana. The main sources of data are inquest reports, first investigation reports, postmortem reports, hospital case sheets, and death summaries (in treated cases and hospital deaths).

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Results and Discussion:

Burns are one of the most devastating injuries a person can sustain. It affects all age groups, from babies to the elderly, and is a problem in both the developed and developing world. The injury represents an assault on all aspects of the patient, from physical to psychological. All of us have experienced the severe pain that even a small burn can bring. Though fire has become one of the most useful agents, it has proved to be one of the most destructive enemies of man.

The present dissertation focuses on deaths due to suicidal burns during the stipulated time period i.e., January 2019 to June 2020 in a sample size of 100 cases that were autopsied at Gandhi hospital mortuary. It reveals that:

1. Maximum cases of deaths due to suicidal burns occurred in the age group of 31-40 years (35%) followed by 21-30 years (33%) and 41-50 years.
2. The present study revealed male to female equal preponderance (males 50% and females 50%). The present study indicates the increasing tendency of suicides in males owing to several factors like the increasing mental strength of females, their individuality, and independence. However, I agree that a study of a larger sample size may affect this opinion.

Dalbir Singh et al. (1998)[2] in their analysis of autopsy records of 240 burn victims admitted to Nehru Hospital of Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh during the period of November 1996 to November 1998 reveals that the majority of burn deaths occurred in the productive age group of 15-40 years (83%) with peak incidence at 21-30 years (43%). Female preponderance (65%) was observed in all age groups. 64% of burn cases are from urban areas. Kerosene was the most common factor in burns death (82%). The majority of the females sustained burns during the daytime in contrast to the males who sustained burns at night. In women, the incidence of burn deaths was higher (73%) in those living with their families, most of the female victims were housewives (65.7%). The majority of deaths due to burns occurred within one week (65%) of the incidence, septicaemia was the major cause of death (53%).

3. Regarding marital status, maximum cases belong to the married category (81%), followed by unmarried (15%) and widowed (3%) cases.

Dhattarwal SK (1997)[3] analyzed medicolegal deaths and 1154 postmortems during the year 1992 occurring at Pandit BD Sharma, PGIMS, Rohtak, where serious medicolegal cases from all over Haryana state are referred and admitted. In the maximum number of cases, burns as a cause of death especially in young females outnumbered other causes of suicide. Accidental cases were 471, suicidal 227, and homicidal 81. In August, there was the highest incidence of cases (49 in number).

Piyush T et al. (2017)[4] in their cross-sectional study on deaths of married women due to burns revealed 37% were between 21-30 years age group, 95% were hindus, 51% were educated upto or below 10th standard, 75% were of low socio-economic status. Apte JS et al (1999)[5] in a prospective study of consecutive admissions to the burns unit have a majority of the patients below the age of 35 years. Females outnumbered males.

4. Majority of the victims were labourers (30% including agriculture laborers) followed by housewives (24%), farmers (7%), students (7%) and others (32%).

Malik AK et al. (2017)[6] in their 2 years study revealed 65% victims were females and housewives constituted the largest population, amounting to nearly 54%.

5. Majority of the cases belong to the low socio-economic group (84%) followed by the middle socio-economic group (16%).
6. Majority of the victims were from rural areas (56%) and the remaining were from urban areas (44%). The present study shows that daily wage labourers, low socio-economic groups, and rural populations form a majority of those committing suicide by burns.

Due to financial problems faced by them, these groups are more vulnerable.

7. Majority of the cases occurred at home (96%).
8. Peak incidence of cases occurred in the winter season (43%) followed by summer (37%) and rainy season (20%).
9. Maximum number of incidents occurred between 6 pm-12 am (43%) and the least between 12 am-6 am (12%).
10. Majority of the cases were preceded by a fight/argument (55%) followed by a history of chronic illness (18%) and financial problems (11%).

The above points (9,10) support the fact that mostly low socio-economic category males in the Indian scenario tend to consume alcohol during the night and commit suicide in a rage of emotions during an argument or fight.

11. Maximum victims died due to the pouring of kerosene oil (84%) followed by petrol (12%) and others.

G.V. Perseley et al.[7] revealed in their study on 1060 admissions to the burns unit, Royal Brisbane Hospital, over a 12-year period, there were 30 cases (2.8%) of attempted suicide. Fourteen (47%) of these patients died. The psychosocial features of people using self-ignition as a method of suicide are consistent with those of suicide in general. The morbidity is high and the outcome is often fatal, especially for those using a flammable liquid.

12. This study revealed that the total body surface area involved was 81-100% in maximum cases (44%).
13. 95% of the cases sustained dermo-epidermal burns.
14. All the 100 cases studied were suicidal burns showing signs of antemortem burning.

Tripathi CB et al. (2000)[8] in the study of "Burns" observed 152 cases of medicolegal autopsies held in the mortuary of the Forensic Medicine Department, BHU, Varanasi from 13.06.1987 to 03.02.1989. Out of 152 cases, 70 (48.05%) died accidentally followed by 47 (30.92%) homicidally and 32 (21.05%) committed suicide.

15. Death occurred in a majority of the cases in the hospital (97%), whereas 3% died on the spot.

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16. Period of survival reveals that the majority of deaths occurred within 2 days to 1 week after the incident (48%).

O. Castana et al.(2013),[9] studied the outcome of patients who committed suicide by burning which revealed majority had a psychiatric history, low socio-economic status, high TBSA percentage, high incidence of inhalation injury, prolonged hospital stay, increased need for surgery and high mortality rate. Their group of patients showed a slight female preponderance (55%) compared to most of the series reported (yet in accordance with the other retrospective study from Athens) and a slightly higher mean age (58 yr).

17. The presence of soot particles in airways was observed in 22% of cases, and in both GIT and airways in 6% of cases.

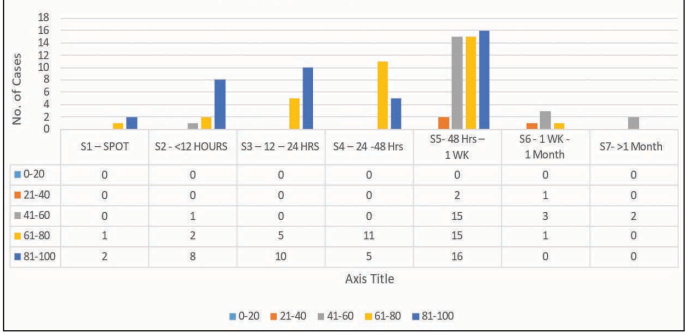
18. The below table suggests that victims who had a lesser percentage of TBSA burns survived for a greater period, whereas victims who had a greater percentage of burns either survived for a short period or died on the spot.

Out of 100 cases studied, 97% of cases were hospital deaths that received treatment and 3% died at the scene of the offense. Period of survival ranging between 12hrs-1month is seen in 86% of cases. Based on hospital records, the majority of the cases died due to septic shock.

Sachil Kumar et al. (2016)[10] revealed that in all burn deaths among older adults, 41.6% of the victims were male and 58.4% were female with a male: female ratio of 1:1.4. Most common manner of death among the elderly was an accident (42.9%) followed by homicide (35.1%) and suicide (22%). Women in all three groups were more prone to the risk of burn deaths. Causative agents for the accidental deaths were fire in all cases while in suicidal and homicidal deaths the causative agents were sprinkling/pouring of kerosene. 54.7% of the suicidal victims had burns >70% TBSA (total body surface area).

Oren P. Mushin et al. (2019)[11] in their study revealed patients with self-inflicted burns have a higher rate of previous self-harm behavior, psychiatric co-morbidities and substance abuse. Self-inflicted burns lead to longer stay in the hospital and ICU and a higher need for excision and grafting compared to non-intentional burn. Among the self-inflicted burn group, 55% of patients were on psychiatric medication and 59% had a previous psychiatric admission. Increased counseling of at-risk populations may help to decrease this potentially preventable method of injury.

Tabe No: TBSA vs Survival Period



	S1 – SPOT	S2 - <12 HOURS	S3 – 12 – 24 HRS	S4 – 24 -48 Hrs	S5- 48 Hrs – 1 WK	S6 - 1 WK - 1 Month	S7- >1 Month
0-20	0	0	0	0	0	0	0
21-40	0	0	0	0	2	1	0
41-60	0	1	0	0	15	3	2
61-80	1	2	5	11	15	1	0
81-100	2	8	10	5	16	0	0

Chaudhary BL et al. (2013)[12] in their 5 years (1st January 2006 to 31st December 2010) autopsy-based retrospective study of 2773 burns cases 56.52% were males and 43.47% were females; 72.94% were accidental followed by suicidal 17.39% and homicidal 9.66%.

Conclusion:

The present dissertation concludes that deaths due to burns are forming a major proportion of the increasing suicidal death rate in our country. Today there is ascending incidence of suicides among all age groups without any gender preponderance due to multiple reasons.

When it comes to the point of suicide, a human being requires lot of courage to deliberately harm himself. Hence, most of the times people resort to methods which are less painful like consumption of pesticides, ingestion/injection of harmful drugs, hanging, incising the wrists, using firearms (contact shots), etc. If one has chosen the most painful method of setting him/herself ablaze, the amount of mental agony in their life can be estimated. Predominantly, suicides are committed under the influence of alcohol or in an emotionally disturbed state of mind. Several incidents proved that persons committing suicide have some triggering factors like financial problems, marital issues, problems related to education, career, and love life; as a part of public protests, depressive illnesses; loss of near and dear ones, etc. Suicidal burns are also seen in cases of dowry harassment and torture by in-laws, bad care to the females, illiteracy, quarrels for the property among siblings, psychics and sometimes failing in examinations by means of pouring kerosene on the body; setting ablaze themselves.

As India is a developing country, the majority of the population is low and middle socio-economic groups. Though their financial condition is a triggering factor for suicide, I would like to stress a strange point i.e. easy availability of the accelerant kerosene to the victims. Kerosene, which is given by the government as a part of a ration to the lower socio-economic families or purchased from outside, is the prime source of burns in my study. Whenever there is a dispute in the house, kerosene is easily available in the premises which is used for self-immolation by the victims.

If the victim attempts self-immolation in an open space other than a closed room, there is a possibility of hospitalizing the victim at the earliest. This increases the period as well as the chances of survival.

Females, especially during the premenstrual phase, postpartum phase and menopause suffer from depressive thoughts during which even a petty quarrel at home might push them towards suicide by self-immolation. People suffering from chronic illnesses and depressive disorders with a history of antipsychotic or antidepressant drug therapy have shown suicidal tendencies to a greater extent.

The victims mostly die due to septic shock, neurogenic shock or hypovolemic shock. The survival rate for burn victims is not satisfactory despite great medical advancement.

By providing proper timely counseling to the vulnerable population, the rate of suicides can be curbed to some extent. Also creating public awareness about the adverse effects of chronic

alcoholism, if not all, few social problems can be avoided. As the rural populations' preponderance is more in deaths due to suicidal burns, most of them succumb by the time they reach the hospital or health care centers. The delay in hospitalization enhances the complications of burn injuries.

Providing adequate healthcare facilities, counseling centers for the vulnerable section of the population and expansion of tertiary medical care all over the country to treat burn victims could be major steps in preventing deaths due to suicidal burns.

Limitations: This study could not include histo-pathological examination of tissues and estimation of carbon monoxide levels in the blood of the deceased.

Financial Support: NIL

Ethical clearance: Taken

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ORIGINAL ARTICLE

Evaluation of Accuracy of Clinical method for Age Estimation in 6–14 Year old Children in Vadodara City: An Institute based Cross-sectional Study

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Abstract:

Age of an individual is important in order to identify a person, living or dead. Unavailability of such important detail mandates estimation of such parameters using different methods. Age estimation using teeth can be highly valuable since teeth are highly durable, resistant to putrefaction, fire, chemicals and shows minimal post mortem destruction. One such age estimation method based on teeth eruption was given by Foti B et al in French Population. However, individual growth factors like genetics, race, ethnicity, tend to exhibit difference in eruption timing and sequence in different population. Hence, the present study aimed to check the accuracy of such models in the Indian subpopulation. And to develop a more accurate and reliable age estimation formula for the children of Vadodara. 80 Children aged 6 – 14 years born in Vadodara were clinically evaluated to check the number of erupted teeth. Foti's clinical method of age estimation based on eruption status of permanent teeth was used to derive the age of each child. A new age estimation formula specific to local population was derived. A comparative evaluation of the Age_New_Formula was done with Foti's equations and chronological age. Statistical analysis revealed higher correlation between chronological age and estimated dental age using Age_New_Formula as compared to original equations given by Foti. Age_New_Formula is based on teeth eruption pattern of the local population. Hence, this equation can be more accurate and reliable for age estimation in 6-12 year of children in Vadodara City.

Keywords: Age estimation; Tooth eruption; Forensic anthropology.

Introduction:

Forensic odontology has grown explicitly worldwide in the past few decades. Human identification is a prime challenge in a lot of criminal cases. Age estimation of the living or dead can be an important determinant in forensic medicine especially in an over populated country like India. Age estimation also has a wide role in situations like child adoption, child marriage, penal code, infanticide, rape, judicial punishment, commercial or sexual exploitation, domestic employment, requests for political asylum, issues of inheritance and pension claims of the elderly etc.[1,2] Unavailability of crucial details like 'Age' mandates estimation of such parameter using various available techniques. Age estimation methods most frequently used in children includes skeletal maturation and number of erupted teeth and its developmental stages. Among the two, age estimation using teeth has demonstrated higher correlation.[3,4] Also, teeth are a valuable tool as they are highly durable, resist to putrefaction, fire, and chemicals and shows minimal post mortem destruction.

The first known attempt to use teeth as an indicator of age originated from England. Edwin Saunders, a dentist, was the first to publish information regarding dental implications in age assessment by presenting a pamphlet entitled “Teeth A Test of Age” to the English parliament in 1837.[5] The time of eruption of primary and permanent teeth are fairly constant in a population, and assessment of age of an individual by the examination of teeth is one of the accepted methods of age determination. There are multiple such methods based on eruption of teeth, which can be used for age identification. Principally, these methods are Radiographic and Clinical methods.[6] However, in areas with unavailability of radiographs, it is important to have accurate Clinical age estimation method. Also, clinical method is quicker, inexpensive and does not require any special equipment.

One such age estimation method was given by Demirjian et al. It seems that both the original and simplified formulas of Demirjian et al.,[6] Demirjian and Goldstein[7] are easy to use and have practical interests. However, this method did not yield reliable results in Asian people[8] and Indians,[9] which was explained by diversity of development stages in children between 5 and 12 years of age.[10] Another such method for estimation of age using clinical as well as radiologic method was given by Foti B et al. in French Population.[11] He proposed mathematical models (equations) for age calculation based on counting erupted teeth. This novel method for age determination in children with calculation models is simple, accurate, and reliable. However, as mentioned above, individual growth factors like genetics, race, ethnicity, geographical location, tend to exhibit difference in eruption timing and sequence in different population groups. The normal tooth eruption patterns that were recorded for a western society cannot be applied to an Indian scenario.[12] Acharya et al. thus derived an Indian specific regression formula using Demirjian's 8-teeth method.[13]

Hence, the present study aimed to check the accuracy of such models in the Indian population. And to develop a more accurate

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and reliable age estimation formula for the children of Vadodara city of central Gujarat.

Material and methods:

The present study was an Observational Cross-sectional study. Ethical clearance was obtained from Sumandeep Vidyapeeth Institutional Ethics Committee. 80 healthy children between 6 – 14 years of age residing in Vadodara since past two generations were selected from the Outpatient Department of Pediatric & Preventive Dentistry. Informed consent was obtained from the parents of these children before initiation on the study. The age group of 6-14 year was selected based of timings of permanent teeth eruption. Patients with any medical history, or Congenital anomalies were not included.

Chronological Age: A photo copy of Birth Certificate/ Aadhar Card was obtained from the parent of each study participant. Based on birth date, age of the child was then calculated. For the convenience of statistical analysis, age was converted to a decimal value (e.g. 7 years 6 months and 5 days was rounded of to 7.6 years, No. of days above 15 was rounded off to a higher number e.g. 7 years 6 months and 25 days was rounded of to 7.7 years) In order to avoid observer bias, these values were calculated independently by a person other than the observer.

Age estimation: A meticulous intraoral clinical examination was done by the principal investigator in presence of sufficient natural light, using mouth mirror and dental probe. The tooth numbers of erupted permanent teeth in each quadrant were filled in the proforma sheet. A tooth was considered to have erupted if at least part of the tooth had pierced the gingiva (gingival emergence/ eruption). Foti's Age estimation Models (1,2,3) were used to calculate the age of each child and this data was compared with the chronological age in order to check the accuracy of this method on the study population. The original regression models derived by Foti B. et al are as follows:

- Model no. 1 (FOTI 1): based on all the teeth present in the oral cavity at the time of examination

  ESTIMATED AGE = 13.652 - (0.514 x number. of deciduous. upper incisors) - (0.236 x number of deciduous. upper molars) + (0.314 x number of permanent Upper canines) - (1.748 x number of permanent Upper 1st molars) + (1.012 x number of permanent Upper 2nd molars) + (0.944 x number of upper 3rd molars) + (0.252 x number of lower premolars) + (0.285 x number of permanent Lower 2nd molars) + (1.537 x number of lower 3rd molars)

- Model no. 2 (FOTI 2): regression model based on all teeth present in upper jaw

  ESTIMATED AGE = 13.704 - (0.567 x number of deciduous upper incisors) - (0.367 x number of deciduous upper molars) + (0.530 x number of permanent Upper canines) - (1.449 x number of permanent Upper 1st molars) + (1.359 x number of permanent Upper 2nd molars) + (2.041 x number of erupted 3rd molars)

- Model no. 3 (FOTI 3): regression model based on teeth present in the lower jaw

  ESTIMATED AGE = 9.726 - (0.571 x number of deciduous lower incisors) - (0.378 x number of permanent Lower canines) + (0.579 x number of lower premolars) + (1.056 x number of permanent Lower 2nd molars) + (2.236 x number of lower 3rd molars)

Statistical Analysis: The chronological age of each individual was compared with the estimated values obtained using Foti's Model 1, 2 & 3. Further, the data collected based on eruption timings of local population from the study population was subjected to forward stepwise linear regression in order to derive the variables of higher significance in the study population. The

Table1. Represents the forward stepwise linear regression analysis.

Excluded Variables[a]						
Model		Beta In	t	P value	Partial Correlation	Collinearity Statistics
						Tolerance
1	DUI	-.118[b]	-1.299	.198	-.146	.792
	DUM	-.392[b]	-3.365	.001	-.358	.432
	PUC	-.143	1.413	.162	.159	.639
	PU1M	-.011[bb]	-.137	.891	-.016	.957
	OY/2N	-.369[b]	4.485	<0.001	.455	.787
	LPM	-.228[b]	1.664	.100	.186	.346
	PL2M	-.378[b]	4.276	<0.001	.438	.693
	DLI	-.098[b]	-1.176	.243	-.133	.942
2	DUI	-.126[c]	-1.550	.125	-.175	.791
	DUM	-.217[c]	-1.789	.078	-.201	.352
	PUC	-.012[c]	.120	.905	.014	.572
	PU1M	-.025[c]	-.329	.743	-.038	.955
	LPM	-.065[c]	.494	.623	.057	.314
	PL2M	-.183[c]	1.304	.196	.148	.269
	DLI	-.079[c]	-1.050	.297	-.120	.939

a. Dependent variable: Chro. Age
b. Predictors in the Model: (Constant), PLC
c. Predictors in the Model: (Constant), PLC, PU2M

Table 2. Represents the R value and standard error of estimate.

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
2	.768[b]	.590	.580	1.1932791

b. Predictors: (Constant), PLC, PU2M.

Table 3. Represents the Comparison of the chronological age in terms of {Mean (SD)} with the age calculated using FOTI's age estimation formula model 1, 2 & 3 and Age_New_Formula using paired t test. (p < 0.05 - Significant*, p < 0.001 - Highly significant).**

		N	Mean±SD	Mean Difference ± SD	t	P Value
Pair 1	Chro. Age	80	10.38±1.84	-1.32.03	-5.74	<0.001
	FotiM1	80	11.68±2.53			
Pair 2	Chro. Age	80	10.38±1.84	-0.52±1.47	-3.16	0.0002
	FotiM2	80	10.9±2.17			
Pair 3	Chro. Age	80	10.38±1.84	-0.02±1.86	-0.10	0.923
	FotiM3	80	10.4±2.12			
Pair 4	Chro. Age	80	10.38±1.84	0±1.18	0.00	0.997
	Age_New_Formula	80	10.38±1.41			

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Regression Analysis suggests that Permanent Lower Canine (PLC) and Permanent Upper 2nd Molar (PU2M) are the most relevant constant variable in the study population. Thus, these two variables were included in the new formula for age prediction. The newly derived formula is titled Age New Formula.

Age = 8.832 + 1.015 (PLC) +0.840 (PU2M);

R value of 0.768 and SEE of 1.1932 years

The Statistical software IBM SPSS statistics 20.0 (IBM Corporation, Armonk, NY, USA) was used for the analyses of the data and Microsoft word and Excel were used to generate graphs, tables etc.

Results:

Forward Stepwise Linear Regression analysis was used to procure the most significant 'variables' necessary for deriving a new formula. Table 1. represents the constant variable derived for the new formula. Here, permanent lower canine (PLC) and Permanent Upper Second Molars (PU2M) are the constant predictors. This suggests that these two teeth are the most relevant constant variables with minimum variation in eruption timing for the study population. A part of regression analysis was used to derive the coefficients in the formula. Here 8.832 is the constant. The unstandardized coefficient for PLC is 1.015 and for PU2M is 0.840.

Table 2. represents the R value and Standard Error of Estimate. An R value of 0.768 represents a good co-relation between chronological age and the newly derived formula. SSE value represents the Standard Error of estimate in age. Thus, an error of 1 year and 1 month can occur in the Estimated Age using the new formula.

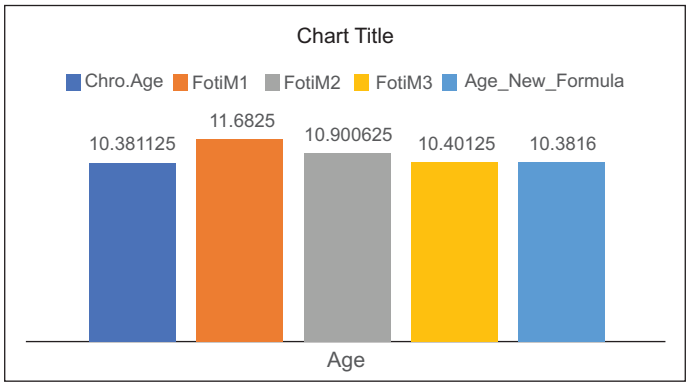

Figure 1. Represents the bar graph of the mean values of chronological age & age calculated using foti's models and age_new_formula.

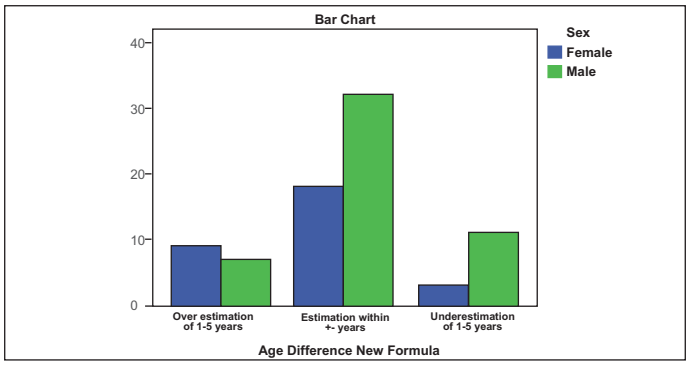

Figure 2. Shows the comparison of estimated values using age_new_ formula among males and females using chi square test.

Chronological age was then compared with Foti et. al's Models and Age_New_Formula using paired t test (Table 3). On comparison of the mean values of chronological age with Foti's Models the mean values of FotiM1 and FotiM2 was higher and statistically significant with a p value of <0.05. The Mean value of FotiM3 represents least Mean difference of 0.02±1.86 when compared with chronological age suggestive of accuracy of FotiM3 as compared to model 1 and 2. Further, when the Age_New_Formula was compared with the Chronological age the difference between the Mean (SD) was 0.0015 indicating a very high correlation between these two formulae.

Further, Chi square test was used to check the distribution of over-estimated and under estimated values in males and females for Foti's Models and Age_New_Formula. Overall Foti's Model 1, 2 have shown overall higher levels of over estimation and under estimation of age in males as compared to females. Foti Model 3 showed over-estimation almost similar in both the genders. However, underestimation was more in males as compared to females. Figure 2 shows the comparison of estimated values using Age_New_Formula among males and females. The Age_New_Formula has shown least values in terms of over-estimation and under estimation. An over estimation of 1-5 years was seen in 9 females and 7 males. Whereas, underestimation of 1-5 years was seen in only 3 females and 11 males. A total of 50 Individuals among which 18 are female and 32 are Male falls in the category of estimation within +/- 1 year indicating that the Age_New_Formula is the most accurate equation to be used for age estimation.

Discussion:

Age determination is an important part of Forensics. The age of cadavers is determined for a variety of reasons, including criminal cases and the severely dismembered victims of mass tragedies like fires, accidents, collisions, killings, feticides, and infanticides. Age estimation is done for people to determine whether the child has reached the age of a person's criminal liability in situations like rape, kidnapping, employment, marriage, orthodontics, premature births, adoption, unlawful immigration and pediatric endocrinopathy malocclusion, especially where records are questionable and the birth certificate is unavailable.[18-21] Kumar et al in a resent study in the year 2023 suggested, the most common and reliable techniques used for fast and secure identification are dental data, fingerprints and DNA comparisons.[22] Age estimation using dental remnants plays a crucial role in the identification of living and dead subjects as dental hard tissues are the least salvageable tissues in the body. Various physical, chemical, and histological methods have evolved over the years to estimate age using the teeth.[23] However, the majority of them result in the loss of physical evidence. Thus, Estimation of age by assessing the sequence of eruption has often been the preferred method as it closely coincides with the chronological age.

Primarily, radiographic & clinical methods are used for this purpose. However, absence of radiographic facility in parts of

Rural India demands accurate clinical methods independent of radiographs. As stated by Dsouza et al.[14] among the clinical methods, methods based on tooth eruption have been established as the most accurate. However, Towlson and Peck questions the reliability of tooth eruption as age indicator.[24] It is generally accepted that no single method can provide an accurate measure of an individual, be it adult or child. It is said that various methods of age estimation should be used in unison to achieve accurate levels of accuracy.[25]

Foti et al. conducted a study in the year 2003 in French children aged 6 to 20 years and proposed 4 regression models based on number of permanent teeth erupted in oral cavity and tooth germs. The 1st model proposed by Foti et al required presence of Orthopantomogram facility whereas the next three models were purely based on clinical evidence of tooth eruption. Since, genetic makeup of Indian population is much more diverse, it was necessary to check the accuracy to these models in Indian population.

When Foti el al's. models were assessed for their accuracy in the study population, Model 1 and 2 showed high level of inaccuracy to that of the chronological age. Model 3 showed highest level of accuracy among the 3 models. These results are in accordance with a study conducted by Dsouza et al.[14] in coastal children of India where they have also found that Model 3 has highest level of accuracy and least error among Foti's 3 Models.

Age_New_Formula shows a mean difference of 0.0015 when compared with chronological age using paired t test. This suggests that Age_New_Formula is more accurate for the study population. Similar results were found in the study by Dsouza et al.[14] wherein the population specific formula's showed better accuracy than Foti et al's models.

Dinkar et al.[26] in the year 2014 also studied the accuracy of Foti's models in Goan Population and concluded that Regression models based of local population showed high levels of accuracy. This difference could be attributed to ethnic and social diversity in a vast country like India. As stated by Khan AS (2020)[12] 'The growth and development patterns cannot be universally applied to the various ethnic variations.' They have also concluded that eruption time of different teeth was either directly or indirectly related to the BMI. Thus, diverse nutritional and lifestyle habits in India can also add into these factors. Gender wise comparison of Age_New_Formula using Chi square test showed no statistically significant difference between the Males and Females.

Sharma et al.[27] in 2015 conducted a study to assess the corelation between Skeletal age and Dental age in living Children and concluded that combination of these two methods should be used for more accurate estimation of age in living individuals.

This study proposed a simple and accurate age estimation equation for the population of Vadodara city. However, one must be judicious while extrapolating the observations made from the current study to the entire Gujarati population as there exists an enormous amount of genetic admixture and cultural diversities which necessitates population and subpopulation specific studies. Overall, smaller sample size mandates validation of the Age_New_Formula in larger population size.

Conclusion:

India is a country with vast genetic & cultural diversity. Studies have shown that people from different ethnic and racial groups not only show different variations in growth and development but also show difference in eruption pattern and timing of individual teeth.[12] Foti et al's Models were based on tooth eruption patterns in French population. These models have shown high level of inaccuracy in the study population. Age_New_Formula is based on teeth eruption sequence of the local population. Hence, this formula is more accurate equation for age estimation in 6-14 year of children in Vadodara city.

This study opens an expected door for a large sample size to be tested in various local populations with different ethnicity and race. Population specific studies on sequence of age eruption can help in better understanding of such parameters in future. Assessment of accuracy of Age_New_Formula in different regions of India is essential. Such studies can provide us formulae accurate to individual population and such research can revolutionise the future of Age estimation in Forensic odontology.

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ORIGINAL ARTICLE

Feasibility of Age Estimation from Exfoliated Buccal Mucosal Cells in Adults: A Cytomorphometric Study

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Abstract:

This study aimed to evaluate the age and gender-related cytomorphometric changes in the buccal mucosal cells of Indian adults and the feasibility of age estimation from them. Exfoliative cytology smears were collected from the clinically normal buccal mucosa of 90 individuals (30 in age groups of 21-30, 31-40, and 41-50 years). They were fixed in 95% alcohol and stained with the Papanicolaou technique. The Cytoplasmic Area (CA) and Nuclear Area (NA) in square micrometers and the Nuclear area: Cytoplasmic area Ratio (NCR) were estimated for each individual by averaging the measurements from 100 clear and unfolded cells. The age and sex-based intergroup comparisons were made with Analysis of Variance and Independent samples T-test (or their non-parametric equivalents), respectively. Pearson and Point Biserial correlations were used to assess the association of NA, CA, and NCR with age and gender, respectively. The cytoplasmic area showed a statistically significant difference (p=.04) between 21-30 years (2572.34 ± 516.54) and 31-40 years (2230.15 ± 516.12). NA and NCR did not differ between age groups. While females (0.030 ± 0.007) showed a higher NCR than males (0.026 ± 0.005, p=.009), no sexual dimorphism was noted for CA and NA. No statistically significant correlations were found between age and CA, NA, or NCR. Though the buccal mucosal cells from adults exhibited some age and gender-related cytomorphometric changes, it is not feasible to predict the chronologic age of an individual from them.

Keywords: Age estimation; Cytomorphometrics; Exfoliative cytology.

Introduction:

Current methods of human age estimation from oral structures are based on assessing the age-related morphological, physiological, radiological, histological, or biochemical changes noted in the teeth.[1–9] The histological and biochemical methods require extracted teeth from the individual and are often not feasible in living subjects.[6,7] The visual techniques based on the number of teeth, eruption pattern, teeth color, attrition, gingival recession, etc., are the easiest for this purpose but are less precise.[1,10-13] In the last few decades, radiographic methods based on stages of tooth development and changes in pulp size have evolved to become the mainstay of age estimation using oral structures in living individuals.[1,4,7,10,11,14,15] While there is little doubt about the utility of radiographic techniques, the need for radiation exposure has ushered in a search for alternatives.

Recent studies on the exfoliated epithelial cells from the normal oral mucosa of living subjects have documented age-related morphologic changes in the cell that can be quantified and analyzed.[16-28] This provides a potential for cytomorphometric evaluation of these cells as a non-invasive method for age estimation in living individuals. Shetty et al. noted a significant negative correlation between the size of exfoliated cells from the normal buccal mucosa and the individual's age.[22] Nallamala et al. found the chronologic age of the individual to be better correlated to the cell size than the pulp-tooth area ratio and hence the better suitability of the former in age estimation.[23] Sex is another variable investigated for effect on the cellular size, but the results are inconclusive.[17,18,27]

Hence, the current study was undertaken to assess the

1. Age and sex-related changes in the dimensions of the normal buccal mucosal cells.
2. Association, if any, between these variables and
3. Feasibility of estimating the chronologic age of an individual by cytomorphometric analysis of exfoliated buccal mucosal cells.

Methodology:

This cross-sectional study was conducted in the Department of Dentistry, Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry, after approval from the Institute Ethics Committee (Human Studies) and following the ethical standards in the 1964 Declaration of Helsinki and its later amendments. Participants were recruited from the Outpatient section of the department. All were apparently healthy individuals aged 21- 50 years and willing to participate in the study. Individuals with deleterious habits such as smoking, alcohol, tobacco, and areca nut use (currently or within the past six months) were excluded. Other exclusion criteria were known systemic diseases or use of medications that can affect oral

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mucosa, clinically evident abnormal alterations in the oral mucosa, multiple grossly decayed teeth, recurrent cheek biting habit, and history of antineoplastic therapy.

The samples for the study were divided into three age groups: Group 1 – 21 to 30 years, Group 2 – 31 to 40 years, and Group 3 – 41 to 50 years. The required sample size was estimated in GPower 3.1(©2021 Heinrich-Heine-Universität Düsseldorf),[29] based on previously reported correlation (r=0.692) between buccal mucosal cell size and chronologic age. To detect a difference between the null hypothesis correlation of 0.692 and the alternative hypothesis correlation of 0.5 using a two-sided hypothesis, the alpha error probability of 0.05 and power of 0.8, a sample size of 88 is required. Therefore, to obtain an equal number of samples in all groups, 90 samples were recruited (30 per group).

Written informed consent was obtained from participants just before data collection. The demographic details collected included age in years (cross-verified with medical records) and sex (Male/Female). The exfoliative cytology smears were obtained by scrapping the normal buccal mucosa using a cytobrush. The scrapings were smeared onto the clean and dry glass slides, serially numbered, and stored for the study. The specimens were fixed immediately by submerging them in 95% alcohol and sent for processing. The smears were stained with the Papanicolaou technique.

The cells were examined in an Olympus CX41 compound microscope (Olympus Corporation, Tokyo, Japan) under 10x magnification. The calibrated images of the different fields were obtained with the integrated Optikam microscopy camera and Optika view 7 software (OPTIKA S.r.l., Ponteranica (BG), Italy). To avoid repetitive inclusion of the same cells, the fields were photographed in a non-overlapping, uniform, and stepwise manner, starting from the upper right corner, moving from left to right, and then down to the next row. The estimation of cellular dimensions was performed in FIJI software. The measurements included the cytoplasmic area in square micrometers (CA), the nuclear area in square micrometers (NA), and NA: CA Ratio (NCR). The photographs were imported into the software and calibrated for size in micrometers. The CA and NA were obtained by tracing the outlines digitally and recording the software-generated value for the selected region(Figure 1). A minimum of 100 unfolded non-overlapping cells with clear outlines were assessed for each participant, and the averaged data were used for data analysis. The stepwise procedure, as described above, was used even while selecting the cells for measurement.

To ensure methodological consistency, the same operators did all the critical steps (smear preparation, cytological processing, image acquisition, and analysis). The intra-observer reliability for measuring NA, CA, and NCR was calculated by repeating the measurements for 20 samples after one month and comparing them with their first set.

Statistical Analysis: The normality of NA, CA, and NCR data distribution was analyzed with the Kolmogorov-Smirnov test. They were normally distributed in all groups based on age and sex except for the NCR in Group III (p=.043) and Females (p=.041). The inter-group differences in NA and CA, based on sex and age, were evaluated with an independent sample T-test and One-way Analysis of Variance (followed by Bonferroni post-hoc tests), respectively. The same for NCR was analyzed with Mann Whitney U and Kruskal Wallis Tests, respectively.

Pearson and Point Biserial correlations were used to assess the association of NA, CA, and NCR with age and gender, respectively. If significant correlations were observed, it was planned to evaluate the possibility of age estimation from these variables using multiple linear regressions with age as the dependent variable and CA, NA, NCR, and gender as independent variables. The intra-observer reliability for measuring CA, NA, and NCR was evaluated with the Intraclass correlation coefficient (Two-way random effects, absolute agreement, single rater/measurement). The alpha for all tests was kept at 0.05, and the data analysis was done in IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, NY, USA).

Table 1. Demographic characteristics of the sample.

Age Group (in years)	Male Mean ± SD (n)	Female Mean + SD (n)	Overall Mean + SD (n)
I (21 – 30)	25.25 ± 2.86 (16)	25.50 ± 2.68 (14)	25.36 ± 2.73 (30)
II (31 – 40)	34.41 ± 2.46 (12)	35.16 ± 2.35 (18)	34.86 ± 2.38 (30)
III (41 – 50)	44.70 ± 4.35 (17)	44.30 ± 2.54 (13)	45.20 ± 3.67 (30)
Overall	35.04 ± 9.07 (45)	35.24 ± 8.33 (45)	35.14 ± 8.66 (90)

Table 2. Comparison of Cytoplasmic Area (CA), Nuclear Area (NA) and Nuclear Area: Cytoplasmic Area Ratio (NCR) by sex and age groups.

Variable	Groups by Sex			Groups by age (in years)		
		Mean ± SD in µm2	p		Mean ± SD in µm2	p
CA	Male Female	2480.20 ± 521.40 2310.44 ± 557.19	NS[a]	I (21-30) II (31-40) III (41-50)	2572.34 ± 516.54 2383.47 ± 558.50 2230.15 ± 516.12	I vs. II-NS[c] I vs. III -*[c] II vs. III-NS[c]
NA	Male Female	58.91 ± 11.06 59.94 ± 08.83	NS[a]	I (21-30) II (31-40) III (41-50)	61.56 ± 11.48 59.14 ± 09.21 57.56 ± 08.93	I vs. II-NS[c] I vs. III-NS[c] II vs. III-NS[c]
NCR	Male Female	0.026 ± 0.005 0.030 ± 0.007	**[b]	I (21-30) II (31-40) III (41-50)	0.027 ± 0.004 0.028 ± 0.007 0.029 ± 0.008	I vs. II-NS[d] I vs. III-NS[d] II vs. III-NS[d]

NS – Nonsignificant, *p<0.05, **p<.01, a Independent samples T test, b Mann Whitney U test, c One-way ANOVA with Bonferroni post-hoc tests, d Kruskal Wallis test.

Table 3. Mean, standard deviation, and correlations for Cytoplasmic Area (CA), Nuclear Area (NA), Nuclear area: Cytoplasmic area Ratio (NCR), age and sex.

	Mean	SD	CA	NA	NCR	Age	Sex
CA (in µm2)	2395.32	543.30	-	.38**	-.71**	-.19	-.15
NA (in µm2)	59.42	9.96		-	.20	-.12	.05
(NCR)	0.020	0.006			-	.13	.25*
Age (in years)	35.25	8.95				-	-
Sex (1=Male, 2=Female)	-	-					-

* p<0.05, ** p<0.01.

Results:

The demographic characteristics of the sample are presented in Table 1. Comparisons of CA, NA, and NCR by sex (Table 2) revealed statistically significant differences for NCR, with females (0.030 ± 0.007) showing a higher ratio than males (0.026 ± 0.005) (p=.009). No statistically significant differences were

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noted for CA [t(88)=1.65,p=.10] or NA [t(88)=-0.41,p=.68] . One-way ANOVA showed a statistically significant difference in intergroup comparisons based on age for CA [F(2,87)=4.38,p=.015]. The cytoplasmic area in Group I was higher than in Group III (2572.34 vs. 2230.15, p=.04). The intergroup differences for NA [F(2,87)=1.10,p=.33] and NCR (p=.30) were not statistically significant (Table 2).

The Pearson's correlations among the study variables are presented in Table 3, and the scatter plots are shown in Figure 2. No statistically significant correlations were found between age and CA, NA, or NCR. Given the lack of correlation, the proposal to predict the individual's age from these variables using multiple linear regression analysis was deemed inappropriate and abandoned.

The single measures Intraclass Correlation Coefficient indicated that the reliability of CA (.93, 95% CI= .85 - .97) and NCR (.89, 95% CI= .76 - .95) was good to excellent while that of NA (.83, 95% CI=.63 - .93) was moderate to excellent.

Discussion:

In our study, the cytoplasmic area gradually decreased with age, with statistically significant differences noted between age groups 21-30 and 41-30. The decrease in cytoplasmic area/ cellular size with advancing age is consistent with many previous studies.[22–26,28] In contrast, Eid et al.[21] observed that the epithelial cells tended to become larger and flatter with age, and Cowpe et al.[17] observed no change. Conflicting results have been reported for NA too. Our study did not find any variation in NA with age, but both increased[17,28] and decreased[24] nucleus size have been reported. Similar to Ilayaraja et al.,[24] the NCR did not differ by age group in our study. However, Cowpe et al.[17] found significant variations in NCR with advancing age. Reddy et al.[28] noted an increase in NCR with age and attributed the same to a decrease in Cytoplasmic Diameter (CD) rather than the increase in ND with age. Though inconsistent and conflicting, these dimensional alterations in cytomorphometric variables are often ascribed to senescence, resulting in decreased cellular activity and epithelial turnover.[17,18,21,22-26,28]

While the NCR ratio was higher in females than males in our

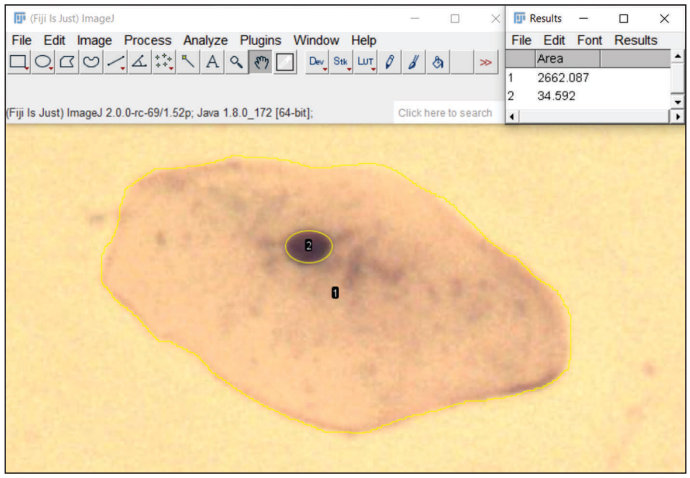

Figure 1. Measurement of the cytoplasmic and the nuclear areas of the buccal mucosal cell in FIJI software.

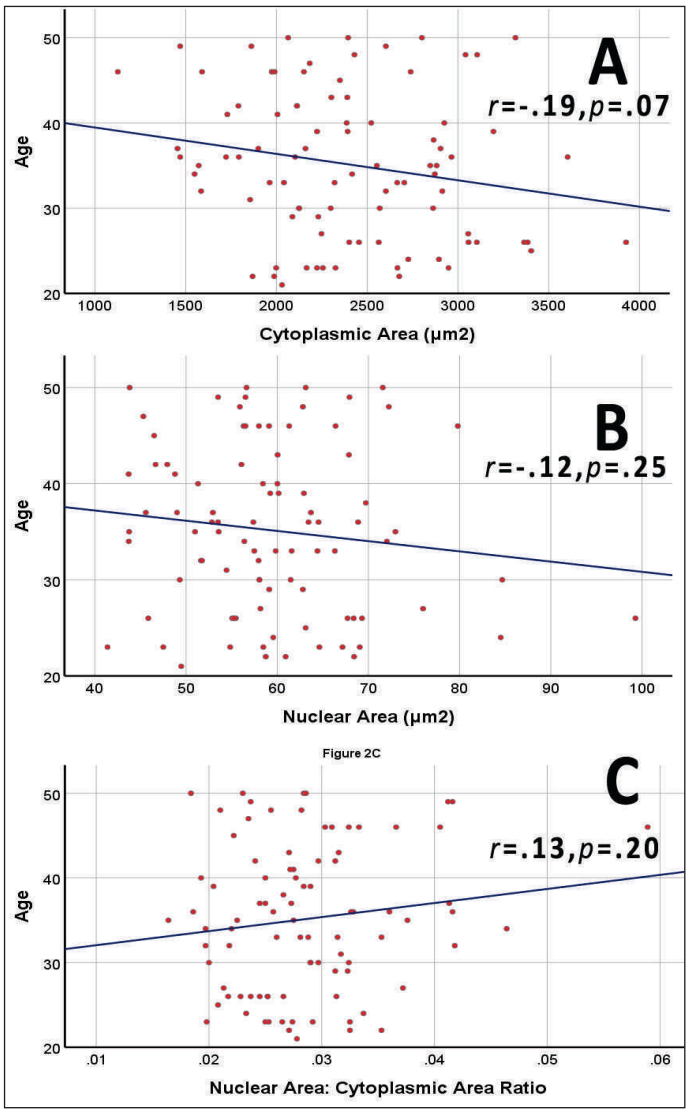

Figure 2. Scatter plots of cytoplasmic area (a), nuclear area (b), and nuclear area: cytoplasmic area ratio (c) against age.

study, no sexual dimorphism was noted for CA or NA. Cowpe et al.[17] found no significant variation between males and females for all three variables. Nayar and Sundharam[18] observed statistically significant sex-related variations only in the 40 – 60 years age group, with males showing comparatively higher values for both. These differences were considered to result from hormonal imbalances occurring in females during this age.

No statistically significant correlation was found between age and the cytomorphometric variables (CA, NA, and NCR) evaluated in this study. Hence, arriving at a regression model to predict the individual's age from these variables was not possible. Shetty et al.[22] found a significant correlation (r=-.692) between the cell size (cytoplasmic area) and the individual's age and suggested its use for age estimation. Nallamala et al.[22,23] observed an excellent correlation between the chronological age and the cell size (r=-.934) and arrived at a linear regression model to predict the age [Estimated age = -0.0516 (cell size) + 57.363.]. Further, the chronological age correlated better with the cell size

(r=-.934) than the pulp-tooth area ratio (r=-.76) in mandibular canines. Therefore, they concluded that age assessment from exfoliative cytology was more accurate than radiographic evaluation of pulp-tooth area ratio.

The inconsistency in the literature regarding age and gender-related changes in the cytomorphometric variables could have stemmed from methodological variations. The sample size, the age range of participants, the differences in the grouping of individuals by age, the number of males and females in the total sample, and agewise subgroups are a few factors related to the sample used in these studies. Factors associated with the method of smear preparation and cytomorphometrics include the number of smears per patient, the instrument and method of obtaining the scrappings, the cytological processing, methods of image acquisition and analysis, the use of linear measurements (diameter) vs. area, number of cells counted per individual and the number of observers.

There is no consensus on the minimum number of cells to be counted in each individual to get an accurate and precise estimate of the cytomorphometric variables used in the study. Numbers as low as 20 have been used earlier.[22-26] We included a minimum of 100 cells per individual, assuming it would yield reliable data. Though the intraclass correlation coefficients noted in our study favor this, the veracity of the assumption needs further testing. Another significant limitation of the study needs mention. The participants in the study were considered healthy based on thorough case history and clinical examination. However, no laboratory or radiological investigations were undertaken to ascertain the status. Hence, the possibility of including individuals with subclinical or asymptomatic disease/disorder cannot be ruled out.

Conclusion:

Cytomorphometric analysis of the exfoliated buccal mucosal cells showed a gradual reduction in the cytoplasmic area from 20 to 50 years and no statistically significant change in the nuclear area or the nuclear area: cytoplasmic area ratio. Females showed a higher nuclear area: cytoplasmic area ratio than males. However, given the lack of significant correlation between these variables and age, it is not feasible to estimate an individual's chronological age by cytomorphometric analysis of the exfoliated buccal mucosal cells.

Declarations:

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors

Conflict of Interest: None.

Ethical approval: The study was approved by the JIPMER Institutional Ethics Committee (Human Studies) Institutional Ethics Committee- Human Studies (No. JIP/IEC/2015/16/606). All procedures performed on the study participants were following the ethical standards of the Institute Ethics Committee and the 1964 Helsinki Declaration and its later amendments.

Consent to participate: Written informed consent was obtained from all participants included in the study.

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ORIGINAL ARTICLE

Forensic Analysis of Physical Disruption of Human Hair after being Treated with Henna and Dyes

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Abstract :

Nowadays, people are going through a lot of cosmetic treatments. The purpose of certain chemical treatments, such as henna and dye applications, is to improve the colour, texture, and other characteristics of hair. When conducting forensic investigations, hair analysis under a microscope and scanning electron microscopy can provide unique insights into trace evidence (hair) that may be retrieved from crime scenes. The non-permanent hair treatments that are applied are henna and dyes. Henna alters the colour and texture of hair by covering the cuticle when applied to individual hair strands. On the other hand, the dye not only penetrates the hair's cortex but also coats the cuticle, changing the structure and colour of the hair. The motive of this particular study was to examine the effects of henna and dyes on hairs within a 20-day period by microscopic inspection of the hair that has been treated with both. Under a phase-contrast microscope, hair samples treated with various brands of henna (namely, Brand H1, H2, and H3) were examined to show changes in the hair's structure, colour, and scale pattern. Under a microscope and scanning electron microscope, hair samples treated with various hues (black, brown, and burgundy) and brands (Brand D1, D2, and D3) were examined. The results showed changes in the colour, texture, and scale patterns of the individual hair strands. Compared to hair treated with henna, dyed hair had higher damage. Additionally, the degree of damage varies based on the brands and colour used. This study can give an investigator a starting point for reducing the number of suspects who have had their hair dyed or hennaed.

Keywords: Brands; Cosmetic-treatment; Dye; Treated hair; Non-treated hair; Hair colour; Texture of hair; Hair scale pattern; Henna; Microscopic comparison; Scanning electron microscopy.

Introduction :

There are different types of biological samples which are found at a crime scene for example sweat, urine, blood etc. Among all these biological specimens, hairs are considered as the most important trace evidence which is found at a crime scene.[1] Therefore, hair is considered as the key component in criminal investigations. Because human hair is subjective and sheds between 100 and 150 times a day, it is one of the biological specimens that is regarded as the most significant trace evidence.[1-3] These days, styling and colouring hair has become a way of life. Individuals get a variety of hair treatments to improve their hair's colour, texture, and other characteristics. Knowing the origin of the hair samples (animal origin or human origin) obtained from the crime scene is the main goal of forensic science analysis of hair evidence.[4-5] According to Edmond Locard, whenever two things or objects come into contact, transfer happens in such circumstance in forensics.[6]

Various dyes and mehndi treatments are given to the hair strands to change the colour, texture of the hair. Different studies have been done to demonstrate the difference between the treated and non-treated hair. Hair samples obtained from the individuals (fallen or cut samples) were treated with various commercial brands of henna available in the market. Phase-contrast microscopy was used to examine hair samples that had been coloured with three distinct henna brands: Neha Herbals Herbal Mehndi, Godrej Nupur Henna, and Patanjali Kesh Kanti Herbal Mehndi. Compared to Nupur Henna and Neha Herbals Mehndi, it was discovered that the more long-lasting effect on the texture and colour of the hair as compared to other brands.[7] Historically, transmitted light and polarised light microscopy have been employed by hair analysers to offer details on the physical properties of hair and other fibre evidence. A skilled forensic expert can categorise hair using light microscopy and determine hair modifications, such as if a hair was coloured, burnt, or clipped.[8-9] Scanning electron microscopic technique can be used to see the changes caused to the hair strand by using several cosmetic techniques. A study done by Man Q., Zang L., and Choy., at Gachon University, Korea determines the level of damage caused to the hair by using SEM, characterises the damage in three categories weak, moderate, and high damage.[10]

In this study, we have aimed to study the effects of commercial henna and dyes available in the market, on the hair strand with the interval of time i.e. after 1 day and 15 days. Henna samples of hair treated with three brands (labelled as H1, H2, and H3) and dyes of three brands (labelled as D1, D2, and D3) of colour burgundy are taken and examined under Scanning Electron Microscope. Thus, this study will be very helpful for the forensic examiners which will help them to narrow down their approach in finding the culprit.

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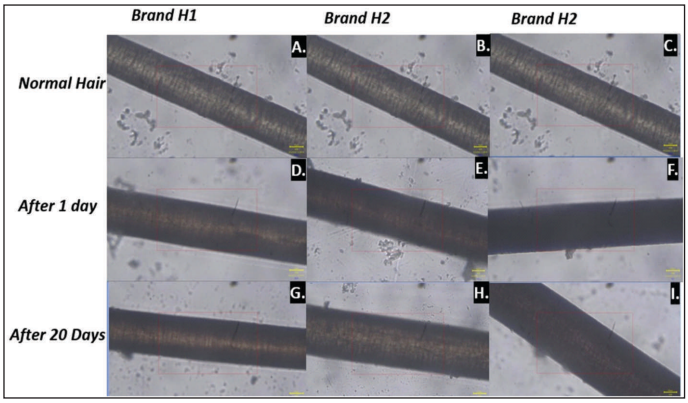

Figure 1. Shows microscopic results of normal hair, hair samples after 1st wash and after after 20 days i.e. after multiple washes. (A,B,C) normal hair i.e. without any treatment; (D,E,F) treated hair after first wash; (G,H,I) treated hair after 20 days i.e. after multiple washes of brand H1, H2 and H3, respectively.

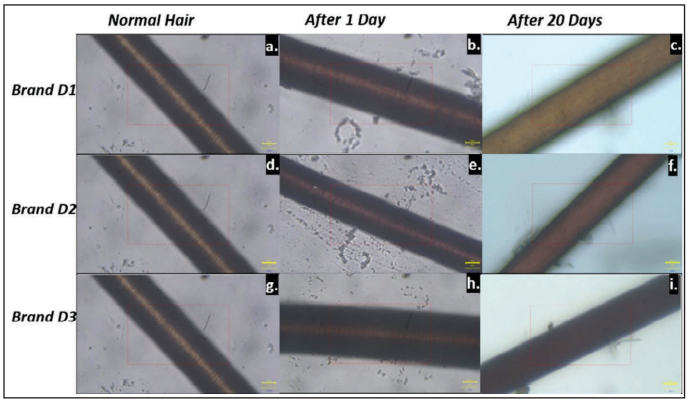

Figure 2. Shows microscopic results of normal hair, hair samples after 1st wash and after after 20 days i.e. after multiple washes. (a, b, c) normal hair i.e. without any treatment; (d, e, f) treated hair after first wash; (g, h, i) treated hair after 20 days i.e. after multiple washes of burgundy colour of three brands of dyes i.e., D1, D2 and D3 respectively.

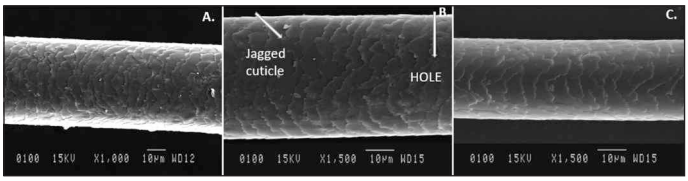

Figure 3. Shows results of hair treated with brand H1 analysed under Scanning Electron Microscope where (A) is Normal hair or non treated hair, (B). is treated hair after first wash and (C) is treated hair after 20 days i.e. multiple washes.

Methodology:

Collection of samples: - A total of 45 samples, both male and female, were collected from the five participants in this investigation. The combed treated and non-treated hair samples of individuals were treated with henna of three different brands (labelled as H1, H2, and H3) and were collected in zip lock bags. Similarly, 45 samples of dyed hairs from 5 individuals were collected for three different brands (labelled as D1, D2, and D3) for burgundy colour and compared.

Preparation of samples: - Samples of combed and fallen hair were obtained from people who had dyed and/or applied henna to their hair. Normal hair, that is, hair that has not been treated, was

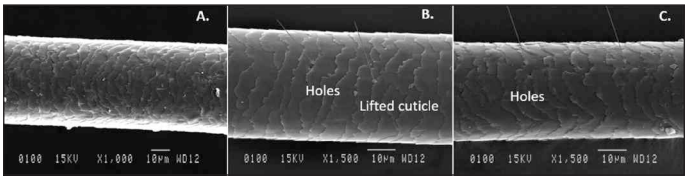

Figure 4. Shows results of hair treated with brand H2 analysed under Scanning Electron Microscope where (A) is Normal hair or non-treated hair, (B). is treated hair after first wash and (C) is treated hair after 20 days i.e. multiple washes.

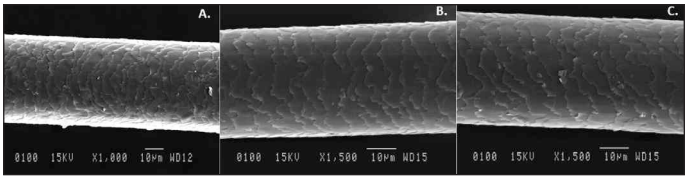

Figure 5. Shows results of hair treated with brand H3 analysed under Scanning Electron Microscope where (A) is Normal hair or non-treated hair, (B). is treated hair after first wash and (C) is treated hair after 20 days i.e., multiple washes.

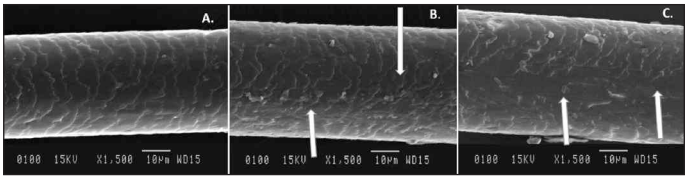

Figure 6. Shows results of hair treated with Burgundy colour of brand D1 analysed under Scanning Electron Microscope where (A) is Normal hair or non-treated hair, (B). is treated hair after first wash and (C) is treated hair after 20 days i.e., multiple washes.

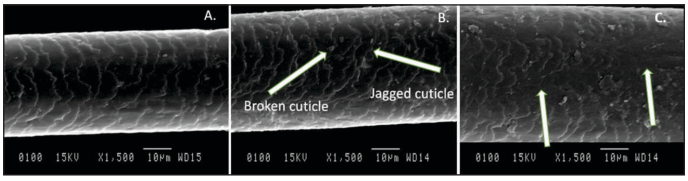

Figure 7. Shows results of hair treated with Burgundy colour of brand D2 analysed under Scanning Electron Microscope where (A) is Normal hair or non-treated hair, (B). is treated hair after first wash and (C) is treated hair after 20 days i.e., multiple washes.

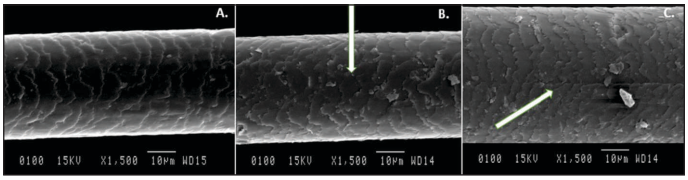

Figure 8. Shows results of hair treated with Burgundy colour of brand D3 analysed under Scanning Electron Microscope where (A) is Normal hair or non-treated hair, (B). is treated hair after first wash and (C) is treated hair after 20 days i.e. multiple washes.

obtained from the subjects who would serve as the control group. Samples were collected both immediately following the treatment, or after one day, and again after 20 days, or after several washes. Separate Ziplock bags, marked properly with all the required details had been taken for the sample collection.

For microscopic analysis, a hair strand had been taken on a clean slide and then covered with a cover slip. Later the sample had been visualised under the microscope. For scanning electron microscopy, double sided carbon tape is pasted on the stubs, 0 number brush had been used to lift the hair sample and placed on

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the tape. The stubs are then put in the desiccator, where vacuum is created so that the sample stick to the tape properly and moisture is removed. Then the stubs are placed in coater for 3 minutes in order to coat the samples. The coated hair samples were analysed under scanning electron microscope.

Analysis of samples: A physical examination of a person with normal hair reveals that while it has a smooth and shining texture, treatment causes the hair to become rough and discoloured. Next, phase contrast microscopy was used to analyse the hair samples that had been dyed and treated with henna under a microscope.

Result and Discussion:

As evident from figure 1: Under a microscope, normal hair, or untreated human hair (A, B and C), was observed. Three brands of henna (H1, H2, and H3) were used to treat hair, and following the initial wash, samples were examined under a microscope (D, E, F). After treating normal hair (A) with brand H1, the effects of the first wash were observed (D), indicating that the henna had penetrated the hair's cuticle layer and given the hair a smooth texture. After multiple washes i.e., after 20 days results were noted (G), indicating that the henna's effects had begun to fade and that the hair had scale patterns and a minor roughness. Secondly, normal hair (B) treated with brand H2 analysed under microscope after first day (E) indicates that the cuticle of the hair is covered with henna and slight roughness is also noted. Then after 20 days i.e., after multiple washes (H), scales patterns are visible which shows that henna affects have started to fade and hair has become rough which depicts that the hair has been damaged. Thirdly, (C) normal hair was treated with H3 brand and after first wash (F) results under microscope depicts that hair surface has been covered properly with henna, giving it a smooth and shiny texture- after multiple washes i.e. 20 days later (I) also the henna stays on the hair only slight scale patterns can be seen. According to *Kizawa et al.,* in 2005, colouring hair results in serious harm to the hair. This particular study looked at the impact of bleaching process on hair and found that bleached hair was vulnerable to cuticle fragmentation into tiny peptides, which makes the hair brittle and fragile.[10]

Figure 2. shows the microscopic results of hair treated with burgundy colour of three different brands i.e., D1, D2 and D3. Normal hair (a) which is brown in colour when treated with burgundy colour of brand D1 examined under microscope after 1st day (b) indicates that dye has penetrated the hair fibre due to which cuticle as well as scale patterns are totally covered with burgundy colour. Then multiple washes are provided to the hair strand and hair is examined under microscope (c) which shows that the dye is washed away from the hair strand leaving the hair rough and damaged with scales slightly visible again as the normal hair. The normal hair (d) when treated with burgundy colour of brand D2 and examined after 1 day (e) depicts that the burgundy colour dye has penetrated inside the cuticle giving the hair a smooth texture whereas after multiple washes i.e. 20 days (f) the hair fibre has become rough and dye has started to vanish from the hair fibre, leaving it in damaged condition. Normal hair (g) when treated with burgundy colour of brand D3, after 1 day (h) also depicts the penetration of the dye and the cuticle layer is covered properly with the dye. After 20 days (i) it shows that the dye is washed away and the hair appears damaged. In 2022, Verma P and Sharma A. have done a study where microscopic analysis of hair samples treated with various commercial brands of henna has been done. It has been noted under microscope that the henna penetrates the hair shaft and covers the cuticle. Even the differences in hair treated with different brands can also been noted.[7]

Figure 3 depicts the results of Scanning electron microscopy where (A) is having damage of Grade 0 - Virgin hair with a consistent cuticle layer i.e Normal Hair. The normal hair then treated with H1 and hair examined after 1 day (B) shows damage of Grade 2 – A severe lifting up of the cuticle with holes or fissures, but with little to no cortical exposure; the cuticle is fractured and angular. (C) is the treated hair fibre after 20 days or multiple washes shows damage of Grade 1 – Uneven layering of the cuticle without breaks or holes, indicating that the hair is beginning to return to its natural colour. Figure 4 depicts the results of Scanning electron microscopy where (A) is having damage of Grade 0 - Virgin hair with a consistent cuticle layer i.e Normal Hair. The normal hair then treated with henna of brand H2 and hair examined after 1 day (B) and 20 days (C) both shows damage of Grade 1 – There is an uneven layer of cuticle without any fractures, however there are little holes visible. Cuticle is jagged and less breakage can also be seen. Figure 5 depicts the results of Scanning electron microscopy where (A) is having damage of Grade 0 – Virgin hair with a consistent cuticle layer i.e Normal Hair. The normal hair then treated with henna of brand H3 and hair examined after 1 day (B) and 20 days (C) both shows damage of Grade 1 – Uneven layering of the cuticle without breaks or holes, indicating that the hair is beginning to return to its natural colour. In 2017, Enrico et al. investigated the relationship between hair damage that may result from undergoing excessive cosmetic procedures and cocaine absorption from a wettable solution into the hair matrix (simulating owing to external pollution or contamination).[11]

Figure 6 depicts the results of Scanning electron microscopy where (A) is having damage of Grade 0 – Virgin hair with a consistent cuticle layer i.e Normal Hair. The normal hair then treated with burgundy colour of brand D1 and hair examined after 1 day (B) shows damage of Grade 2 – Severe cuticle lifting that exposes the cortex yet has holes or fissures in it. After 20 days (C) shows damage of Grade 3 – Partially exposed cortex. The cuticle appears rugged and hair seems to be damaged. According to a study done in 2021, Qiaoyue et al. discovered with the use of SEM that hair is effectively damaged. Weak, moderate, and high damage levels were used to categorise the degree of harm. To determine the extent of the damage, a convolutional neural network was employed, and a database was created.[12]

Figure 7 depicts the results of Scanning electron microscopy where (A) is having damage of Grade 0 - Virgin hair with a consistent cuticle layer i.e Normal Hair. The normal hair then treated with burgundy colour of brand D2 and hair examined after 1 day (B) shows damage of Grade 1 – There is an uneven layer of cuticle without any fractures, however there are little holes visible. There is less breakage and a jagged cuticle. After 20 days (C) shows damage of Grade 3 – Partially exposed cortex. The cuticle appears jagged and hair seems to be damaged. Figure 8

depicts the results of Scanning electron microscopy where (A) is having damage of Grade 0 - Virgin hair with a consistent cuticle layer i.e normal hair. The normal hair then treated with burgundy colour of brand D3 and hair examined after 1 day, (B) shows damage of Grade 1 – There is an uneven layer of cuticle without any fractures, however there are little holes visible. There is less breakage and a jagged cuticle. After 20 days (C) shows damage of Grade 1 – Irregular overlay of the cuticle without cracks or holes. Cuticle is lifted and broken. Kaliyadan F et al. in 2016 had done a study where hair shaft of volunteer females had been taken who took cosmetic treatments like bleaching, dyeing and straightening. Samples had been analyzed under scanning electron microscope and damage had been visualized which was categorized as grade 0, grade 1, grade 2 and grade 3.[13]

Conclusion:

The study of trace evidence is crucial to forensic science. Therefore, if recovered at a crime scene, trace evidence from a hair might be used as corroboration in the inquiry. Since hair varies in size, colour, and texture, forensic analysis of hair evidence utilising a variety of techniques can clarify situations and allow a connection to be formed between a suspect and the scene of the crime. This study has shown that applying henna and dyes to hair results in some modifications to the texture, colour, and other features of the hair. The level of damage has been noted with respect to the brands and colours used on the hair. This study also shows that the dyes create more damage if compared with the damage done by henna. As a result, this study will assist the investigators in focusing their efforts and frequently offer crucial details that can help identify a suspect or victim.

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ORIGINAL ARTICLE

To Evaluate the Knowledge, Attitude, and Perception of Students towards Forensic Pharmacology: A cross-sectional study

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Abstract :

The study of forensic pharmacology holds paramount importance among MBBS students due to its vital role in the realm of legal medicine. Understanding the interactions between drugs and the human body is essential in accurately determining the cause of death or injuries in cases of poisoning, drug-related crimes, and overdose incidents. MBBS students equipped with knowledge in this specialized field can help identify the presence of illicit substances in post-mortem examinations, analyse toxicological reports, and provide crucial evidence in criminal investigations. Furthermore, a comprehensive understanding of forensic pharmacology enhances the ability to prescribe medications safely and responsibly, reducing the risk of adverse drug reactions and medical malpractice. Thus, this study is planned to determine the knowledge of Forensic pharmacology among 378 Indian medical graduates through a predesigned google form. Informed consent was obtained, and a brief objective and goals of the study were explained to the students. The obtained results were analysed, which implies that most students were aware of and comprehended the importance of forensic pharmacology. However, a lot of students had trouble understanding how forensic pharmacology would help with victim justice, law enforcement support, and the resolution of drug-related crime cases. Thus, awareness on forensic pharmacology is of utmost importance in preparing the next generation medical professionals to navigate the complex interface between medicine and law.

Keywords: Forensic pharmacology; Toxicological crimes; Expert opinion; Pharmacological jurisprudence.

Introduction :

The branch of medicine known as "forensic medicine" is concerned with using medical knowledge to investigate crimes, particularly for determining what caused injuries or fatalities. Forensic pharmacology is concerned with using pharmacologist expertise for legal purposes. It is a significant and developing topic that presents an opportunity to increase our understanding of medications and how they affect biological systems.[1] In forensic pharmacology, toxicities from frequently consumed pharmaceuticals, often abused pharmaceuticals, pharmaceuticals with no medicinal purpose, and "street" or "designer" drugs are discussed. Although Forensic toxicology and forensic pharmacology are frequently used the same way, the two fields of medicine have important distinctions. Pharmacology deals with the experimentation and synthesis of drugs, while the study of drug effects on biological systems in the context of legal or medical investigations is known as forensic toxicology. It is the application of pharmacological knowledge to legal issues including drug regulation, lawsuit resolution, and criminal justice system functions like identifying the cause of death at a crime scene. Forensic toxicologists examine for signs of toxicological interferences when poisoning or drug use is suspected in criminal cases include pill bottles, dirty needles, illegal drugs, and trace residue. Whereas forensic pharmacologists investigate drug effects, abuse, and duration of action for the medicolegal process.[2] A distinct and understandable explanation of pharmacological techniques and knowledge is provided by forensic pharmacology, together with an explanation of the manner in which these are applied to the resolution of various legal issues.[3] Pharmacologists' roles in supporting the legal team include interpreting drug action, assessing possible interactions between drugs, assessing how likely it is that drugs will interact with related disease processes, estimating the timescale of events based on the characteristics of the drugs involved, and confirming other evidence by supplying associated data. With this knowledge and the importance of this particular field, this research is being proposed to evaluate medical students knowledge and awareness about the forensic pharmacology and also to create awareness of Forensic Pharmacology in health care.

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Materials and methods:

The analysis was carried out upon obtaining of ethical approval from the Institutional Ethics Committee. Data were collected from 378 Indian medical graduates. All the voluntary participants from phase III/I students and Interns were included in the study. A preformed, 20 close-ended questionnaires (Awareness questions – 4, Knowledge based questions – 11, Clinical application - 5) were formulated through a review of the existing literature. Questionnaires were given them after obtaining informed consent. All of the volunteered participants were informed of the study's goal and given instructions concerning how to honestly respond to questions. The responses from students were recorded

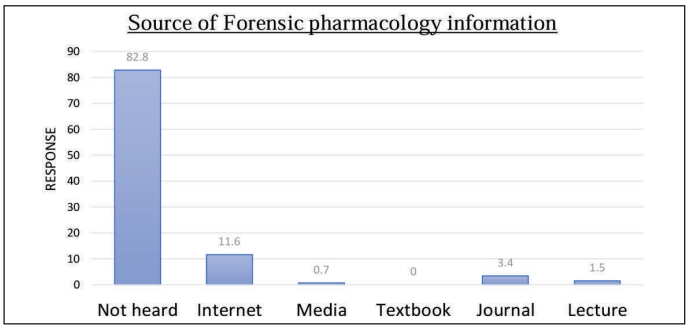

Figure 1. The figure presents a bar graph depicting the sources that provides students with information about forensic pharmacology. The X-axis represents different sources like internet, media, textbook or not heard. Y-Axis represents the number of responses. Each bar on the graph represents the number of responses for each source.

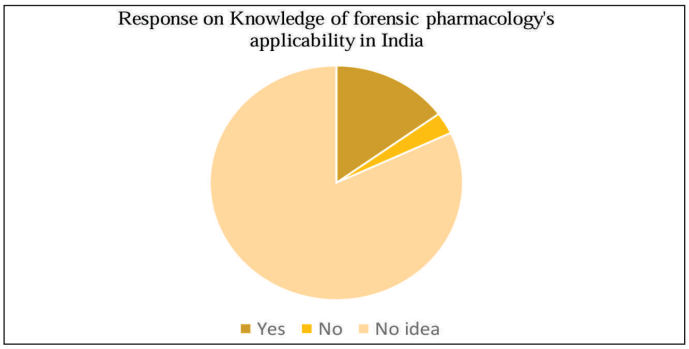

Figure 2. The figure presents a pie chart depicting the response on forensic pharmacology's applicability in India.

in a predesigned Google form and entered in Microsoft® Excel 2016. Statistical analysis was performed using the Chi-square test for proportionality using IBM SPSS version 20.

Results:

The study involved 400 students in all, 378 of whom provided informed consent to be included in the research. Among them 59% were male and 41% were female. Most of the students (80%) had never heard of forensic pharmacology, around 15% heard the word from Journal and the Internet (Figure 1). In response to questions on knowledge of forensic pharmacology, 95% of students knew that Forensic pharmacologists determine the cause of death in cases involving drug overdose by assessing drug levels and their effects on the body. Only 54% of students knew that by comparing the deceased's medication levels to established reference ranges, forensic pharmacologists can distinguish between therapeutic and toxic drug levels. Only 40% students had knowledge about hair analysis in forensic pharmacology. 77% of students had mentioned forensic pharmacology is a subset of clinical pharmacology which is not true (Table 1). In response to questions on clinical application of forensic pharmacology 95% of students had knowledge on role of forensic pharmacology on post-mortem analysis. Only 34% had knowledge on commonly available methods used for drug testing in forensic pharmacology and only 33% knew the purpose of a chain of custody in forensic pharmacology (Table 3). In response to applicability of forensic pharmacology in India majority of students had no idea of it (Figure 2). In cases where it came to knowledge and clinical application, the test for proportionality

Table 1. Knowledge of forensic pharmacology.

Questions	Number of students n=378		
	Yes (%)	No (%)	No idea (%)
1. Forensic pharmacology deals with the application of pharmacological principles in legal investigations	95	3	2
2. It helps to assess the cause of death and possible drug involvement.	90	1	9
3. Forensic pharmacologists determine the cause of death in cases involving drug overdose by assessing drug levels and their effects on the body	93	4	5
4. Forensic pharmacologists differentiate between therapeutic and toxic drug levels in the deceased by comparing drug levels to established reference ranges	54	5	41
5. Role of forensic pharmacology in cases of impaired driving or DUI (Driving under the influence) by identifying the type and amount of substances in the driver's body	80	3	17
6. Hair analysis in forensic pharmacology provide a long-term history of drug use	40	7	53
7. Technology has had no impact on forensic pharmacology	79	5	16
8. Hair analysis used to assess the deceased person's genetic makeup	43	7	46
9. Forensic pharmacology used to determine the time of death	34	43	23
10. Forensic pharmacology is a subset of clinical pharmacology	77	4	19
11. Forensic pharmacology used to determine whether the drugs were a factor in a person's behaviour or actions	68	17	15

Table 2. Clinical application of Forensic pharmacology.

Questions	Number of students n=378		
	Yes (%)	No (%)	No idea (%)
1. In clinical practice, post-mortem pharmacology provide insight into the possible cause of death in cases with drug involvement	95	3	2
2. Difference between therapeutic and toxic drug levels is the minimum concentration required to achieve the desired therapeutic effect, while toxic drug levels are the maximum concentration that can cause harm	80	11	9
3. Common methods used for drug testing in forensic pharmacology are Gas chromatography-mass spectrometry (GC-MS), High-performance liquid chromatography (HPLC), Enzyme-linked immunosorbent assay (ELISA)	34	13	53
4. Purpose of a chain of custody in forensic pharmacology is to to ensure that the samples collected are not contaminated or tampered with	33	5	62
5. Gas chromatography is used for separating and identifying drugs in forensic pharmacology	36	3	61

was used to see if there was any statistical difference between correct and incorrect answers. It was found that a statistically significant number of students had sufficient knowledge of forensic pharmacology, but a statistically significant number of students lacked sufficient knowledge of the clinical implications of forensic pharmacology.

Discussion:

The branch of pharmacology primarily focuses on drug classifications, actions, side effects, and therapeutic applications. Pharmacology is described in standard textbooks used in educational institutions as a broad field that encompasses knowledge of the physiological effects, chemical and physical

makeup, absorption, metabolism, excretion, and medical applications of medications. One such textbook is "Goodman & Gillman's The Pharmacological Basis of Therapeutics." Additionally, it defines a drug as an agent that affects living protoplasm.[4] Poisons and toxic substances are also included in this definition of drugs. The harmful effects of poisons and chemical agents on all biological systems are the focus of toxicology.[5] In India's medical curriculum, toxicology is a component of forensic medicine. It is defined as the scientific study of identifying medications and toxins in biological samples and using that knowledge to legal and medical issues.[6] Forensic pharmacology is the study of how drugs affect the body, how long they last, and how they affect people. It helps in the medicolegal process.[7] Forensic Pharmacology is included as a component of forensic medicine in Parikh's textbook on medical law, Forensic Medicine & Toxicology. It explores the side effects of medications used therapeutically, drugs that are abused, and substances that have no medicinal use. The intersection of pharmacology, toxicology, and forensic medicine is characterised by forensic pharmacology.

The field of pharmacology can now be extended beyond treatments owing to advancements in technology and pharmacology. For pharmacologists, a specialty such as "Forensic Pharmacology" might be beneficial in applying their knowledge to medicolegal difficulties. The basis of forensic pharmacology is the understanding that drug pharmacokinetics and pharmacodynamics alter following death, leading to varying interpretations of test results and potential medical-legal repercussions.[8] The use or abuse of drugs, personal injury or death from drug exposure, exposure to chemicals in the environment, doping, forensic pharmacokinetics, drug interactions or adverse drug reactions leading to medicolegal issues, and forensic pharmacovigilance are the other areas of forensic pharmacology.[9]

With a few exceptions, it is clear from the graphs and tables that most students understood the significance of forensic pharmacology and were aware of it. However, many students found it difficult to understand how forensic pharmacology would aid in resolving drug-related crime cases, supporting law enforcement, and providing victims' justice. As a result, although the students were interested in and had solid understanding of forensic pharmacology overall, they lacked understanding of its application and interpretation. Numerous universities and educational institutions across the world have specialised departments that teach forensic pharmacology. However, the MBBS program does not have an integrated semester that emphasises forensic pharmacology as a specialty subject. For this reason, a reformed forensic pharmacology teaching system is required. The number of medicolegal cases involving drug usage is rising, which is concerning for the need for forensic pharmacologists. In conclusion, awareness among students on forensic pharmacology is of utmost importance in preparing the next generation of medical professionals to navigate the complex interface between medicine and law.

Conclusion:

The application of medications and poisons that practising doctors encounter, as well as how to assess their medico-legal role in determining the cause of an illness, damage, or death, are fundamental concepts of forensic pharmacology. It also covers postmortem toxicology and important ideas regarding the medicolegal ramifications of drug usage in humans and its impacts and hazardous actions.[9] Students should be able to appropriately evaluate pharmacological and toxicological data for medicolegal reasons using forensic pharmacology.

Additionally, they must be able to defend and explain their scientific conclusions, which they will need to do when they testify in court. Toxicological data from various biological sources will be compiled and analysed using precise procedures, which will be further helpful. In the period of growing and changing scientific disciplines, the understanding of these disciplines is becoming more and more important. Investigating the medico-legal cases in India will also provide fresh resources and altogether new perspectives. Also understanding of forensic pharmacology empowers medical students to become competent and responsible prescribers, ensuring patient safety and minimizing the risks of drug-related incidents.

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ORIGINAL ARTICLE

Sex Determination using Condylar Height in south Indian population - A Retrospective Study

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Abstract :

Mandibular parameters evaluation has been used to determine sex in forensics and for treatment planning in dentistry. The present study aims to determine condylar height in a group of 20 to 70 years old males and females using panoramic radiographs for sex determination. This study was performed to measure the height of the condyle indicating that females and males showed significant differences for condylar height by 5.81 mm. The results of the present study indicate that condylar ramus height can be used effectively for sex determination.

Keywords: Sex determination; Condylar height; Panoramic radiograph; Orthopantomograph.

Introduction :

Growth and development are parallel processes that are influenced by internal factors (heredity, race, gender, genetics, etc.) and external factors (nutrition, function, etc.). The mandibular growth process is a complex process with intramembranous and endochondral ossification.[1,2] The mandible grows in various directions, including vertical, horizontal, lateral, and rotational. Acceleration of mandibular growth runs in parallel with the accelerated phase of height. In other words, the increase or decrease in skeletal maturity has variability similar to facial growth, especially mandibular growth.[3,4] Mandibular assessment was used in the forensic field to determine age and sex,[3,5,6] Mandibular growth was a constant remodelling process. Bone juxtaposition and bone resorption. The mandible is a bone with many morphological changes and shows the most postnatal growth compared to other facial bones.[7,8] Morphological changes, calcification and fusion at the centre of ossification. Panorama radiographs can provide morphological information and bone morphology during growth. In some studies, panoramic radiographs have also been used to measure the vertical and horizontal dimensions of the lower jaw, and the only method for assessing the growth of lower jaw length is the height of the condyle. Mandibular growth is also assessed by measuring the distance of mandibular landmarks.[9] The purpose of this study is to determine the condylar height of 20 to 70 years old men and women using panoramic radiographs for role in sex determination.

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Materials and methods:

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

This study was undertaken with an aim of establishing certain mandibular parameter as criteria, thereby setting a population specific standard for sex determination. Digital orthopantomograms (OPG) archived in the Department of Oral Medicine and Radiology, JSS Dental College and Hospital, Mysuru were used for this study. The study sample consisted of 400 OPG (200 male and 200 female subjects) that were divided into five groups on the basis of chronological age by decades (40 in each group for male and female subjects), in the age range of 20-70 years(Table 1). Mandibular parameter condylar height was studied and assessed whether they aid in determining the sex.

Digital orthopantomograms were obtained from PLANMECA PROMAX SCARA 3 Digital OPG Machine, (70 kVp, 8 mA for 16 seconds), Manufactured by PLANMECA OY, Helsinki, Finland, with a 1:1 ratio. The digital orthopantomograms were imported into Planmeca Romexis Viewer Software 2.9.2.R., and the measurements were done. Microsoft Office Excel (2016) sheet was used for compiling the data. The statistical analysis was carried out using SPSS Software Package version 20.

Eligibility Criteria of samples: The digital orthopantomograms were selected according to the selection criteria in which Panoramic radiographs on which all structures were visible clearly.

Table 1. Sample size distribution.

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

Table 2. Mean value of condylar ramus height for females and males in relation to different age groups.

Age group (years)	Female		Male		Statistically significant
	No.	Mean (mm)	No.	Mean (mm)	
Group 1: 20-30	40	68.73 4.60	40	78.24 6.67	Yes (P = 0.00)
Group 2: 31-40	40	68.55 4.82	40	76.29 6.66	Yes (P = 0.00)
Group 3: 41-50	40	69.34 4.87	40	76.57 5.07	Yes (P = 0.00)
Group 4: 51-60	40	70.10 5.21	40	76.92 5.29	Yes (P = 0.00)
Group 5: 61-70	40	78.20 0.00	40	75.95 6.02	Yes (P =0.02)
Overall: 20-70	200	70.98 5.66	200	76.79 5.97	Yes (P = 0.00)

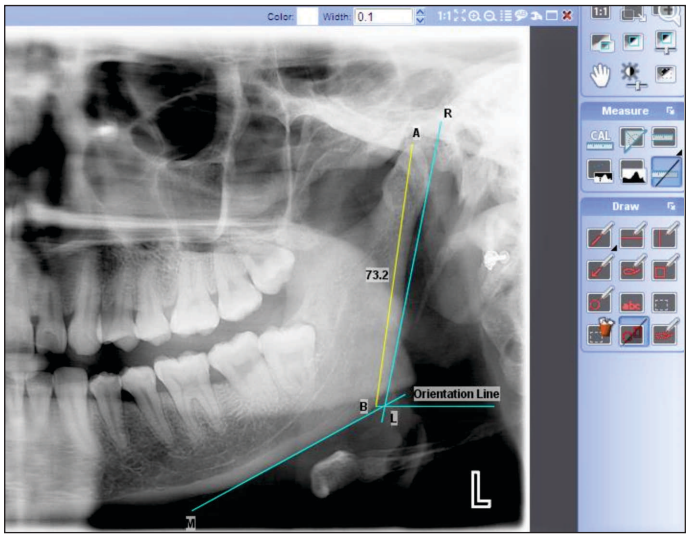

Figure 1. Condylar ramus height A-B (in yellow).

Methodology:

Ethical clearance was obtained from JSS Dental College & Hospital's Institutional Ethical Committee prior to conducting the study (No: JSS/DCH/IEC/2017-18 /02). The digital orthopantomograms were selected based on the inclusion and exclusion criteria mentioned above. The selected radiographs were imported to Planmeca Romexis Viewer 2.9.2.R software, where the Condylar Height was digitally traced and the measured values noted (FIG 1). Literature states that a very high degree of symmetry exists between the left and the right sides, therefore all the measurements were made on the left side of the radiograph for uniformity.[10,11] The measurements were calibrated in millimeters (mm) and the measured values were entered in Microsoft Office Excel sheet.

1. Condylar Height (A-B): The distance from the condylion (A) to the intersection of the orientation line with the inferior border of the ramus (B). This methodology is obtained from Taleb NSA, Beshlawy ME, 2015.[10] One line drawn horizontally (orientation line) at the intersection of the tangents along the posterior border of the ramus (RL) and along the inferior border of the mandible

Table 3. Comparison of mean value of condylar height in different studies in Indian population.

Sl.No	Study (mm)	Male	Female
1.	Indira et al. 2012[12]	131.30 ± 9.26	123.27 ± 7.36
2.	Anupam Datta et al. 2015[18]	67.98 ± 4.40	55.72 ± 5.33
3.	Chaudhary S et al. 2015[23]	66.78 ± 5.47	59.99 ± 5.07
4.	Usha J et al. 2016[24]	70.30 ± 7.90	61.84 ± 5.79
5.	Sairam et al. 2016[25]	65.01	59.48
6.	More CB et al. 2017[26]	70.2	64.3
7.	Maloth KN et al. 2017[27]	70.72 ± 5.40	65.43 ± 4.65
8.	Kartheeki B et al. 2017[28]	78.3 ± 5.09	71.3 ± 5.06
9.	Samatha K et al. 2017[29]	65.34 ± 4.33	61.69 ± 10.11
10.	Aditi Ramesh et al. 2018[30]	59.03 ± 6.28	54.15 ± 7.21
11.	Shivaprakash et al. 2018[16]	59.21 ± 4.69	55.55 ± 4.93
12.	Pangotra N et al. 2018[31]	70.26 ± 3.90	60.88 ± 3.47
13.	Altaf Hussain et al. 2019[32]	71.07 ± 4.37	68.21 ± 2.50
14.	Aruleena et al. 2019[33]	71.55 ± 5.6	66.21 ± 4.09
15.	Mehta H et al. 2020[34]	58.69 ± 4.84	53.95 ± 4.48
16.	Kaur R et al. 2021[35]	73.31 ± 5.83	67.11 ± 5.22
17.	Ghata savoriya et al. 2021[36]	69.27 ± 1.1	61.71 ± 0.75
18.	Present study 2021	76.79 ± 5.97	70.98 ±5.66

(ML), serve as reference lines to aid in the measurement of the condylar ramus height.

Group 1: 20-30 years: The mean value of condylar height in females was 68.73 mm +/- 4.60 with a standard error mean of 0.72, while for males it was 78.24 mm +/- 6.67 and standard error mean was 1.05. The mean difference between females and males was 9.51 mm.

Group 2: 31-40 years: In female subjects, the mean condylar height was calculated to be 68.55 mm +/- 4.82. The SEM was 0.76. In males, mean condylar height was 76.29 mm +/- 6.66, SEM being 1.05. The mean difference between females and males was 7.7375 mm. The P value was 0.000, thus indicating that it was statistically significant (P > 0.05), thereby implying that condylar height showed significant differences between females and males by 7.7375 mm.

Group 3: 41-50 years: In the 41-50 years age group, the mean value for condylar height in females was calculated to be 69.34 mm +/- 4.87, with SEM being 0.77. In males the mean was calculated to be 76.57 mm +/- 5.07, SEM being 0.80. The mean difference between females and males was 7.23 mm. The P value was 0.000 (P < 0.05) indicating that significant differences exist between females and males for condylar height by 7.23 mm.

Group 4: 51-60 years: The mean value for condylar ramus height in females was 70.10 mm +/- 5.21 with a SEM of 0.82. The mean value in males was 76.92mm +/- 5.29, SEM = 0.83. The mean difference between females and males was 6.825 mm. The P value calculated was 0.000 (P < 0.05). In other words, significant differences were seen between females and males for condylar ramus height by 6.825 mm.

Group 5: 61-70 years: The mean value for condylar height in the 61-70-year age group was 78.20 mm +/- 0.00, SEM was 0.00 in females and for males it was 75.95 mm +/- 6.02 with SEM being 0.95. The mean difference between females and males was 2.2475 mm. The P value was 0.021 which is lesser than 0.05 thus indicating that significant differences exist between females and males by 2.24 mm.

Overall Age Group: 20-70 years: The overall group statistics reveals that the mean condylar height was 70.98 mm +/- 5.66, SEM of 0.40 for females and 76.79 mm +/- 5.97, SEM of 0.422 for males. The mean difference between females and males was 5.811 mm. The P value obtained was 0.000, which was statistically significant ($P < 0.05$), indicating that females and males showed significant differences for condylar height by 5.81 mm.

Discussion: The mean condylar ramus height obtained in the present study was 70.98 mm +/- 5.66 for females and 76.79 mm +/- 5.97 for males. Thus, the mean value was larger in male subjects than in female subjects. Also, the P value was calculated to be 0.000 ($P < 0.05$), implying that mean condylar ramus height was statistically significant. In other words, females and males showed significant differences. The present study revealed that the condylar ramus height showed difference between sexes irrespective of age groups. In the present study, the condylar height decreases with age in the 3rd decade of life, remains constant up to the 5th decade and then decreases in the 6th decade of life in males. In females it increases with age (Table 2). Mandibular condyle and ramus in particular are generally the most sexually dimorphic as they are the sites associated with the greatest morphological changes in size and remodelling during growth.[10,12,13] Generally, the overall size and bone thickness of the male skeleton is greater than that of the female; however, this is not universal, since bone size and thickness are related to many things other than sex; better nutrition and heavy physical activity.[14] On an average, males have greater masticatory force than females that influences the bone size.[15] This accounts for the larger dimensions seen in male subjects compared to female subjects.

Table 3 shows that mean condylar ramus height shows larger values for male than female subjects and also in comparison with different studies all over India till date using orthopantomographs . This shows that males have greater condylar height dimensions than female subjects. The result obtained in this study is similar to those obtained by Shivaprakash S, Ashok KR 2018,[16] Nagaraj et al., 2017,[17] Anupam Datta et al., 2015[3] and Indira et al., 2012[28] all of which show greater mandibular dimensions in males than females. Shivaprakash S, Ashok K's study (2018) involved 200 adult mandibles in a South Indian population.[16] Nagaraj et al., 2018 conducted a study by taking orthopantomograph of 50 males and 50 females in an Indian population.[17] In the study conducted by Anupam Datta et al., (2015) on an Indian population, 50 adult, dry, complete human mandibles were assessed.[3] Indira et al., 2012 conducted a study wherein 100 orthopantomograms from an Indian population were analyzed.[12] The condylar ramus height was measured as the distance from the highest point on the mandibular condyle to gonion.[16,17,3,12] The mean values of females (70.98 mm) and males (76.79 mm) in the present study is similar to the mean values obtained by Nagaraj et al., 2017[17] for females (68.72 mm) and males (73.80 mm) with a difference of 2.26 mm for females and 2.99 mm for males. Smaller mean condylar ramus height measurements were observed in Anupam Datta et al., 2015, 55.72 mm for females and 67.98 mm for males[18] and in Shivaprakash S et al., 2018, where mean values were 55.55 mm for females and 59.21 mm for males.[16] This could be due to the fact that measurements were made on mandibular specimens. Larheim and Svanaes in their study have found that an image magnification of approximately 18% to 21% was seen when measurements were done on radiographs compared to dry specimens.[19] The mean value obtained by Indira et al., 2012[12] was considerably higher than those obtained in the present study and other studies as well. This could be due to the magnification factor since the software used for obtaining the orthopantomograms and measuring the mandibular dimensions were different. It has been stated however, that all images were uniformly magnified in their study.[12] Studies conducted by Taleb NSA and Beshlawy, 2015,[10] N Ongkana and P Sudwan, 2009[20] and Vodanovic et al., 2006[21] all show that males have higher mean mandibular condylar height than females.

Sex:

All of the above-mentioned studies showed statistically significant P values indicating that significant differences exist between females and males.[3,10,12,17,16,20,21] These results are in concordance with those obtained in the present study. This indicated that condylar ramus height is a reliable parameter that can be used to determine the sex of an individual. Studies conducted by Taleb NSA et al., 2015 showed that condylar ramus height can be used effectively in determining sex,[10] while studies conducted by Indira et al., 2012, Nagaraj et al., 2017 and Shivaprakash S, Ashok KR, 2018 revealed that condylar ramus height plays a significant role in the determination of sex.[12,17,16] This is in accordance with the present study. In the present study condylar ramus height was statistically significant with $P = 0.000$ for males and females thus showing that females and males have significant differences. This indicates that condylar ramus height is a good parameter for determining the sex of an individual. This study contradicts the results of a previous study conducted by Kedarisetty et al., 2015 (South Indian population, 60 lateral cephalograms) where there was no statistically significant difference between male and female subjects in height of the condyle.[22]

Conclusion:

Mass disaster victims often go unnoticed due to a lack of readily available material on site, challenging forensic experts to think beyond their capabilities. "When all else fails, teeth and bones prevail." The jawbone, the largest bone in the skull, is the most resistant to damage and disintegrate, and is believed to be an important tool for sex determination. It provides sex-specific measurements and is reliable in sex determination. This study demonstrates that mandibular index is a reliable instrumental parameter for sex determination in forensic odontology.

Conflict of Interest: 'The Author(s) declare(s) that there is no conflict of interest'

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ORIGINAL ARTICLE

Anthropometric Analysis of the Greater Sciatic Notch: A Radiographic Study

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Abstract :
The pelvis is a sexually dimorphic bone due to hormonal effects that facilitate its adaptation for parturition in females. This study aimed at determining the radiographic morphometry of the greater sciatic notch (GSN) in a selected Nigerian population. A Tertiary health facility in Delta State Nigeria provided permission to access its radiological database for the pelvic radiographs retrospectively examined in this cross-sectional study. The GSN of 300 patients (154 males and 146 females) were identified and the following measurements taken using digital callipers and protractors; width, depth, posterior segment, total and posterior angles. Statistical Package for Social Sciences version 22 summarised the data in means and further assessed the gender, side and age differences. The association between variables was tested using the Pearson's correlation test. Inferential statistics were deemed significant at $p<5\%$. All variables except the depth and posterior angle were sexually dimorphic ($p<0.05$). The width and posterior angle varied significantly across the age-groups. All variables except the width were asymmetrical ($p<0.05$). All the GSN measurements lacked significant correlation with age ($p>0.05$). The normative values for GSN dimensions in the study population have been provided. Their sexual dimorphism highlights their utility in sex determination of unknown human remains.

Keywords: Greater sciatic notch; Radiographs; Dimension; Index: Forensic.

Introduction :

Body structures exhibit variations in their anthropometric measurements mainly due to the influence of genetics, sex, race, gender and cultural practices. This highlights the need of establishing baseline ranges which forensic experts can use for accurate identification of skeletal relics in mass disasters and medico-legal cases.[1,2] Human identification relies on the comprehensive establishment of an individual's biological profile which consists of sex, stature, age and ethnicity or race.[3-5]

Bones are useful in forensic investigations because of their dense nature that makes them resilient to decay, putrefaction and extreme temperatures.[1,4] Nevertheless, in high-impact catastrophes like plane crashes or explosions, bones are usually fragmented and rarely recovered intact. This makes the forensic identification process challenging.[6,7] Sex differences in the human skeleton are due to trait expression influenced by sex hormones, nutrition and cultural differences that shape gender roles.[3] Sex determination has been conducted using various parts of the human skeleton including the pelvis, skull and long bones. The pelvis provides the highest accuracy for sex determination; approximately 98%.[6, 7] The sexual dimorphism of the hip bone or ossa coxae is attributed to the demands for child bearing and adaptations for bipedalism.[3,8] Despite its susceptibility to damage, the pubic bone is the best sex indicator. Several indices of the pelvis have been used for sex determination namely; the chilotic index, turner pelvic index, ischiopubic (Washburn) index, and sciatic notch index.[1,9] The greater sciatic notch (GSN) is a U-shaped indentation on the posterior aspect of the pelvic bones. It is highly resistant to fragmentation hence, has a high probability of being recovered intact in poorly preserved skeletons.[9-11] The shape and size of the GSN correlate directly with the pelvic inlet.[1] The metric parameters of the GSN show intra and inter-population variations mainly due to racial and ethnic differences.[1,12-14] The GSN displays sexual dimorphism across diverse population groups and this has been linked to sex variances in the development of the hip bone.[1-3,12,13]

For accurate sex prediction in forensic investigations, population-specific standards are required. However, data regarding the radiographic dimensions of the GSN in Delta State, Nigeria is scarce. This research aimed to determine the radiographic measurements of the GSN in adult Nigerians. Furthermore, the association between the metric parameters with age and sex were evaluated to elucidate their role in forensic investigations.

Materials and methods:

This retrospective observational research entailed the analysis of pelvic radiographs stored in the Picture Archiving and Communications System (PACS) software of a Hospital in Delta State, Nigeria. The evaluation began after seeking the Institution's permission (HREC/PAN/2023/020/0559).

Apparently normal antero-posterior pelvic radiographs of patients aged 18-80 years were assessed. The lower age limit of 18 years was chosen to guarantee the evaluation of fully matured pelvises. Excluded radiographs had evidence of previous surgery and visible pelvic pathologies including fractures, osteophytes, tumors, and reduced joint space. Technically inadequate pelvic radiographs with over-penetration, patient rotation or

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Table 1. Age distribution of patients.

Age groups (years)	Total Population	
	N	%
<20	9	3.0
20-29	44	14.7
30-39	59	19.7
40-49	51	17.0
50-59	46	15.3
60-69	59	19.7
>70	32	10.7
Total	300	100

Table 2. Side differences in the metric variables of the GSN.

Variables	Side	N	Min	Max	Mean ± SD	P-value
Width (cm)	L	300	3.81	7.01	5.24 ± 0.62	0.100
	R	300	3.67	6.87	5.23 ± 0.61	
Depth (cm)	L	300	1.17	2.85	1.76 ± 0.32	0.001*
	R	300	0.55	2.80	1.71 ± 0.33	
Posterior Segment (cm)	L	300	1.04	3.24	1.82 ± 0.44	0.021*
	R	300	1.02	3.21	1.85 ± 0.43	
Posterior Angle (O)	L	300	24.70	76.70	43.59 ± 6.95	0.315
	R	300	21.5	73.9	43.75 ± 7.03	
Total angle (0)	L	300	57.9	129.2	105.06 ±11.28	0.001*
	R	300	52.9	132.0	105.84 ±11.74	
Index I	L	300	20.88	61.69	33.90 ± 7.36	0.001*
	R	300	11.85	63.82	33.19 ± 7.41	
Index II	L	300	21.84	59.32	34.77 ± 7.01	0.004*
	R	300	21.47	59.48	35.28 ±6.97	

***- significant difference, SD – standard deviation, R- right, L- left, Min- minimum, Max- maximum**

indistinguishable landmarks were also excluded. Three hundred (300) pelvic radiographs of 154 males and 146 females met the defined selection criteria.

The pelvic radiographs were viewed on a computer desktop and the symmetry verified. Thereafter, the age and gender of the patient was noted and the bilateral GSNs identified. Using a linear digital ruler the depth, width, and posterior segment of the GSN were measured in cm while a digital protractor was used to measure the posterior and total angles in degrees.

The width (AB) of the GSN was defined as the maximum vertical span between the ischial spine (A) and the piriformis tubercle (B) while the depth (CO) was measured as the perpendicular distance from the deepest point of the GSN (C) to where it intersects the line measuring the GSN width (point O). The posterior segment (BO) was the length from the piriformis tubercle (B) to the intersection point (O) of the lines measuring the width and depth of the GSN (Fig 1).[1]

Total angle (ACB) was formed at the deepest point of the GSN (C), from the ischial spine (A) to the piriformis tubercle (B). Posterior angle (BCO) was the deepest point of the GSN (C) formed by the meeting of straight lines from the piriformis tubercle (B) and point O. Index I was calculated as the ratio of depth to width multiplied by 100. Index II was calculated as the ratio of posterior segment to width multiplied by 100 (Fig 1).[1]

Statistical Package for Social Sciences (SPSS) version 22 analyzed the variables considering gender, side and age categories. Means and standard deviations were tabulated and compared across different age and sex groups using the analysis of variance (ANOVA) and independent t-test respectively.

Table 3. Gender differences in the measurements of the GSN.

Variables	Side	Sex	N	Mean ±SD	P-value
Width (cm)	L	M	154	4.99 ± 0.53	0.001*
		F	146	5.51 ± 0.54	
	R	M	154	5.00 ± 0.54	0.001*
		F	146	5.46 ± 0.60	
Depth (cm)	L	M	154	1.75 ± 0.31	0.639
		F	146	1.76 ± 0.34	
	R	M	154	1.71 ± 0.33	0.964
		F	146	1.72 ± 0.32	
Posterior segment (cm)	L	M	154	1.66 ± 0.37	0.001*
		F	146	1.99 ± 0.44	
	R	M	154	1.69 ± 0.39	0.001*
		F	146	2.01 ± 0.43	
Posterior angle (o)	L	M	154	43.05 ±7.61	0.165
		F	146	44.17 ± 6.20	
	R	M	154	43.08 ± 7.70	0.089
		F	146	44.46 ± 6.20	
Total angle (o)	L	M	154	100.34 ± 10.38	0.001*
		F	146	109.93 ± 10.11	
	R	M	154	101.39 ± 10.87	0.001*
		f	146	110.52 ± 10.79	

***- significant sex differences, SD – standard deviation, R- right, L- left, M- male, F- female.**

Table 4. Gender differences in the measurements of the GSN.

Variables	Side	Sex	N	Mean ±SD	P-value
Index I	L	M	154	35.37 ± 7.41	0.001*
		F	146	32.35 ± 7.01	
	R	M	154	34.60 ±7.64	0.001*
		F	146	31.71 ± 6.89	
Index II	L	M	154	33.44 ±6.90	0.001*
		F	146	36.16 ± 6.89	
	R	M	154	33.93 ± 7.17	0.001*
		F	146	36.70 ± 6.49	

***- significant sex differences, SD – standard deviation, R- right, L- left, M- male, F- female.**

Laterality was investigated using paired t-test and Pearson's correlation test determined the relationship between age and the variables. Significance was considered at probability level of less than 5%.

Results:

Out of the 300 pelvic radiographs, 146 (48.7%) belonged to female patients, while 154 (51.3%) were from males. The sample's average age was 47.26 ± 16.89 years, ranging from 18 to 80 years. The 30-39 years' and 60-69 years' age-groups had the maximum frequencies, each accounting for 20% while the < 20 years age group had the lowest frequency (9, 3%) of patients (Table 1).

Significant side differences in the depth, posterior segment, total angle and both indices were observed ($p<0.05$). The left side exhibited larger depth and index I while the right side had larger total angle, posterior segment and index II ($p<0.05$). The side variations in the width and posterior angle were however not statistically significant ($p>0.05$) (Table 2).

Females displayed significantly larger GSN width, index II, posterior segment, and total angle while the index I was larger in males ($p<0.05$). The GSN depth or posterior angle didn't show any sex variances ($p>0.05$) (Tables 3 and 4).

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Table 5. Difference in mean variables of the GSN within the age groups.

		Age Groups (Years)							
Variables	Side	<20	20-29	30-39	40-49	50-59	60-69	>70	P-value
Width (cm)	L	5.10 ± 0.77	4.98 ±0.63	5.34 ±0.54	5.29 ±0.56	5.21 ±0.56	5.38 ±0.68	5.18 ±0.65	0.034*
	R	4.99 ±0.71	4.98 ±0.61	5.33 ±0.55	5.26 ±0.56	5.23 ±0.53	5.33 ±0.70	5.18 ±0.62	0.051
Depth (cm)	L	1.73 ± 0.45	1.70 ±0.31	1.83 ±0.35	1.72 ±0.28	1.70 ±0.32	1.76 ±0.31	1.84 ±0.33	0.203
	R	1.65 ±0.40	1.67 ±0.29	1.78 ±0.35	1.67 ±0.26	1.68 ±0.33	1.73 ±0.34	1.77 ±0.39	0.451
Posterior segment (CM)	L	1.68 ±0.40	1.72 ±0.40	1.94 ±0.51	1.80 ±0.36	1.85 ±0.37	1.84 ±0.43	1.76 ±0.53	0.200
	R	1.75 ± 0.50	1.77 ±0.44	1.95 ±0.48	1.82 ±0.38	1.85 ±0.39	1.86 ±0.43	1.79 ±0.50	0.429
Posterior angle (0)	L	37.32 ±6.12	42.43 ±8.22	44.96 ±9.00	43.82 ±5.77	44.65 ±4.48	43.82 ±6.21	42.13 ±6.13	0.035*
	R	36.68 ±6.80	41.59 ±7.67	45.80 ±9.08	43.96 ±6.29	44.62 ±4.97	44.08 ±5.60	42.73 ±5.90	0.002*
Total angle(o)	L	97.31 ±10.87	102.77 ±12.50	106.11 ±10.07	105.87 ±10.97	107.11 ±11.06	105.84 ±12.43	102.80 ±9.47	0.127
	R	98.12 ±12.09	102.97 ±12.01	107.32 ±11.14	107.21 ±11.74	106.95 ±11.00	106.54 ±13.05	104.14 ±10.01	0.148
Index I	L	34.42 ±10.11	34.62 ±7.34	34.53 ±6.94	32.83 ±6.77	32.96 ±7.66	33.31 ±7.74	35.77 ±7.17	0.525
	R	33.68 ±9.44	33.88 ±6.75	33.54 ±7.04	32.19 ±6.85	32.35 ±7.28	33.12 ±8.28	34.41 ±8.06	0.818
Index II	L	33.14 ±7.19	34.53 ±6.46	36.25 ±8.26	34.20 ±6.78	35.57 ±6.22	34.11 ±6.18	33.78 ±8.09	0.516
	R	34.81 ±7.11	35.37 ±6.95	36.53 ±7.89	34.78 ±7.07	35.39 ±6.67	34.90 ±6.01	34.32 ±7.44	0.816

*** significant age difference, SD – standard deviation, R- right, L- left.**

Table 6. Correlation between the GSN variables and age.

		Age	Width		Depth		Posterior Segment		Posterior Angle		Total Angle		Index I		Index II	
Side			L	R	L	R	L	R	L	R	L	R	L	R	L	R
Age	r	1	0.096	0.096	0.040	0.048	0.013	0.000	0.035	0.068	0.056	0.058	-0.013	-0.007	-0.044	-0.058
	p		0.098	0.096	0.486	0.403	0.817	0.997	0.540	0.242	0.337	0.318	0.821	0.909	0.445	0.320

L- left, R- right, r- Pearson's Correlation, p- Sig. (p-value).

A significant variance in the width and posterior angle were noted across the age-groups (Table 5). However, age lacked significant correlation with all the GSN parameters investigated ($p < 0.05$) Table 6. Table 7 compares the findings of different studies on GSN, highlighting the population differences.

Discussion:

The GSN width in this study surpassed the mean value documented in several earlier reports.[1,2,12,14] It was however smaller than the width reported by Alizadeh et al.[3] and Sarac-Hadžihalilović et al.[13] The depth was smaller than the research findings in India, Iran, and Bosnia.[1,3,13,14] The posterior segment was larger than the values reported by Karki et al.[1] and Shangloo et al.,[2] but smaller than reports by Sarac-Hadzihalilovic et al.,[13] Jain and Choudhary,[12] and Alizadeh et al.[3] (Table 7). The GSN angles (posterior and total angles) were larger than the measurements by Shangloo et al.,[2] Sharma et al.[14] and Karki et al.[1] Index I was lower than the findings by Jain and Choudhary,[12] Karki et al.,[1] and Shangloo et al.[2] Index II was lower than the results by Jain and Choudhary.[12] and Alizadeh et al.[3] and higher

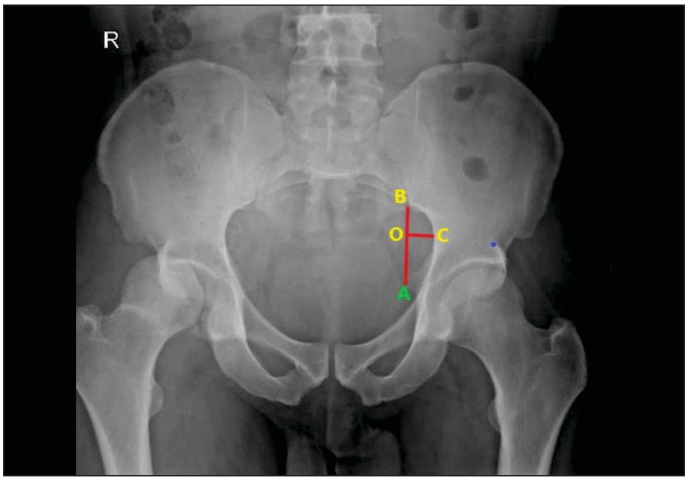

Figure 1. Antero-posterior pelvic radiograph showing measurement of GSN. A – tip of the ischial spine, B – Piriformis tubercle, AB –Width, OC- Depth, C- deepest point of the GSN, OB- posterior segment.

than the studies by Shangloo et al.[2] and Karki et al.[1] The population differences in Index II could be ascribed to the variant influence by the posterior segment, sacrum development, piriform tubercle, and ischial spine.[1]

These measurements varied across many studies due to different ethnic, cultural, genetic, racial and environmental factors like occupation, nutrition, climate and physical activity.[1,4,7,15] Variations in sample size, sample composition, and data collection tools; ranging from traditional rulers and goniometers to digital substitutes, may also explain the observed differences.[7,16] Disparities in sample types namely; dry bones, radiographs, or computed tomography scans, can influence the GSN measurements in diverse populations.[7] The accuracy of the morphometry in radiography could be influenced by superimposition of structures and inherent magnification that varies in studies.[1]

We report asymmetry in the GSN depth, indices, total angle and posterior segment, corresponding with Alizadeh et al.[3] and Shangloo et al.[2] Consistent with Alizadeh et al.,[3] the left GSN was deeper than the right. This contradicted Shangloo et al.,[2] who observed a deeper right GSN. Bilateral asymmetry may distort, delay, or speed up the skeletal markers used in estimating the indicators of biological profile. Many factors are responsible for GSN asymmetry including; handedness, genetics, biomechanical and environmental factors.[11,15,16]

The GSN was wider in females and this was congruent with other literature reports that highlight the GSN's significance in forensics.[1,3,14] Parallel with several reports, the GSN depth lacked significant sex variation.[1,3,13,14] However, this differed from studies by Jain and Choudhary.[12] and Shangloo et al.[2] These disparities exist because of varying magnitude of sexual dimorphism of bones in different populace. Aligning with several studies, females had larger posterior segment of GSN which could be utilized as a good sex indicator.[1-3,13,14] The posterior angle lacked sexual dimorphism, contradicting with the findings of some studies.[1,2,14] Corresponding with previous reports, the total angle was significantly larger in females hence relevant in forensic investigations.[1,2]

Table 7. Comparison between the GSN morphometry in this study and other studies.

Author		Karki et al.[1]		Shangloo et al.[2]		Alizadeh et al.[3]		Jain and Choudry,[12]		Sarac- Hadžihalilović et al.[13]		Sharma et al.[14]		Current study	
Country		Nepal		India		Iran		India		Bosnia		India		Delta, Nigeria	
Modality		Radiographs		Dry bones		Radiographs		Dry bone		Dry bones		Dry bone		Radiographs	
Population		64		68		98		46		98		100		300	
Unit		cm		cm		cm		mm		mm		mm		cm	
		M	F	M	F	M	F	M	F	M	F	M	F	M	F
Width	L	40.31	50.28	4.11	5.18	5.58	6.3	34.1	43.3	53.93	60.65	39.11	41.36	4.99	5.51
	R			4.36	5.16			33.8	45					5	5.46
Depth	L	25.13	24.75	2.66	1.88			26.5	24.2	33.47	33.55	28.26	28.22	1.75	1.76
	R			2.75	2.36			25.6	24.7					1.71	1.72
Posterior segment	L	11.12	16.65	1.24	1.3			28	22	19.57	28.85	12.16	21.68	1.66	1.99
	R			1.65	1.64			28.9	24.7					1.69	2.01
Posterior angle (o)	L	25.47		22.08	26.09							22.44	29.7	43.05	44.17
	R			30.79	33.78									43.08	44.46
Total angle (o)	L			67.69	70.52							59.58	71.77	100.34	109.93
	R			63.74	73.06									101.39	110.52
Index I	L			66.19	64.12	41.96	39.98	78	57					35.37	32.35
	R			63.74	66.46	32.74	37.12	74	55					34.6	31.71
Index II	L			29.7	26.65	40.5	47.26	82	50	0.58	0.86			33.44	36.16
	R			37.6	39.52	40.87	45.98	85	55					33.93	36.7

M- male, F- female, L- left, R-right, mm- millimeters, cm- centimeters.

Indices I and II exhibited population diversity due to racial disparities and different measuring methods used. These indices were sexually dimorphic mainly due to hormonal effects on the pelvic growth. The indices can therefore be useful in sex determination of skeletal relics during forensic investigations.[1,4,16] The GSN morphometry lacked significant association with age, hence, they aren't reliable age indicators in the study population. Nevertheless, this warrants further investigation using a larger sample size consisting of an even age distribution. On the contrary, DesMarais et al.[11] noted that the GSN becomes narrower with advancing age mainly due to the effects of hormones on bone metabolism.

Following the comparison of GSN morphometry in different studies, this research emphasizes on the need for population-specific normative values for accurate identification during forensic investigations. Sexual dimorphism due to hormonal effects and pelvic adaptations for childbirth make the GSN significant in forensics.[1,10] The presence of the GSN in any human remains recovered from our study population can therefore be utilized in the prediction of sex of the individual. Misinterpretation of sex may occur if the values applied are not from the population the bone originated from.

Conclusion:

The normative values for GSN dimensions in the study population have been provided. Their sexual dimorphism highlights their utility in sex determination of unknown human remains.

Limitations of Study: The sample size was limited to radiographs from radiological database of a single hospital hence findings can not he generalised to the broader population. Inherent limitations of radiographs such as magnification and superimposition could have affected the precision of the morphometry.

Future Research Directions: The morphometry of the GSN can be evaluated using a larger sample of radiographs from many hospitals thus ensuring diverse age, regional and ethnic representation. Advanced imaging modalities like computed tomography can be utilised for precise morphometry. Formulas for accurate sex determination using GSN morphometry can be derived.

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ORIGINAL ARTICLE

Dental Age Estimation using Cameriere's Method in Indore Population

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Abstract :

Forensic Dentistry, which is also referred to as Forensic Odontology is defined by James cotton as the branch of dentistry, which deals with proper handling, and examination of dental evidence and the proper evaluation and presentation of dental findings in the interest of justice. Teeth are most durable structures in the human body and have been found in many archeological sites or forensic cases, as only human remnants. Due to the low variability of dental maturity indicators, they have been used for the estimation of chronological age in individuals. Age estimation using teeth plays an important role in identification of humans in mass disasters and accidents. In addition chronological age is important in most societies for school attendance, social benefits, employments and marriages. Morphological and radiological techniques are used for the estimation of age in adults. There are few radiological techniques which have been devised on American, European or French, Canadian population. These techniques need to be validated for Indian population by doing several studies in different parts of India. In the present study, an effort is made to estimate the age of individuals by non-destructive radiographic method (Cameriere's method) in Indore population.

Keywords: Forensic dentistry; Dental evidence; Mass disaster; Chronological age; Radiographic method.

Introduction :

Since the earliest times, the primary tools in the investigation of forensic cases have been observation and interpretation of physical evidence. In the second half of the nineteenth century, advancement in applied forensic science was used to investigate cases which improved the validity of the conclusions drawn.[1]

Age estimation is an important division of forensic odontology especially when the subject under question is unidentified. The estimation should be as close to actual age as possible to narrow down the list of missing persons to enable time and energy saving. Age estimation is also used in cases of accidents and mass disasters along with sporadic crime investigations. In addition chronological age is important in most societies for school attendance, social benefits, employment and marriage.[2]

Dental maturity indicators help in estimating age of individuals with more accuracy because of their low variability. In children the developmental stages of teeth help in estimating age and in adults' morphological and radiological techniques are used.[2]

Morphological techniques are invasive and require extraction and /or histologic sectioning of teeth, which can't be done because of ethical concerns.[3] Radiographic age estimation is a non-destructive, simple method and descriptions in charts yield "maturity scores", which help us to assess the age of an individual.[4]

Forensic odontologists can utilize these techniques that are relatively precise and accurate, and avoid the bias inherent in observer subjectivity.[4] Ethnic differences between various population groups were found to affect the accuracy resulting in overestimation or underestimation of the dental age. Since the various studies for assessing the dental age have been conducted predominantly on the Western population, and India being a large country, studies from different parts of India are needed. To examine the application of pulp/tooth area ratio of mandibular canine for estimation of age of an individual.

Material and methods:

The pilot study was done as a retrospective study from the archival radiographs and case sheets with 34 samples (Table 1) with an age range of 39-47 years having 23 females and 11 males. The chronological age of the patient was calculated from the date of birth of the patient.

Inclusion criteria: 1.The subject should be clinically free from any developmental, endocrinal and nutritional disorder as these may affect development of individuals.

2. Subject should not have past history of any past prolonged medical / dental illness.

3. The selected tooth on the radiograph i.e. the mandibular canine is fully erupted into the oral cavity.

4. The root of the canine is fully formed.

Exclusion criteria: 1.Teeth with any pathology, such as, caries or periodontitis or periapical lesions, which would alter the surface

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Table 1. Distribution of subjects according to age range and sex.

Samples	No of samples	Age Range
Males	11	39-46 years
Females	23	40-47 years
Total	34	39-47 years

Table 2. Comparison of chronological & estimated age by cameriere's method.

Sex	Chronological Age	Estimated Age	Mean Difference	P Value (Paired t test)	Pearson's Correlation
Males	41 ± 2.09	44.08 ± 3.69	3.08	> 0.05 (0.481)	0.49 (NS 0.121)
Females	42.5 ± 2.24	41.73 ± 4.21	-0.72	> 0.05 (0.057)	0.31 (NS 0.140)
Combined	41.94 ± 2.27	43.25 ± 3.98	1.31	< 0.05 (0.045)	0.42 (Sig 0.013)

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

area of the tooth.

2. Malaligned canines or rotated canines.
3. Canines with any prosthetic fittings.

The digital form of intraoral periapical radiographs of mandibular canine was retrieved from the archives in JPEG format.

The sample: • Total 34 samples have been collected and analyzed. Random sampling method was used to collect samples from males and females from routine O.P.D. The chronological age of the patient was noted from patient's history taking.

Procedure: • After clinical examination, radiographic examination is done in the form of Intraoral Periapical Radiograph (IOPA).

- The radiographic films are processed in dark room with predefined protocol.
- The processed films are digitized on X-digi IOPA digitizer. After digitization the images will be stored in digital format with proper numbering done to individual case for further analysis.

Sample Analysis: •Samples were analyzed by Carmeriere's method for the determination of dental age with mandibular canine of the individual. The radiographic images were imported to image morphometry software, where the tooth outline is traced and the tooth area is measured using the area measurement tool of image morphometry software. (Figure 1). Similarly the pulp outline was traced and the pulp area was measured. Using tooth area and pulp area, pulp/tooth ratio (x) was calculated.

Dental age assessment by Cameriere method: All morphological variables and the chronological age of the patient were again entered in "Microsoft Excel" spread sheet for use of age estimation and age was calculated using the linear regression equation developed by Cameriere et al. (2007) for mandibular canines.

$$Age = 89.456 - 461.873(x)$$

Results:

After statistical analysis it was observed that the chronologic age average found to be 40.83 years & 42.55 years in males and females respectively whereas dental age assessed by Cameriere's

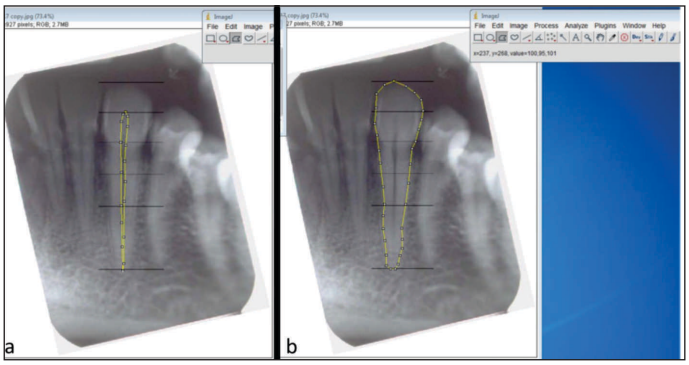
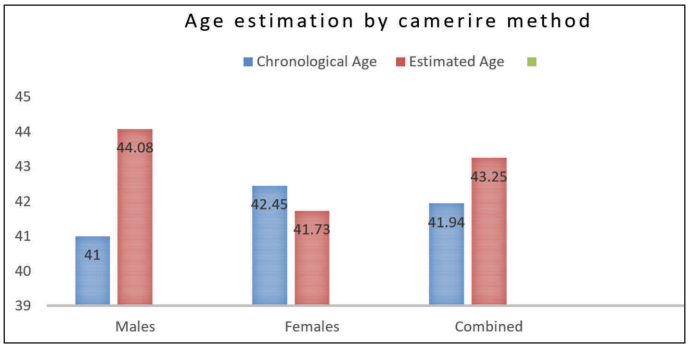


Figure 1. The area of pulp (a) and mandibular canine(b) is traced in the image morphometric software.



Graph 1. Graphic representation of chronological & estimated age by cameriere's method

method was observed to be 44.08 years and 41.73 years in males and females respectively. When total population was compared the average of chronologic age and estimated age came out to be 41.94 and 43.25 respectively. There is overestimation of age by Cameriere's method by 3.08 and 1.31 years in males and total population respectively whereas there is underestimation of age by 0.72 years in females (Table 2).

When chronological age and dental age estimated by Cameriere's method was correlated statistically. The values for total population showed statistically significant correlation ($p<0.05$) and values for males and females showed statistically insignificant correlation ($p>0.05$).

Discussion:

The importance of forensic odontology is now increasingly being recognized in the identification of dead as well as in the investigation of various offences, from the likes of dentition, bite marks etc. It is used in forensic archaeology to identify the fossils and interpret their life styles, food habits etc.[5]

Knowing age of unidentified dead person and person in question with a disputed age is of prime importance. Also finding the age at death helps in identifying a dead person.[6] Age estimation narrows down the pool of persons with whom the comparison is to be done for identification.

From infants to young adults the age estimation correlates with the development of dentition as it is more accurate.[7] Dentition has a unique role to play in identifying human remains because of its durability, resilience and stability.[7] Age estimation using ageing changes in different tissues have been done but with constrained results as many get affected by environmental factors.[7]

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In forensic odontology the radiographs provide vital information which can't be seen on physical examination and it is also a non – destructive method. Comparative study of post-mortem and anti-mortem radiographs along with clinical dental examination make the process of identification less difficult and reliable. Stage of eruption in radiographs also give an idea about the age of an individual.[8] The estimation of age at time of death is often an important step in identification of human remains.[6] If the age can be accurately estimated, it will significantly narrow the field of possible identities that will have to be compared to the remains in order to establish a positive identification.

Some of the more accurate methods of age estimation, in the juvenile and younger adult, have been based on the assessment of the degree of dental development as it relates to chronological age.[9]

Examination of teeth in many ways forms a unique part of human body, as they are most durable and resilient part of the skeleton. The science dealing with establishing identity of a person by teeth is popularly known as Forensic Odontology or Forensic Dentistry.[9]

Changes that are appreciable in teeth with increasing age are attrition, periodontal disease, and deposition of secondary dentine, root translucency, cementum apposition, root resorption, color changes and increase in root roughness. By taking into consideration, these secondary changes in teeth with advancing age, various studies were done to estimate the age of an individual. Such research has resulted in multifactorial methods that help in age estimation.[9]

The age related changes in the dentition could be divided into three categories, formative, degenerative, and histological. The formative or developmental changes are good predictors of age in the early years, until age 12. Formative changes are subdivided into following stages: the beginning of mineralization, the completion of the crown, the eruption of the crown into the oral cavity, and completion of the root.[10]

Degenerative changes also provide data for age estimation. The obvious degenerative changes in adult dentition are color, attrition, and periodontal attachment level. Color change is highly variable and is closely related to diet and oral hygiene.[10]

The changes connected with age are the following: [11] 1. Attrition takes place from the wearing down of the incisal or occlusal surfaces due to mastication. This change is seen both macroscopically and microscopically.

2. Periodontitis, loosening of the tooth, or continuous eruption, is characterized by changes in the attachment of the tooth. This change again, is seen both macroscopically and microscopically.

3. Secondary dentin may develop within the pulp cavity; partly as a direct sign of aging and partly as a reaction against pathologic conditions like caries and periodontitis. This change is to be seen only in the microscopic sections.

4. Cementum apposition may take place at the root and around it, particularly in connection with periodontitis. It is seen in microscopic sections only.

5. Root resorption may involve both cementum and dentin.

6. Transparency of the root increases with age and is best appreciated in ground sections.

Radiographs being non-destructive method also play a vital role in forensic dentistry to uncover the hidden facts, which cannot be seen by means of physical examination. Dental examination and comparison between antemortem and postmortem dental records and radiographs produce results with a high degree of reliability and relative simplicity. Radiographs are also helpful to determine the age of an individual by assessing the stage of eruption.[8]

The present study was designed with the objective of determination of the dental age in an Indore (Madhya Pradesh) population using estimation methods i.e. Cameriere's method which was used on a European. Cameriere et al. performed the study in Italian population in 2004. Due to ethnic differences in the two population groups, i.e., the European population and the Indore population, the applicability of the methods was tested.

A sample size consisting of 34 patients from Indore region which were selected randomly having no pathology with the mandibular canine.

The obtained dental age in this study in different groups was found to be higher than the chronologic age in both males and females by Cameriere's method.

An average overestimation of 0.84 years in males and 1.52 years in females and 1.30 years in total sample was found by Cameriere's method. In the present study we found the significant correlation between chronological age and estimated age by Cameriere's method and was statistically significant for combined sample i.e. $p<0.01$, $r=0.422$ by Cameriere's method. This was in accordance to the previous studies conducted by Cameriere et al. (2004)[12,13] and N.Bosmans et al. (2004).[14]

Previous studies have shown that with advancing age the size of the dental pulp cavity is reduced as a result of secondary dentin deposit, so that measurements of this reduction can be used as an indicator of age. Similarly correlation was found pulp/tooth volume ratio and biological age by Yang Fan et al (2006)[15] and N. Jagannathan et al. (2011).[16]

Similarly, the effect of gender on age estimation was also determined in this study, and we found that gender had no significant influence on age. This is in accordance with the original study carried out by Cameriere et al. (2004).[12,13]

Babshet et al. (2010)[17] applied the formula reported by Cameriere et al. (2007)[18] and the modified Indian formula in Indian population on mandibular canine and found that the use of population specific formula did not improve age estimation to a great degree and the original Italian formula itself may be used in Indians. Several other Indian and non-European studies have shown similar results as that of the present study.[19-21] The different formulae given by various authors need to be checked and validated for Indian population in general.

In this study we chose only mandibular canine as the tooth of choice. We would preferably have included molars, but the preliminary study clearly demonstrated that accurate measurements of multi-rooted teeth were difficult to perform, and for the same reason maxillary first premolars, which

frequently have two roots, were likewise excluded, and this is one of the major drawback of the study. Rotated teeth, decayed teeth or teeth with any prosthetic fitting were excluded from the study. If the individual has any of the mentioned conditions, then this method cannot be employed to estimate the age, as these conditions alter the tooth surface area.

Some questions concerning precision and accuracy of the measurements have been reported in literature when using digital measurements. So in future, image analysis programs which can recognize pulp outlines in a radiographic images could be developed, which will be very useful in minimizing human manual measurements of morphological parameters, and will probably reduce both inter- and intra-observer variability.

As discussed earlier, the effect of distortion of the radiographic image on age estimation is to be seen. Therefore in future, studies can be taken up to see the effect of distortion on age estimation. Selecting two different single rooted teeth on a same radiograph for calculating the age, and then comparing the two readings can help in determining the same.

We made our sincere efforts to prove applicability of the Cameriere's method in assessment of dental age. Moreover, further studies should continue with larger sample size for clear assessment to prove creditability of Cameriere's method for dental age estimation.

Conclusion:

The study can be carried forward with a larger sample size to validate the Cameriere's formula in Indore population as the pilot study shows promising results with the same. To increase the accuracy, automated software can be used for eliminating the observer bias on anatomy of tooth.

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ORIGINAL ARTICLE

Pattern of Drug Poisoning cases reported in Poison Detection Centre at Tertiary Care Hospital, Belgaum

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Abstract:

The trend of reported drug overdose cases in Poison Detection Centre is a critical area of research that sheds light on the prevalence, distribution, and specifics of cases of drug poisoning. Drug toxicity is a major problem for the public health that has an impact on all ages and socioeconomic groups. This study's objective is to evaluate the trends in drug poisoning cases that have been reported to the Poison Detection Centre by examining the types of drugs involved and the demographics of the affected individuals. The findings of this study will provide valuable insights into the current trends and patterns of drug poisoning cases, which can help in making informed policy decisions and guide interventions to prevent and manage drug poisoning incidents. In this study, retrospective analysis of 315 drug poisoning cases were performed. Information was collected from cases reported between January 2010 and December 2021. Microsoft Excel ® 2021 was used for analysis and the results were calculated in percentages. The study found that sedative-hypnotics like benzodiazepines and analgesics like paracetamol (acetaminophen) were the most used drugs. The current data may not accurately depict the prevalence of poisoning in India, but it does show a general trend. The Poisons Information Centre is crucial in informing doctors about commonly used, abused medications so that they are aware of them before prescribing them.

Keywords: Clinical toxicology; Drug poisoning; Drug monitoring; Overdose; Poison detection centre; Prescription drug abuse; Toxicology.

Introduction:

Drug poisoning is a serious medical emergency that can be caused by either an intentional or unintentional misuse of drugs. It can occur with both legal, prescribed medications as well as illicit drugs. Risks of poisoning have increased significantly over the past few decades because of the easy accessibility of pharmaceuticals. Higher doses of drugs taken orally or intravenously can cause poisoning or even death.[1] The second-leading cause of morbidity globally is acute poisoning.[2] Over the past ten years, drug overdose mortality has significantly increased in several nations around the world. Each nation experiences distinct poisoning pattern. There may be a significant relationship between social, cultural, and religious factors and the origin of poisoning.[3] Drug overdose is a medical emergency for which it's critical to determine the incidence, pattern, and outcome in order to make the appropriate plans for strict management. Overdose from drugs is a significant but poorly understood public health issue. Drug overdoses were once considered to be a problem with substance addiction or law enforcement rather than a public health issue. Public health specialists have, however, grown more interested in the subject and in minimising the burden that unintentional overdoses place on society because of the rise in the use of legal prescription medicines.[4] There are two significant ways that accidental drug overdoses vary from other causes of morbidity and mortality. First, drug users rarely overdose alone, and unintentional overdose deaths are unusually rapid. Hence, the majority of overdose deaths can be prevented. For instance, those who perceive an overdose situation able to access first aid and call for emergency services.[5] Secondly, drug availability is inextricably linked to drug overdoses as a necessary factor in overdose, in particular.[6] In the case of drug poisoning, it is important to identify the type and amount of drug taken, as well as the time frame in which it was taken, in order to provide appropriate medical care considering that overdose can be avoided and is influenced by one's surroundings. Community health ought to concerned about drug overdoses from the perspectives of understanding their causes and promoting interventions to lessen their effects. Treatment for drug poisoning depends on many factors such as the type and dose of drug consumed. Treatment plans typically involve supportive therapies such as airway management, hydration, fluid replacement therapy, and monitoring of breathing rate and oxygen levels. It is important for healthcare professionals to stay abreast of emerging trends in drug poisonings so they can be adequately prepared to take proper action whenever an incident arises. To be able to treat patients effectively, when necessary, medical professionals must stay informed about the problems associated with drug poisoning. This study's objective is to offer pertinent data on the patterns of drug poisoning cases that have been reported to the Poison Detection Centre of Belgaum's Dr. Prabhakar Kore Charitable Hospital.

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Materials and methodology:

After obtaining ethical approval from the Institutional Ethics Committee the analysis was conducted out. The current study was carried out for a period of, at Belgaum District, Karnataka state which is in Southwestern region of India. Figure1 displays the study area. Data were collected retrospectively for this study includes information about all the drug poison samples analysed at Poison Detection Centre (PDC) that is reported from the Tertiary Care Hospital. Cases which were referred from nearby Hospitals to the central hospital were also considered. Age, sex and the names of drugs taken were included in the study's data collection on the pattern of poisoning from records of poison detection centre. In total 315 case histories were studied to uncover pattern of poisoning in the region. Based on the total cases reported for each class of Drugs along with the patient's age gender, the frequencies of the incidence of poisoning in each year were calculated. Relevant information was gathered and entered in Microsoft Excel using a standardized proforma. In this study, drugs linked to poisoning incidents were categorised based on their therapeutic group. Microsoft Excel 2021 was used for analysis and the outcomes were calculated as percentages.

Results:

In total, 2038 suspected poisoning cases were reported, 315 of which were drug-related, available for analysis. Figure2 illustrates the year-wise distribution of cases. Between 2016 and 2020, drug poisoning cases shows varied patterns. Age wise distribution of poison is mentioned in Figure3. 107 (34%) Poison cases were reported from age group between 21-30 years of age, 75 (24%) is between 11-20 years of age, 67 (21%) is between 31-40 years of age, 26 (8%) is between 41-50yrs of age, 13 (4%) is between 51-60yrs of age & 9 (3%) is reported in 61-70, 9 (3%) <10yrs & >70 years of age each. Majority of cases were reported between 21 – 30 years of age and less cases were is reported from person with either more than 70years or less than 10 years. Males (60%) were reported more than Females (40%) which is represented in the Figure 4. The common groups of drugs reported in PDC in decreasing order of frequency were Sedative-Hypnotics (61%), NSAID (9%), Antidepressant & Antipsychotics (4%), Antihistaminic, Iron & Amlodipine (3%) each, Betablockers (2.5%), Antiepileptics (2%), Antidiabetic (1.5%), Phenol, Domperidone, PPI & Calcium (0.6%) each & Remaining drugs of 0.3% which is mentioned in Figure 5. Among Sedative-Hypnotics, Benzodiazepines (88%) are most reported followed by Phenobarbitone (10%) & non-Benzodiazepines (2%) are mentioned in Figure 6. Among NSAID, Paracetamol (71%) was reported most common followed by COX 2 inhibitor (14%), Non selective COX inhibitor (11%) & Preferential COX inhibitor (4%) is mentioned in Figure 7.

Discussion:

The intentional or unintentional consumption of chemicals that are harmful to a human's body would represent drug poisoning. In our research, the number of drug poisoning cases varies by year, more cases were reported in 2016 (13%) and least in 2014 (4%). Males (60%) predominated over Females (40%) at the ratio of 1.5:1 which in convergence with the national and global findings. A possible explanation to these findings can be the easy exposure of males to poisoning agents & males are more prone to the stress which may lead to the suicidal use of poisoning agents.[7] It is found to be similar to the research done by Zia et al.,[8] Issa et al.,[9] Singh et al.,[7] Prajapati et al.,[10] Kumar and Reddy,[11] Maskey et al.,[12] Aatika et al.[13] Minor increments were reported by Jalali et al.[14] and Hameed et al,[15] Jailkhani et al.[16] certain studies have also reported more number of poisoning cases in females.[17-19]

The greatest proportion of cases in the current study were between 21-30 years old (34%) followed by between 11-20 years old (24%) between 31-40 years old (21%), while the age groups with the lowest percentage of patients were under 10 years old and over 70 years old. It is so because, a person will be more energetic and also has more hard times when they are between the ages of 21 to 40 years of age. This finding is also supported by the studies that have been done by Gupta et al.,[20] Dash et al.[21] and Srivastava et al.,[22] Singh et al.,[7] Liu et al.,[23] Escoffrey and Shirley,[24] Meel,[25] Sandhu and Dalal,[26] Batra et al.,[27] Dash et al.,[28] Nigam et al.,[29] Garg and Verma.[30] The Sedative Hypnotics group (61%) has more drug toxicity reports followed by NSAID (9%) compared to all other groups. Benzodiazepines (88%) were reported more often than other sedative hypnotics & Paracetamol (71%) is most reported among NSAID. This finding is in accordance with various studies like Babys et al.,[31] Dash SK et al.[32]

From this, it can be inferred that benzodiazepines are routinely prescribed medications for the treatment of insomnia and also as anticonvulsants. NSAID are widely found as over-the-counter medication, hence lack of knowledge and the easy accessibility of drugs attributed to this issue. Medical practitioners should also take the initiative to remain knowledgeable and up-to-date on the risks of drug poisoning as it is a serious and fatal condition. Practitioners should work to understand how medications influence the body, including the toxicity of certain substances and interactions between various substances. They should also be aware of the possible antidotes or remedies for medication overdoses so they are ready to offer the necessary medical care whenever required. Additionally, practitioners must familiarize themselves with ways to ensure safe storage and disposal of these potentially dangerous substances in order to reduce unintentional overdose exposures. These results are a reminder that regulatory guidance on decisions regarding the transfer from prescription to over-the-counter medications needs to be developed.

Conclusion:

Drug poisoning is an increasingly prevalent problem across all demographics. In particular, our study revealed that there is an alarming rise in the number of poisonings associated with anti-anxiety medications and NSAID among young and middle-aged adults. The results of this study highlight the need for increased public health education and awareness about medication safety, as well as more stringent healthcare guidelines regarding prescription drug monitoring, in order to protect individuals from potentially dangerous drug interactions and misuse.

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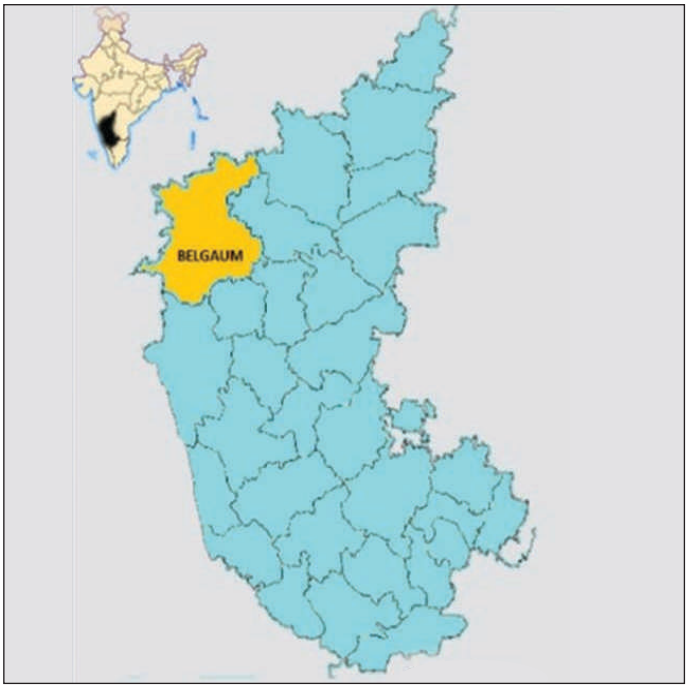

Figure 1. Illustration of Study Area. The figure depicts the study area for the research conducted in this study. The study area is represented by a geographical map, showcasing the relevant geographic features and boundaries.

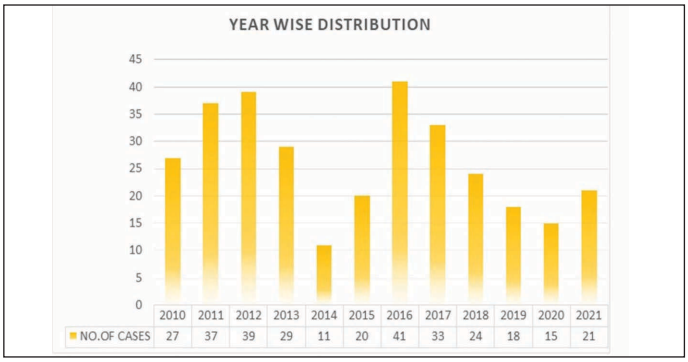

Figure 2. Cases of drug poisoning distributed by year. The figure presents a bar graph depicting the annual distribution of drug poisoning from 2010-2021. The X-axis represents the years. Y-Axis represents the number of drug poisoning cases recorded during each year. Each bar on the graph represents the number of cases reported in a specific year.

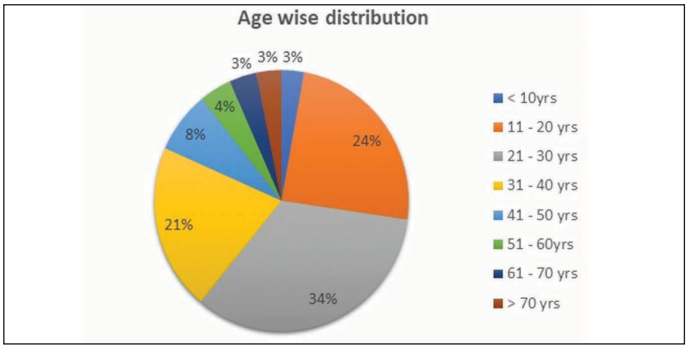

Figure 3. Age-based distribution of cases of drug poisoning. The pie chart provides a visual representation of the proportion of cases within each age category.

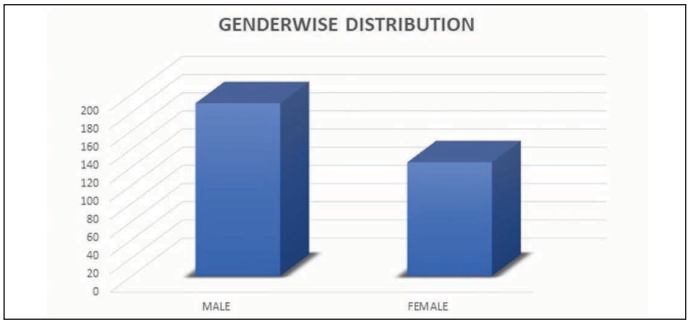

Figure 4. Distribution of drug poisoning cases based on Gender. The figure presents a bar graph depicting the distribution of drug poisoning cases based on gender.

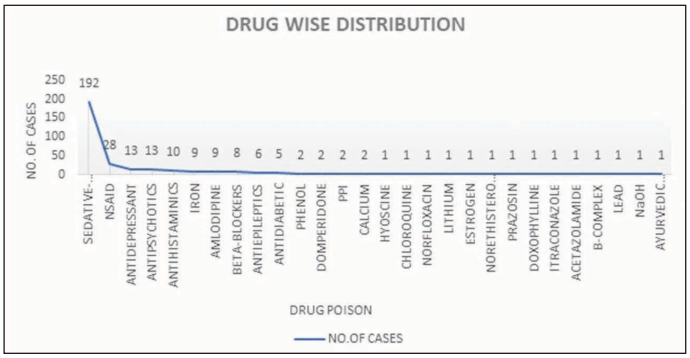

Figure 5. Distribution of drug overdose cases as per the substance consumed. The figure presents a line graph depicting the distribution of drug overdose cases based on the specific substances consumed. X-Axis represents the substances consumed in drug overdose cases. Y-Axis represents the number of drug overdose cases associated with each substance.

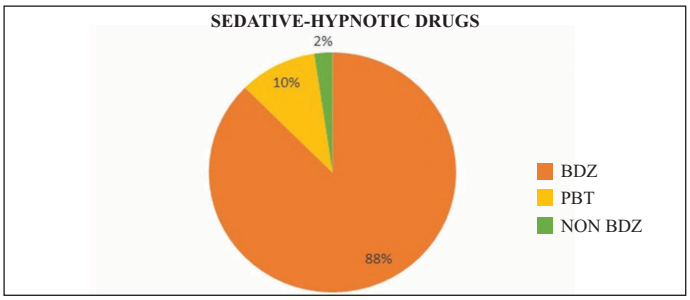

Figure 6. Number of drug poisoning cases with sedative-hypnotics ingested. The pie diagram provides a visual representation of the proportion of cases attributed to sedative-hypnotic ingestion out of the total drug poisoning cases.

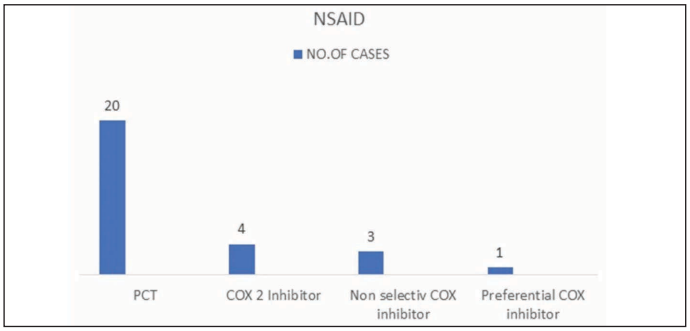

Figure 7. Number of drug poisoning cases with NSAID. X-Axis: The horizontal axis represents the specific NSAIDs involved in the drug poisoning cases. Y-Axis: The vertical axis represents the number of drug poisoning cases attributed to each NSAID.

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CASE SERIES

Autopsy Diagnosis of Vaso-occlusive Crisis in Sickle cell Disease: A case Series Study from Northern Odisha

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Abstract :

Sickle cell anemia is a qualitative genetic defect leading to abnormal HbS formation. During certain stressful conditions like infections, severe physical exertion, pregnancy, dehydration etc. complications may arise especially in subclinical sickle cell trait/ disease cases. Among all Sickle cell crises which include vaso-occlusive crisis, aplastic crisis, hemolytic crisis and sequestration crisis, vaso-occlusive crisis is the most commmon. Though many case reports were published on vaso-occlusive crisis in SCD, rarely we get series of cases. Here we present four cases of sickle cell crisis diagnosed during routine autopsy procedure. All the cases lost their life due to vaso-occlusive crisis involving different organs. First case was a sudden death of a pregnant lady presenting with respiratory infection and renal failure. During autopsy, all the organs were congested. Spleen was fibrotic and atrophied. Microscopic examination revealed sickled red cells with classical Gamna-Gandy body with thick fibrous bands. An HPLC report was of sickle cell disease (SCD). Case 2 was a 26 year female died suddenly in her post-partum period with features of cardiomyopathy. Spleen had Gamna-Gandy bodies. The coagulation factors and liver enzymes were deranged. HPLC study showed HbS & HbA2 only. Third case was an elderly male, a known case of sickle cell trait presented to emergency with left side hemiplegia. During the hospital stay of 7 days, he developed generalized anasarca and died because of multiorgan failure. Microsections from all viscera demonstrated sickled RBCs. Last case was a 26 year young lady who had sudden collapse while working in rice field. Histopathology examination of heart demonstrated features of acute myocardial infarction because of sickle cell crisis. HPLC confirmed the case as SCD. Sickle cell disease has complications involving many organs. Vaso-occlusion can lead to ischemic crisis of heart, brain, lungs, kidney & liver causing acute myocardial infarction, CVA, ARDS, renal failure and many more. Clinicians must have eyesight of these complications in an undiagnosed hemoglobinopathy case. Initiation of prompt treatment may reduce mortality & morbidity.

Keywords: Sickle cell disease; HPLC; Gamna-Gandy body; Autopsy.

Introduction :

Sickle cell disease is a genetic disorder due to point mutation at the 6th position of β chain of hemoglobin. Valine amino acid replaces Glutamic acid and an abnormal hemoglobin (HbS) results. Homozygous and heterozygous states are classified depending on the HbS percentage. The geographic distribution in India covers the tribal belt of states like Odisha, Maharashtra and Madhya Pradesh.[1,2] Sickle cell trait cases may lead a near normal life except in stressful conditions like dehydration, major surgery, infection and severe physical exertion.[3] Complications observed in sickle cell disease (SCD) are vaso-occlusive, aplastic, hemolytic and sequestration crisis. In hypoxic state, deoxygenated HbS polymerizes into long strand which is initially reversible. Repeated episodes lead to irreversible sickle shape of red cells and cause membrane damage. Due to inflammation, chemical mediators are formed and express adhesion molecule on endothelial cells. This leads to stagnation of blood flow and sickle shaped red cells get trapped in the microcirculation causing vaso-occlusive crisis. Again increase in blood viscosity and adhesion of these deformed red cells to the endothelial cells result in continuous damage to the visceral organs.[4] Infarction involving multiple organs may cause death.[5,6] Presence of other abnormal hemoglobin like HbSC, HbSD, HbS- β thal modify the pathogenesis and the clinical manifestations.[7] Here we present four cases with vaso-occlusive crisis involving different organs.

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Case 1:

A 19 year old primigravida of Northern belt of Odisha with 14th week of gestation was received with alleged history of sudden death after complaining of cough and dyspnea for last 2 days. The deceased had not visited hospital and was treated locally for her chest symptoms.

On autopsy examination, the uterus was of 14 weeks size. The viscera like kidney, liver and lungs were congested. There was an emboli lodged in pulmonary artery. Spleen was reduced in size weighing 120 grams. The external surface showed multiple white nodules. Cut section revealed severe congested areas with firm consistency.

Uterus, cervix with bilateral tubes and ovaries, both the kidneys, a

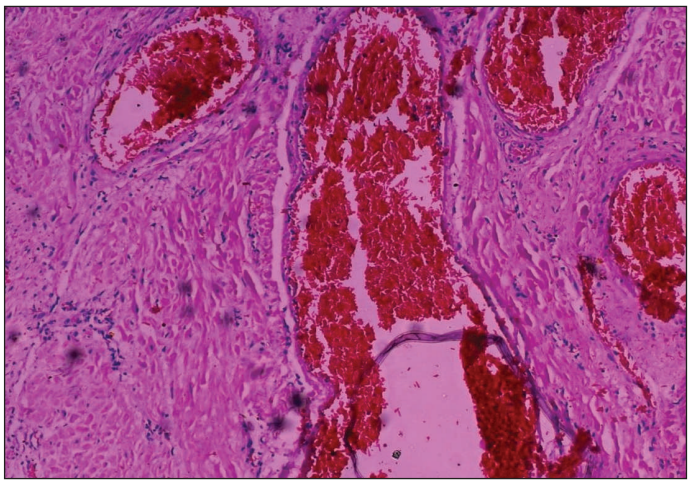

Figure 1. Myometrial blood vessels show congestion by sickle shaped red cells. H&E 200X

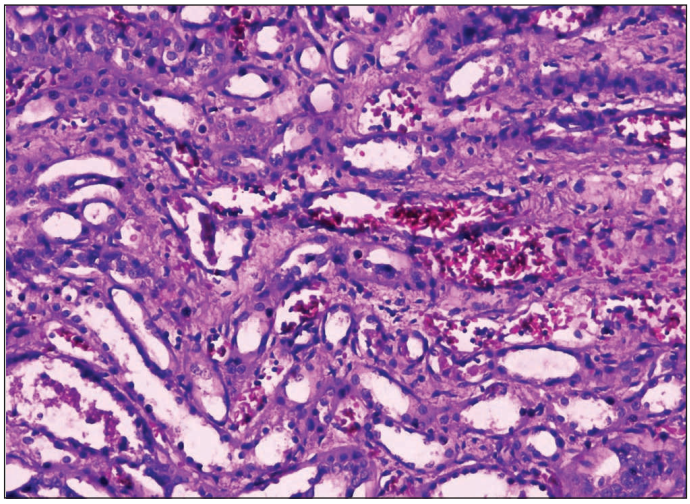

Figure 2. Section from kidney shows congestion of interstitial blood vessels. H&E 200X

piece of liver and spleen were sent for histological examination. Uterus, cervix with appendages measured around 15x9x12 cm. Cervix was effaced and dilated. Endometrial cavity content was brownish black friable material. On microscopy, endometrium showed decidualized stroma and fibrinohemorrhagic material containing villi. There were dilated and congested blood vessels in the myometrium filled with sickled red cells [Fig-1]. Cervix also revealed sickled RBCs within blood vessels. In both the kidney sections, glomerular capillaries and interstitial blood vessels were filled up with sickled red cells [Fig-2]. Proximal tubules had features of acute tubular necrosis. Liver sinusoid also demonstrated microvascular occlusive features.

Spleen had congested red pulp with widespread thick fibrous bands [Fig-3]. There were presence of yellowish-brown pigments and flecks within the parenchyma. These classical Gamna-Gandy bodies were noted along with giant cell reaction at places [Fig-4]. The blood vessels were congested with sickled red cells [Fig- 5] and dilated with proliferation of tunica media at places. The blood sample was sent for HPLC and it showed HbS & HbA2 bands. After careful autopsy and histopathological observation, the cause of death was reported as vaso-occlusive crisis leading to

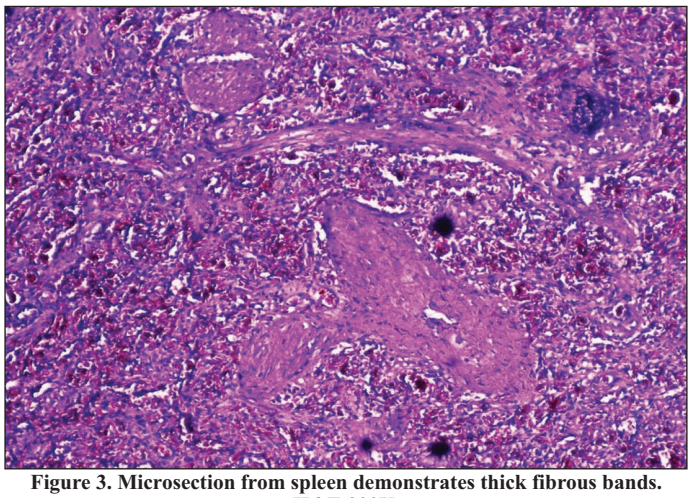

Figure 3. Microsection from spleen demonstrates thick fibrous bands. H&E 200X.

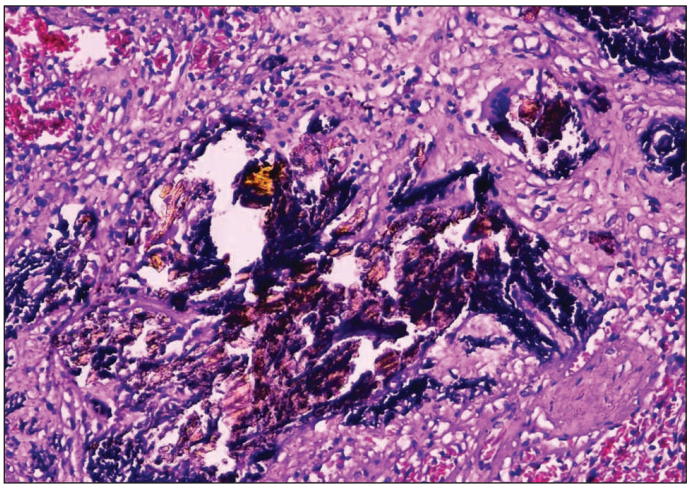

Figure 4. Microsection from spleen demonstrates Gamna-Gandy bodies as yellowish-brown flakes and pigments. H&E 400X

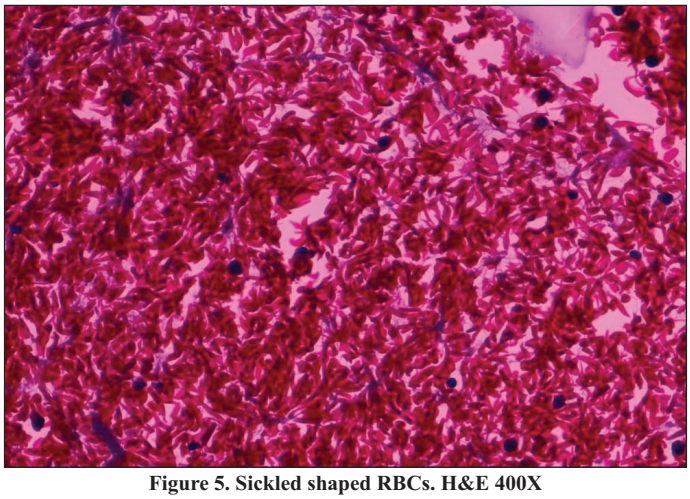

Figure 5. Sickled shaped RBCs. H&E 400X

multiorgan failure in an undiagnosed sickle cell disease.

Case 2:

26 year female of North Odisha was brought to casualty with sudden loss of consciousness. On examination, pulse was feeble, blood pressure was 100/60 mmHg and respiration was 32/minute.

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Past history revealed similar type of attacks. On systemic examination, cardiovascular functions were normal. Blood tests revealed mild anaemia, elevated liver enzymes and creatinine kinase. ECG had tall T wave with normal ST segment. HPLC was performed on the basis of doubt as her brother was a known case of sickle cell anemia. The report came out to be sickle cell trait. Unfortunately we lost the patient. Autopsy examination revealed cardiomegaly. Right ventricle was dilated. Aorta had small fatty streaks. Spleen showed mild atrophy. There was a thrombus detected in right renal vein. Lungs were heavy weighing 255 grams and external surface showed patchy hemorrhages. Cut surface of other viscera like liver & uterus were unremarkable. On microscopic examination of heart, cardiac myocytes had box shaped nuclei. There was derangement in myocardial fibers. The intervening blood vessels were filled with sickle shaped red cells. Kidney had congestion with acute tubular necrosis. Sections from lung revealed alveolar hemorrhage, hyaline membrane & pulmonary edema along with acute inflammatory cell infiltration [Fig- 6]. The cause of death was due to vaso-occlusive crisis leading to multi organ failure.

Case 3:

An elderly male of 53 years of age, a known case of sickle cell trait presented to emergency department with left side hemiplegia and respiratory distress. Hb was 6.8g% and total leucocyte count was 24,500 with neutrophilia. CT scan of brain revealed ischaemic lesion of lacunar type in the internal capsule. Peripheral smear showed schistocytes and reticulocytosis. After 3 days of hospitalization, patient developed generalized anasarca. Due to massive pulmonary infection, the patient succumbed. Autopsy findings showed there was cardiomegaly with dilated right chamber and a thrombus detected in left anterior descending artery. Right lung showed a consolidated focus in lower lobe and left lung was congested. The final diagnosis was death due to ischemia leading to CVA and multiorgan failure.

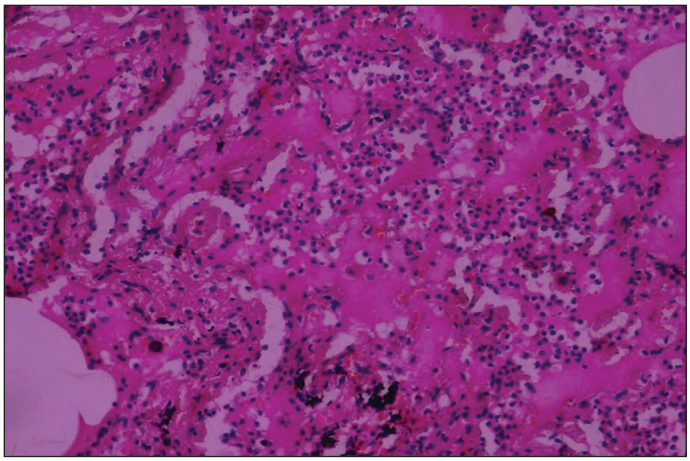


Figure 6. Lung alveoli show proteinaceous exudate with interstitial edema and acute inflammatory cell infiltration. H&E 200X

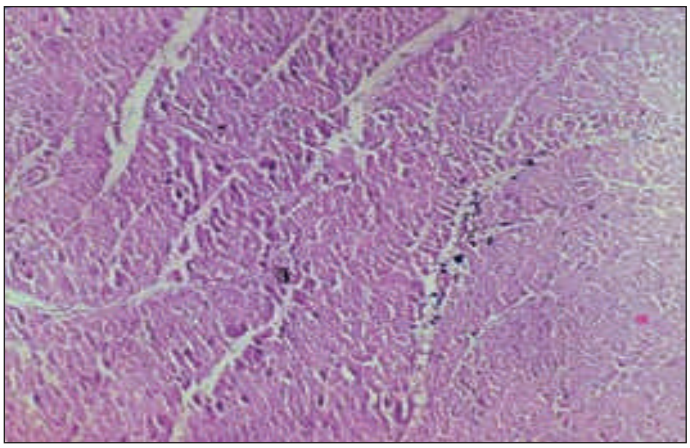


Figure 7. Waviness of myocardial fibers & contraction band necrosis.

Case 4:

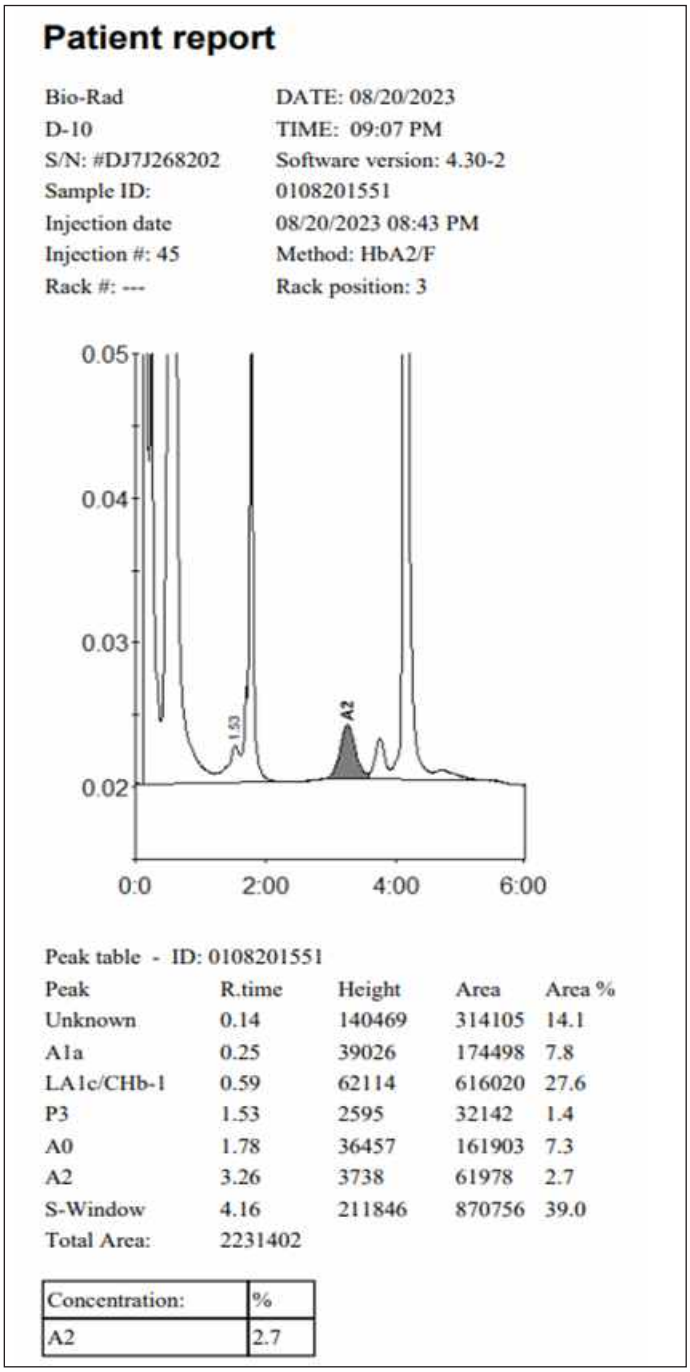
A young 25 year female was brought dead with sudden collapse while working in the rice field. There was no similar past history. Autopsy was performed. There was cardiomegaly with a whitish patch near the apex region. Aorta was normal. A white fibrotic patch was present in myocardium of left ventricle. Left anterior descending artery cross section showed a clot. Microscopic examination showed congestion and acute inflammation of lungs. Cardiac blood vessels were blocked with sickle shaped red cells. There was waviness of myocardial fibers, contraction band necrosis and neutrophilic infiltration [Fig- 7]. The lumen of left anterior descending artery was completely obstructed. HPLC confirmed sickle cell disease [Fig- 8]. The death was due to acute myocardial infarction as a consequence of sickle cell crisis.

Discussion:

Sickle cell disease in a homozygous state usually presents with complications at an early age. In review of literature, it was observed that many case reports were on sickle cell disease patients with sudden death due to heavy exercise, bacterial infection, viral illness, dehydration and high altitude.[8] Infections by encapsulated bacteria like Streptococcus pneumoniae may cause collapse and sudden death. SCD patients are easy prey for

Table 1.

Case	Age	Sex	Clinical details	Organs involved	Hemo-globin	Cause of death	Other findings (Autopsy & Microscopic)
1	19	F	14 weeks pregnancy	Uterus, liver, lung, spleen, kidney	HbS, HbA2, HbF	Acute Respiratory Distress Syndrome (ARDS), Renal failure	Gamna-gandy body in spleen
2	26	F	Had delivered a full term baby and was in Lactation period	Heart, spleen, uterus	HbS, HbA2, HbF	Cardiomyopathy, ARDS with diffuse alveolar damage	Aorta with fatty streak Spleen showed Gamna-gandy body
3	53	M	CVA causing left hemiplegia	Lung, liver, spleen. Kidney	HbA, HbS, HbA2	Multi organ failure	Generalized anasarca
4	25	F	Sudden cardiac death	Lung, heart	HbS, HbA2, HbF	Acute Myocardial Infarction	Lungs showed interstitial thickening of septa and inflammation



Patient report

Bio-Rad DATE: 08/20/2023
D-10 TIME: 09:07 PM
S/N: #DJ7J268202 Software version: 4.30-2
Sample ID: 0108201551
Injection date 08/20/2023 08:43 PM
Injection #: 45 Method: HbA2/F
Rack #: --- Rack position: 3

Peak table - ID: 0108201551

Peak	R.time	Height	Area	Area %
Unknown	0.14	140469	314105	14.1
A1a	0.25	39026	174498	7.8
LA1c/CHb-1	0.59	62114	616020	27.6
P3	1.53	2595	32142	1.4
A0	1.78	36457	161903	7.3
A2	3.26	3738	61978	2.7
S-Window	4.16	211846	870756	39.0
Total Area:	2231402			

Concentration:	%
A2	2.7

Figure 8. HPLC report demonstrates presence of HbA2, HbF and HbS.

infection due to splenic infarction since childhood. Some authors also cited that lazy leucocyte syndrome is one of the important contributors causing infection.[9] Case No 1 & case no 2 of present study had lost their life due to severe respiratory infection and development of ARDS.

Pregnancy in SCD has many medical complications both for the mother and fetus. Physiological changes in pregnancy like increase in metabolic demands, blood viscosity and the hypercoagulable states are aggravated in SCD.[10] Due to recurrent vaso-occlusion, placental tissue may be infarcted leading to decreased utero-placental circulation and chronic fetal hypoxia. Spontaneous abortion is not uncommon.[11] Special medical care may decrease maternal mortality as well fetal loss.[12]

Preeclampsia and eclampsia like complications are usually seen in mid and late trimester. Pregnancy in SCD present with these complications with higher percentage of incidence than general population.[13] In our study, one deceased had recent delivery and other one is in her 4th gestational month. Both the cases were not diagnosed cases of hemoglobinopathy.

Due to obstetric complications, there was spontaneous abortion followed by infection. Poor general health condition and lack of medical awareness were additive risk factors. Due to septicemia, there was development of acute respiratory distress syndrome (ARDS) and the deceased had history of dyspnea and cough. ARDS can also result due to pulmonary embolism and warrant LMWH. A study by Deepti et al,[8] reported that heavy physical exertion resulted in sudden collapse and death in a sickle cell trait case. In our case, presence of fatty streaks on aorta predisposed more pathological favorable platform for the sickle cell crisis.

Histopathological examination revealed irreversible sickle shaped red cells completely obstructing the glomerular capillaries and interstitial blood vessels of kidney leading to decreased glomerular filtration rate (GFR) and proximal tubular necrosis and subsequently acute renal failure. As HbS polymers are repeatedly formed, the red cell membrane gets damaged resulting in release of procoagulants. Ultimately derangement of liver enzyme occurs and renal failure ensues. Classical Gamna-Gandy bodies in spleen along with thick fibrotic strands were due to autoinfarction. We got these classical bodies in two cases. Though Gamna-Gandy bodies are not confined to sickle cell disease only, their presence signifies repeated hemorrhage and deposition of iron pigments and calcium salts.[14] These bodies are usually seen around central arteriole of the white pulp.

Infarctive crisis is more common than hemolytic, aplastic and sequestration crisis. Autosplenectomy results by the age of adolescence. Autopsy finding in our case was reduced but not fibrotic and small spleen which could be due to other associated hemoglobinopathies like HbSD, HbS- β thal, HbSC, where splenomegaly results due to extramedullary hematopoiesis.[15] Cerebral vasculature blocked by sickled red cells, results in cerebro-vascular accidents. Many authors reported that ischemic strokes were more common than hemorrhagic one.[16,17]

Sickle cell homozygous cases are more prone for stroke than trait cases.[18] Tumaj et al reported a 21 year old SCD patient presenting with frontal lobe infarction.[19] In our case, the 53 year sickle cell trait case succumbed to death due to multiorgan involvement and failure. John et al study highlighted diffuse ischemic stroke in a HBSC patient precipitated due to infection by Babesia and disseminated Anaplasmosis.[20]

Kark et al study review highlighted the sudden unexplained death risk was 30 times more common associated with sickle cell trait than normal individuals.[21] SCD patients may present with coronary syndrome at an earlier age as in our 4th case. Sickled RBCs had blocked the left anterior descending artery along with histological changes of infarction in cardiac myocytes.

Conclusion:

Many literatures had demonstrated on sickle cell disease causing vaso-occlusion as a complication even leading to death in some cases. Pregnancy in SCD patients' needs extra medical support and care, both during pregnancy and delivery. About patients from known hemoglobinpathy belt zones like Northern-Odisha need awareness, knowledge and high index of suspicion of clinicians which can prevent a crisis to develop and progress.

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SYSTEMATIC REVIEW

Toxicological Analysis and Interpretation in Cases of Suspected Drug-induced Organ Toxicity: Systematic Review

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Abstract:

When pharmacological drugs have negative effects on a particular organ or organ system, it is referred to as drug-induced organ toxicity. It is crucial to correctly recognize and comprehend these toxicities to guarantee proper medical action and the mitigation of additional injury. Through the identification of putative toxicological pathways, quantification of drug metabolites, and assessment of the connection between drug exposure and organ damage, toxicological analysis plays a crucial part in this process. This study aims to identify the critical elements of toxicological analysis of drug-induced organ toxicity, focusing on the importance of interdisciplinary collaboration for reliable findings interpretation. A digital database was employed to conduct a literature and database search for this investigation. 8,530 results from Bullion Words were returned, and 7,360 sample articles were chosen. The sample was reduced for inspection by further analysis to 1,170. 960 samples were disqualified due to download problems. After 210 articles were eliminated due to quality issues, 180 articles underwent full-text examination, and 33 papers (n=33) were ultimately chosen. Numerous methods, such as immunoassays, chromatography, mass spectrometry, and molecular biology tests, are used in toxicological investigation when there is a suspicion that a medication has caused organ toxicity. The target organ, the drug of interest, and the level of analytical sensitivity needed all play a role in choosing the best analytical technique. Considerations for interpreting toxicological data include drug concentrations, the presence of metabolites, pharmacokinetic characteristics, and the timing of the beginning of organ damage. In situations of suspected drug-induced organ toxicity, accurate toxicological analysis and interpretation are essential for effective diagnosis, therapy, and medico legal investigations. A more accurate diagnosis of drug-related organ damage is made possible by combining cutting-edge analytical methods, including mass spectrometry, with thorough clinical and pathological examinations. We will be able to comprehend and function more effectively in this crucial field of toxicology as a result of ongoing study, technological developments, and cooperative efforts among specialists from many disciplines.

Keywords: Analytical techniques; Biological samples; Organ toxicity; Reliability; Suspected cases; Toxicological tests; etc.

Introduction:

When toxicological investigation and interpretation are essential for an accurate diagnosis and subsequent therapy, drug-induced organ toxicity offers a substantial problem for medical personnel and forensic scientists.[1] In these situations, it is crucial to have a thorough grasp of the processes and techniques used in toxicological studies.[2] Accurate diagnosis and interpretation of drug-induced organ toxicity may be achieved, allowing for efficient medical action and the avoidance of future injury.[3] This can be done by using the right methodologies and taking interdisciplinary collaboration into account.[4] The main factors involved in toxicological analysis and interpretation in situations of suspected drug-induced organ toxicity are summarized in this section.[5]

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Organ Toxicity Caused by Drugs Is Complex: Drug-induced organ toxicity is the term used to describe the harmful effects that pharmacological substances have on certain organs or organ systems.[6] It is a complex condition with several potential causes, including immune-mediated responses, direct cellular injury, and metabolic abnormalities.[7] Accurate diagnosis, suitable medical management, and the avoidance of future harm to patients depend on the recognition and comprehension of drug-induced organ toxicity.[8]

Significance of toxicological analysis and interpretation: A critical component of evaluating suspected instances of drug-induced organ harm is toxicological analysis.[9] It entails the identification and measurement of hazardous intermediates of drug metabolites in biological samples, which can help establish a link between drug exposure and organ damage.[10,11] Additionally, toxicological analysis aids in identifying probable toxicological pathways, evaluating the seriousness and scope of organ damage, and selecting the best therapeutic approaches.[12]

Selection of Biological Samples: The selection of acceptable biological specimens for toxicological investigation is essential

in situations of suspected drug-induced organ toxicity.[13] The target organ impacted, the drug's pharmacokinetics, and the level of analytical sensitivity required all play a role in the selection of the specimen.[14] Blood, urine, and tissues taken from the diseased organ during an autopsy or biopsy are examples of frequently utilized specimens.[15,16] Each type of specimen has unique benefits and drawbacks, and a thorough examination frequently entails comparing many specimens to improve diagnostic precision.[17]

Sample Preparation Techniques: To extract and isolate pharmacological components or metabolites from biological matrices for further investigation, sample preparation must be done effectively.[18] To get rid of interfering elements and concentrate the target analytes, several procedures are used, including solid-phase extraction, liquid-liquid extraction, and protein precipitation.[19] The selection of suitable sample preparation techniques that guarantee optimum recovery and reduce possible matrix effects, which may affect the precision and dependability of the following analysis, should be carefully considered.[20]

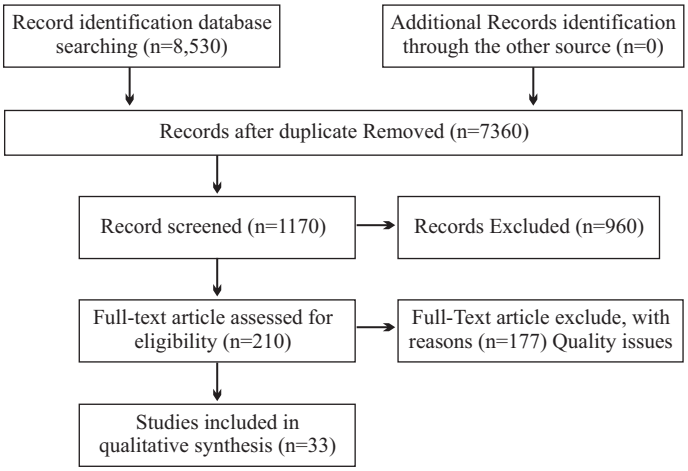
Analytical Techniques: If organ toxicity caused by drugs is suspected, a broad variety of analytical methods are available for toxicological examination.[21] Enzyme-linked immunosorbent assays (ELISAs), for example, are an example of an immunoassay that may be used for quick screening but may fall short in terms of specificity and sensitivity.[22] Drug components and metabolites may be identified and quantified with great selectivity and sensitivity using chromatographic methods including gas chromatography (GC) and liquid chromatography (LC), in combination with a variety of detectors.[23] In terms of sensitivity, specificity, and structural characterization, mass spectrometry (MS) methods like gas chromatography-mass spectrometry (GC-MS) and liquid chromatography-tandem mass spectrometry (LC-MS/MS) are unmatched.[24] It is possible to explore genetic variables influencing drug metabolism and toxicity by using molecular biology tests like gene expression analysis and polymerase chain reaction (PCR).[25]

Significance of Interdisciplinary Collaboration: Collaboration across disciplines among toxicologists, pathologists, physicians, and forensic specialists is crucial to improving the precision and dependability of toxicological results in situations involving suspected drug-induced organ toxicity.[26] A complete review that incorporates the clinical, toxicological, and pathological aspects is possible because of the integration of knowledge from several domains.[27] Collaboration makes it easier to understand toxicological data thoroughly and guarantees that the results are reliable.[28]

Methodology:

A digital database was used in this study's literature review to search through a variety of publications and databases. The objective was to locate pertinent studies, and Bullion Words returned a total of 8,530 hits. 7,360 articles were chosen after careful consideration to serve as a representative sample. The selection of 1,170 samples for examination was the result of further analysis. However, 960 study samples were disregarded as a result of download issues. After 210 articles were eliminated due to quality problems, 178 articles underwent a full-text analysis, leading to the final selection of 33 papers (n=33).

Prisma Flow chart:



Result:

When there is a suspicion that a medicine has caused organ toxicity, toxicological analysis, and interpretation are performed. This process comprises choosing the best biological samples, using sample preparation procedures, and applying a variety of analytical approaches. Drug concentrations, metabolites, pharmacokinetics, and their relationship to organ toxicity are all taken into account when interpreting toxicological data. Collaboration across disciplines among professionals improves the quality and dependability of findings, enabling accurate diagnosis, management, and medico-legal investigations.

Discussions:

Toxicological analysis that is accurate is essential for determining the reason why drugs cause organ toxicity. Drug metabolites are identified and organ damage is evaluated using a variety of techniques, including GC-MS and LC-MS. High sensitivity, selectivity, and the capacity to recognize a variety of medicines and their metabolites are all features of these approaches. Immunoassays and ELISAs offer quick screening but lack specificity, necessitating further testing using more accurate methods like GC-MS or LC-MS.[29] In toxicological research, biomarkers are frequently examined to evaluate drug-induced organ damage. Biomarkers accurately describe organ damage and may distinguish between various toxicological routes. For instance, bilirubin, AST, and ALT, which are liver-specific biomarkers, are used to assess hepatotoxicity, whereas BUN denotes renal illness. Clinicians can assess the presence of biomarkers in biological samples to gauge the degree of organ damage brought on by drugs and choose the best course of treatment for their patients.[30] The results of drug-induced organ damage might be difficult to interpret for a variety of reasons. It might be challenging to distinguish between medication toxicity and underlying organ failure brought on by illnesses. Concurrent drug usage and pre-existing diseases might make interpretation more difficult. Although causality assessment tools like RUCAM are helpful, drug metabolism and interactions make it difficult to

establish a strong causal relationship.[31] In toxicological investigation, genomic approaches are essential for evaluating drug-induced organ damage. Individual vulnerability to toxicity is influenced by genetic differences in drug-metabolizing enzymes and transporters. Organ toxicity has genetic connections, according to GWAS. Understanding of drug metabolism and adverse drug reactions is improved when toxicological studies and genetic data are combined.[32,33]

Conclusion:

Finally, in situations where drug-induced organ toxicity is suspected, toxicological evaluation and interpretation are critical. Accurate identification and quantification of drug components and metabolites may be achieved by choosing suitable biological samples, using efficient sample preparation processes, and applying a variety of analytical approaches. It is easier to evaluate drug-related organ damage when toxicological results are interpreted in conjunction with clinical and pathological findings. Collaboration across disciplines among specialists promotes thorough assessments and enhances the accuracy and dependability of toxicological results, permitting accurate diagnosis, management, and medico-legal investigations. We shall be able to do toxicological analysis and interpretation to a greater extent with further study and improvements in this area.

Future prospective: Future developments in analytical methods, the incorporation of omics technologies, improved biomarker identification, and improved cross-disciplinary collaboration for more precise and individualized assessments are all possible future perspectives in a toxicological analysis and interpretation of suspected drug-induced organ toxicity

Conflict of Interest: There is no conflict of interest

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Ethical Clearance: Not Applicable

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REVIEW ARTICLE

Law of Rape: Sec 63 of Bharatiya Nayay Sanhita: Does it require amendment? Yes.

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Abstract :

A single Judge bench of M. P. High Court has recently passed a judgment which is going to have long lasting repercussions in society and would particularly affect married women and would be married women. At the same time the Parliament has passed B.N.S. (Bharatiya Nayay Sanhita). The sec 63 and related sections about rape have given expansive definition of sexual intercourse. The referred judgment talks about this expansive definition of sexual intercourse and pronounces that now no sexual intercourse is unnatural. A liberty is given to husband in the form of Exception-2 to indulge in so many sexual acts which were unnatural and unlawful till date. In my view this has happened without the knowledge and free and fair consent of concerned women folk. Paper discusses these issues and gives an amicable short solution to resolve the problem.

Keywords: Consent in marriage by woman; Expansive meaning of sexual intercourse; Stakeholders, Long lasting repercussions.

Text :

Have you ever bothered what is the sexual intercourse in the marriage for which the consent is given for ? So far, I also did not bother but like you presumed and assumed that it is for normal and natural (peno-vaginal) intercourse. I also presumed that women who entered into the wedlock and are entering also thought the same way (Presumption is mine).

But now I have to rethink. The reason behind this rethinking is this judgment.[1] The single Judge bench of the M. P. High Court delivered a landmark judgment which would have revolutionary effects about the sexual intercourse within marriage, if not looked into and amended.

We now see further.

From 1860, our IPC (Indian Penal Code) came into effect from this date, till 2013 things were normal and natural for me as a normal person(woman included) and as a married man. Definition of rape was simple and revolved around normal and natural peno vaginal sexual intercourse.[2] Since the passing of CLAA, 2013 (Criminal Law (Amendment) Act, 2013), which changed radically the definition of rape,[3] and after this judgment[1] and passing of B.N.S.(Bharatiya Nyay Sanhita)[4] things have changed drastically. I dare say they have become worst for man, society and particularly for the women folk of the country.

Now we see the judgement in reference in short. The case was that wife lodged an FIR (First Information Report) alleging that husband indulges in anal intercourse without her consent under IPC377 and 376 (2) (n). The husband filed the petition before the High Court to quash the said FIR. When this case was lodged and decided by the High Court the IPC 377 and 376 (2) (n) very much existed in the law book of the country.

Both parties put forth arguments in favour of their point of views.

The judgment allowed the petition and ordered to quash the FIR.

The single Judge bench of the M.P. High Court put forth the following arguments in quashing the FIR and supporting the judgment (Not in verbatim)-

1. Apparently, there is repugnancy in these two situations in the light of definition of Section 375 and unnatural offence of Section 377. It is a settled principle of law that if the provisions of latter enactment are so inconsistent or repugnant to the provisions of an earlier one that the two cannot stand together the earlier is abrogated by the latter.
2. The Criminal Law (Amendment) Act 2013 imported certain understandings of the concept of sexual intercourse into its expansive definition of rape in Section 375 of the Indian Penal Code, which now goes beyond penile– vaginal penetrative. It has been argued that if 'sexual intercourse' now includes many acts which were covered under Section 377, those acts are clearly not 'against the order of nature' anymore.
3. This means that much of Section 377 has not only been rendered redundant but that the very word 'unnatural' cannot have the meaning that was attributed to it before the 2013 amendment. Section 375 defines the expression rape in an expansive sense, to include any one of several acts committed by a man in relation to a woman.
4. At this point, if the amended definition of Section 375 is seen, it is clear that two things are common in the offence of Section 375 and Section 377 firstly the relationship between whom offence is committed i.e. husband and wife and secondly consent between the offender and victim. As per the amended definition, if offender and victim are husband and wife then consent is immaterial and no offence under Section 375 is made out and as such there is no punishment under Section 376 of IPC.
5. In Navtej Sing Johar case the hon Supreme Court has

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decriminalise the anal intercourse between consenting adults.

6. Therefore, here in a present case there are two points- one new law of rape after CLAA,2013 makes IPC 377 redundant because the anal orifice is included in the definition of rape and there is repugnancy in the situation when everything is repealed under Section 375
7. In my opinion, the relationship between the husband and wife cannot be confined to their sexual relationship only for the purpose of procreation, but if anything is done between them apart from the deemed natural sexual intercourse should not be defined as 'unnatural'. Normally, sexual relationship between the husband and wife is the key to a happy connubial life and that cannot be restricted to the extent of sheer procreation. If anything raises their longing towards each other giving them pleasure and ascends their pleasure then it is nothing uncustomary and it can also not be considered to be unnatural that too when Section 375 IPC includes all possible parts of penetration of penis by a husband to his wife.

This author while commenting on the definition of rape under CLAA, 2013 voiced that the law is made in hurry and it would have many confusions and repercussions that now becoming true.[5]

Post Nirbhaya due to public outrage and hue and cry a committee was formed to look into the law of rape. The committee was headed by Justice J. S. Verma. It did have a woman member in Justice Leila Thomas. It is learnt that the committee received more than eighty thousand suggestions; many of them from woman activist groups. I feel that committee and various suggestions forwarded to committee were more focussed on the criminality and enhancement of punishment part in the offence of rape and some important points were missed.

I now discuss the larger repercussions beyond this individual case, parties there off and judgement which has come in front of us.

According to this judgement purpose of marriage is more than procreation on one hand and anything done between married couple apart from the deemed natural sexual intercourse should not be defined as unnatural. Further the judgment says that in the wider definition of rape under sec 375 which includes all parts of penetration of penis by husband to his wife. Prima facie now nothing remains unnatural. Before going into the discussion further I replicate the sec 63 of B.N.S.- 63. A man is said to commit "rape" if he—

(a) Penetrates his penis, to any extent, into the vagina, mouth, urethra or anus of a woman or makes her to do so with him or any other person; or

(b) Inserts, to any extent, any object or a part of the body, not being the penis, into the vagina, the urethra or anus of a woman or makes her to do so with him or any other person; or

© manipulates any part of the body of a woman so as to cause penetration into the vagina, urethra, anus or any part of body of such woman or makes her to do so with him or any other person; or

(d) applies his mouth to the vagina, anus, urethra of a woman or makes her to do so with him or any other person, under the circumstances falling under any of the following seven descriptions:—

(i) against her will;

(ii) without her consent;

(iii) with her consent, when her consent has been obtained by putting her or any person in whom she is interested, in fear of death or of hurt;

(iv) with her consent, when the man knows that he is not her husband and that her consent is given because she believes that he is another man to whom she is or believes herself to be lawfully married;

(v) with her consent when, at the time of giving such consent, by reason of unsoundness of mind or intoxication or the administration by him personally or through another of any stupefying or unwholesome substance, she is unable to understand the nature and consequences of that to which she gives consent;

(vi) with or without her consent, when she is under eighteen years of age;

(vii) when she is unable to communicate consent.

Explanation 1. For the purposes of this section, "vagina" shall also include labia majora.

Explanation 2. Consent means an unequivocal voluntary agreement when the woman by words, gestures or any form of verbal or non-verbal communication, communicates willingness to participate in the specific sexual act:

Provided that a woman who does not physically resist to the act of penetration shall not by the reason only of that fact, be regarded as consenting to the sexual activity.

Exception 1. A medical procedure or intervention shall not constitute rape.

Exception 2. Sexual intercourse or sexual acts by a man with his own wife, the wife not being under eighteen years of age, is not rape.

For me this is the definition of rape. Does it means that it impliedly give blanket consent of wife to husband in marriage and makes all provisions of this definition legal under Exception-2? Ironically, yes.

You see till so far we were discussing sexual intercourse in addition to that in the Exception -2 there is a word "sexual acts".

Here the section 63 however does not define "sexual intercourse", neither it defines so called "sexual acts".

The Hindu Marriage Act, 1955 does refer consummation of marriage, cohabitation, conjugal rights and sexual intercourse.

But these terms are not defined under the law.

However, indirectly sec 67 and 68 of B.N.S. do say that (I quote)- "sexual intercourse" shall mean any of the acts mentioned in clauses (a) to (d) of section 63.

These (a) to (d) I have replicated above.

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The referred judgement has discussed part (a) of this definition that too partly; I will come to another part of it a little later, which deals with penetration of penis into various orifices of woman, probably because that was the only thing before the Court.

Does it mean that remainder part of definition of rape (b), (c) and (d) also fall under the Exception -2 if done by husband?

The whole hue and cry which became the genesis in changing definition of rape was the infamous Nirbhaya case where it was not only peno vaginal penetration but also insertion of object, sec (b) of sec 63 into the orifices of woman causing injuries to her.

Can husband insert 'any object' in the any of the orifices of his wife? Is law giving this right to husband? Has wife given consent for this while she is entering into the wedlock? Does she know about it? Are women folk of this country consulted before passing such law? Did they agree?

For me this is unfair to wife and should also be unlawful.

There is more than meet the eye if we again read the provision (a),(b),(d) and (d) of sec 63 of B.N.S. These sections not only talk of man alone but "any other person". Does it mean that here in present context husband can compel other person to do any of the acts prescribed in the above sections and be part of 'Exception -2'

For me these are also unfair to wife and also be unlawful.

Recently I came across the Supreme Court verdict which denied surrogacy to have a child to a single woman to save the sanctity of institution of marriage.[6] Similarly, the Delhi high Court denied anticipatory bail to husband who was an accused of sexual violence.[7] So on one hand we have such judgments and on the other hand we have judgment which we just discussed as well as the law of rape which is open to any type of violence against wife (woman) on the name of blanket consent by virtue of marriage.

Whatever is happening between consenting adults, husband and wife, man and woman, man and man and woman and woman does not matter to me. It does not affect society. But not defining natural and normal sexual intercourse in marriage and interpreting things happening in marriage via definition of rape and giving blanket right to husband is very very dangerous. I am sure most of the man and all women would agree.

I propose that law should directly define sexual intercourse. There should be wide and open debate between stake holder man and woman about this aspect. This becomes more pertinent when the new B.N.S. does not have any equivalent of old IPC 377.

Till then, suggest that Exception- 2 in the definition of rape can be suitably amended – Only peno-vaginal intercourse is the exception done by husband.

Conclusion:

The referred judgment has opened up a new vista in the relationship of husband and wife in marriage. The new law of rape included in the B.N.S. as sec 63 requires amendment. This is more pertinent because the B.N.S. does not have an equivalent of old IPC 377. Before law is further amended a fair debate on the issues raised in the paper is to be held amongst the stake holders, particularly woman folk.

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SHORT COMMUNICATION

Future of virtual autopsy in India

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Abstract:

Presently in India virtual autopsy service is not provided by any center. All India institute io Medical Science, New Delhi is trying to establish virtual autopsy center, they have got the infrastructure established for research purposes. In India many autopsy centres are trying to learn and explore the training related to virtual autopsy, first basic training done national forensic science university at Gandhinagar, Gujarat. Large money, training, and legal hurdles are the main barriers. Initial stage institute of national importance has funding ability to start, then slowly it will on the public demand, it would be started most of the center. As per legalities, the legal system easily adapts the scientific use of technology in the court of justice. X ray examination report taking consideration in various court judgement, indication of the virtual autopsy report is considerable in the court. India has presently two autopsy centers have their own CT scan machine they are utilizing learn for the virtopsy, 1st in AIIMS Delhi and second in St John's hospital Bengaluru, in future it's going to established in many autopsies center of India. The possibility of First will be central institute then peripheral institute. In 4 to 5 years, virtual autopsies will be implemented in numerous autopsy centers.

Keywords: Radiology; Imaging; Virtual; Autopsy; Dead bodies; Techniques; Pathologist.

Introduction:

The virtual autopsy concept was invented by Richard Dirnhofer, former Director of Forensic Medicine, Berne, which was then continued by Michel Thali and his colleagues at the University of Berne's Institute of Forensic Medicine, situated in Switzerland.[1] Virtual autopsy or Virtopsy word is derived from the Latin word virtus, which means, "useful, efficient, and good.[2] In conventional autopsy we can observed by necked eye, can touch the organs, can see the colour change, feal the hardness of the any abnormalities observed. In virtual autopsy we cannot observed colour, hardness, smell of the organs. Virtopsy was to detect forensic findings in dead bodies using radiological techniques such as CT and MRI, as surface documentation by 3D photogrammetry which was based on optical surface scanning. Findings observed by this machine by help of 3D surface reconstruction, Minimum intensity projection, maximum intensity projections, volume rendering techniques etc.

Feasibility: Presently everyone acquainted with the machines and technology in hospitals. life is going very easy by use of machines and technology. Examination of body by MDCT multidetector tomography, much less time taking technique, it hardly takes 5-10 min to scanning of the whole body. Mutilated, decomposed body, polytrauma cases even minute injury of unapproachable area of body part, finding we can observe very easily in machine. In virtual autopsy we get forensic records and its keep for longer time. The results provided are highly sensitive, specific, and accurate.[3] Problems of the post-mortem examination are commonly mistakes or missed minor injuries in conventional autopsy, that are sufficiently well known.[4] Various religious, cultural, and other Objections to invasive techniques.[5]

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Problems and solutions:

India is a developing country establishment of autopsy centre is Costly business. To start a virtual autopsy centre required approx. ten crores Indian currency, initially very few centres will be able to be establish. In future usability and public Demand push the multiple centre establishment. To start a virtual autopsy centre training also a hurdle, 1st to produce resource persons then they can facilitate training at multiple centres. Presently Basic training started at some centres in India. We have started walking towards the virtual autopsy in India.

In Indian, related to this speciality providing degree course of MD forensic medicine which must be oriented to forensic radiology. In future it will grow as MD forensic radiology. Other core of forensic medicine is forensic pathology which also grow in different direction in future. For the large population, required large number of autopsy centre also hurdle of application of virtual autopsy in pan India. Initial virtual autopsy may start at few reputed centres, then it will be expanding the wide range. Acceptability of virtual autopsy report in court, as scientific report like x Ray and other report accepted by the court.

Discussion:

In Indian scenario one study suggested that only 15.4% doctors of autopsy surgeon know the complete procedure of Virtual Autopsy. Major problem to start virtual autopsy is financial support. To start a virtual autopsy centre required large money , India is a developing country where CT Scan MRI not easily

available for live patients then how easy for deceased.[6] The international humanitarian law states that human rights are also applicable for the dead as live person.[7] Conventional autopsy mutilate the deceased, which is considered as taboo in many cultures.[8] The virtual view can also be used in the field of histopathology which can help in a non-invasive, non-destructive, and 3D examination of naturally.[9] Virtual autopsy in the alternative of conventional autopsy? To know the answer of this question, A research team from the Institute of Forensic Medicine, University of Berne, Switzerland done a project on virtopsy as an alternative to the conventional autopsy in the year 2006 and they found that it's not absolutely but yes.[10] Use of virtual autopsy technology some flaws not possible to physiological senses of anatomical pathologist like touch, feel, texture and smell senses.[11] It is very easy to identifies the identity, detects foreign bodies and easy demonstration of observations of virtual autopsy in the court of law.[12] At present, there are many institutions in the world they have recognized the feasibility and developed facilities and techniques for the post-mortem investigation and that have invested efforts in its establishment and implementation. For example, the Office of the Armed Forces Medical Examiner (Washington, DC; Dover, Del), the Institute of Forensic Medicine (Copenhagen, Denmark), and the Victorian Institute of Pathology (Sydney, Australia) have already installed their own CT scanners. In future, the use of CT technology will become more widespread at distinguished institutions of forensics and pathology. Many cases virtual finding in form of X ray report taken in consideration in various court judgement in India.[13,14] Without X ray claiming fracture and compensation court refused.[15]

Conclusion:

In India many autopsies center trying to learn and exploring the training, first basic training done national forensic science university at Gandhinagar, Gujarat. Cost issues, training, and legal hurdles are the main barriers. Initial stage institute national importance has funding ability to start then slowly it will on public demand will start most of the center. As per legalities, the legal system easily adapts the scientific use of technology in court of justice. In India also presently two autopsy centers have their own CT scan machine they are utilizing for the virtopsy, in future it's going to established in many autopsies center of India. The possibility of First will be central institute then peripheral institute. In four to five years, virtual autopsies will be implemented in many autopsy centers.

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LETTER TO EDITOR

Modernizing Blood Donation Policies: Challenging the Lifetime Ban on MSM and Transgender Individuals

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Dear Editors,

This article will shed light on a medico-legal issue where MSM (male sex with male) are life-time debarred from blood donation on the basis of suspicion that they can have HIV infection and can transmit the same to others through blood transfusion. In the 1980s, acquired immunodeficiency syndrome, popularly known as AIDS, left the world in fear and stigma. Until 1980, the number of cases and causes of HIV were greatly unknown.[1] During the 1980s, HIV reached around 5 continents (Australia, South America, North America, Europe, and Africa), covering around 1 million people affected by it. The early detection of HIV was linked to males who have sex with males (MSM). In 1982, many gay men in southern California were diagnosed with HIV, and because of this, HIV at that time was called gay-related immune deficiency.[2] In 1982, CDC used the term "AIDS".[2]

According to the WHO, around 39 million people around the globe will be living with HIV by 2022.[3] National Blood Transfusion Guidelines 2017 under Point 51 prohibits the donation of blood by people who have male-to-male sex and are transgender.[4] The same kind of prohibition on blood donation can also be seen in the USA.

A team of scientists determined that if a one-year deferral[5] is done instead of a lifetime ban on blood donation by MSM, this will save many lives. Here, it is important to know and understand the reasoning behind keeping a one-year deferral period for blood donation by MSM. For this one must know about the window period. The window period is the time between HIV infection and when a test can accurately detect it.[6] Different tests have varying window periods. Among all available tests to detect HIV, only the nucleic acid test (NAT) can detect HIV the soonest (typically within 10 to 33 days after exposure).[7] Earlier the medical test was not that advanced and owing to this reason only medical experts asked to keep ban on blood donation by MSM. But now with this new test HIV can be detected within 10-33 days of the exposure.

In this study, the researchers aim to argue that the blood donation ban on men who have sex with men (MSM) and transgender individuals is discriminatory, lacking a rational connection to modern circumstances, and infringing upon basic human rights and constitutional guarantees. They contend that the blood ban policy is arbitrary, and its continued enforcement would violate the rights of MSM and the transgender community. The article sheds light on this outdated ban and explores potential avenues for challenging it. The paper intends to demonstrate how the blood ban is a relic of the past, considering the advancements in blood testing capabilities worldwide and the numerous countries that have already amended or lifted similar bans, surpassing the USA and India.

In India, we had The HIV and AIDS (Prevention & Control) Act, 2017[8] to protect HIV patients so that no one can discriminate against their rights. However, discriminating only based on assumption is also biased on the part of MSM as medical technology has a different saying in terms of HIV testing because the fourth-generation test for HIV is much more advanced in comparison to previous tests. Thus, researchers here would like to conclude that a complete ban on MSM is not required. A maximum of two months deferral or waiting period will be sufficient as NAT can detect HIV accurately within 33 days of exposure. Thus, based on new scientific evidence, the waiting period should be kept for MSM.

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OBITUARIES

Dr. Hasumati Patel (LM No. Gujarat 268/ 1990)

Dr Hasumati R Patel first female Forensic Medicine expert of Gujarat retired as Police Surgeon at Civil Hospital, Ahmedabad. She served many medical colleges as faculty after superannuation. She served in Governing Council at various occasions and was confered Fellowship of IAFM in 2017. Just before her demise she attended first conference of AFMTE (Gujrat) despite of old age and physical incapacity.

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Professor of Forensic Medicine & Toxicology, BPS Government Medical College for Women, Sonipat.

He did his MD from Govt Medical College Patiala and served at Gian Sagar Medical College Rajpura before shifting to BPS Khanpur. He was webmaster for the Journal of Punjab Academy of Forensic Medicine and Toxicology.

Dr. Ramachandran (LM No. Kerela 69/1982)
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The Forensic Medicine & Toxicology Department started functioning in the College in the year 2010 when he took charge on 01.01.2010 as Head of Department in Forensic Medicine & Toxicology and Chairman of Research Committee in the college. He was dynamic and played a integral role in the functioning of Sree Narayana Institute of Medical Sciences and he retired from here on 30.09.2015. He was (Former) Principal, Yenopoya Medical College, Mangalore, Medico- Legal Expert & Consultant to Govt. of Kerala, Police Surgeon, Professor& HOD of Forensic Medicine, Sri Ramachandra University, Chennai, Vice Principal, Medical College, Calicut. President of Kerala Medico legal Society.


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