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The Journal covers all technical, medico-legal and clinical aspects including the ethical and social issues related to the subject specialty of Forensic Medicine and Toxicology and allied specialities. The journal promotes dissemination of original research findings.

#### Abstracting and Indexing:

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Contents	Pages
From Editor's Desk Prof. (Dr.) Manish Nigam	1
EDITORIAL	
The Bolam Test: A Seismic Change in the Hon'ble Supreme Court's Stand on its Acceptability <i>Dasari Harish, Varun Modgil.</i>	2-6
ORIGINAL ARTICLES	
A 10-year Retrospective Study of Child Homicides brought to the Mortuary of a Tertiary Care Hospital in Imphal. <i>Neha S, Phanjoubam M, Zohlupuii LB, Devi TM.</i>	7-10
A Three Years Study on Histopathological Changes in Various Tissues in Cases of Snake Bite in a Mortuary. <i>Biswas A, Chowdhuri S, Hansda S, Roy DG, Ghosal S, Das S.</i>	11-14
Study on Behaviour of Pellets fired from Airguns on Gelatin Block Chinmayi BG, Nirosha S, Anthea MR, Mane M.	15-20
Accuracy of age Estimation using Cervical Vertebral Maturation index and Demirjian's Method : A comparative study Sarannya K, Sreenivasan P, Sylvester V, Thomas RM, Bhaskar B, Vengalath J.	21-25
Determination of Sex Using Anthropometric Measurements of Clavicle – An autopsy based study <i>Vishal Vincent, Seena MM, Sharija S.</i>	26-31
Pattern of Injury in Lightning Deaths-A Post Mortem Study in Southern Odisha. Sethi A, Patnaik KK, Panigrahi H, Bisoyi CK, Das S.	32-37
Sequential Blood Lactate Measurement as Death alarm for the Patient with Sepsis Borah P, Saloi DK, Deka B, Konwar R, Basumatary J, Basumatari B, Kataki M, Mahanta P.	38-41
Determination of Sex from Hyoid bone – Is it feasible? James RI, Bakkannavar S, Anitha S.	42-45
Profile of Medico-legal cases Autopsied at S.S.I.M.S & R.C, Davangere : A retrospective study. <i>Marigoudar RM, Kamaradgi PN, Jatti VK, Kumar A</i> .	46-49
A Comparative Analysis of Pattern of Homicidal Deaths among Males and Females in a District of West Bengal <i>Chakrovarty A, Bhattacharjee A, Mazumder A.</i>	50-54
Utilization of Serum Chloride Level from Post mortem Blood in determination of Time since Death-A critical analysis <i>Roy P, Roy K, Banerjee U, Debnath BJ.</i>	55-58

Pattern of Snake Bite Cases Admitted at a Tertiary Hospital of Khammam <i>Guntheti BK</i> .	59-63
A study on Pattern and Outcome of Poisoning Cases in Tertiary care Hospital in South India <i>Palimar V, Gupta C, Pratap B</i> .	64-66
Smoking, Alcohol and Coronary Artery Occlusion – A morgue based study Mondal N, Goswami AK, Thakur S, Gurbani V.	67-69
Study of Diurnal Variation of Stature among MBBS Students in a Medical College of Andhra Pradesh. Peethala P, Rajesh T, Rao PU, Suresh K.	70-74
REVIEWARTICLE	
Scope and Relevance of Forensic Odontology in India – A review <i>Hande A, Ali HJ, Choudhari M.</i>	75-77
Modern Mortuary Complex Plan in Covid-19 Era Kumar B, Kumar A, Nilabh, Singh P, Gupta RB, Goel N, Singh NK.	78-86
<b>CASE REPORT</b>	
Murder Suicide with Offensive Corpse Mutilation: A Case Report Tingne CV, Wankhade VK, Giri SS.	87-90
Death due to Rupture of Tubal Pregnancy Pramod KGN, Prashanth BM, Roopa AN, Shetty SS, Ananthan MAS.	91-93
Rare Inward Compression Fracture of Hyoid Bone In Hanging: A Case Report and review of literature <i>Patil A, Narang H, Ranjan R, Kumar P.</i>	94-98
Unplanned Complex Suicide - Poisoning Followed by Hanging Jayanth SH, Singh A, Hugar B.	99-101
Strychnine Poisoning: A rare occurrence Bhat VR, Durgekar TD, Bakkanavar SM, Saravu K, Rai S.	102-103
LETTER TO EDITOR	

Obstacles in the Pathway of Creating an Empathetic Indian Medical Graduate - An	104-105
AETCOM Perspective	
Sunil M. Doshi	

#### From Editor's Desk

#### Dear All,

Now I have a gut feeling that we are prepared for a long journey together and things are settling down. Today, we as a team are aware of each other's strengths and weaknesses. We have started developing our standard operating procedures and making each other aware of the do's and don'ts of journal publications. I am thankful to my editorial team that has supported me in all my endeavours of bringing up JIAFM volume 44. The first and second issues of JIAFM volume 44 are on board, published and can be accessed on our website. Hard copies as were required by the subscribers have been posted and received by them.

Despite getting too late to start with the preparation of our journey after May 2022 (due to covid, causing the postponement of the conference, and the election, resulting in delayed taking over of the charge of the editorial board and new governing council) we are ready with JIAFM volume 44 issue third. I thank **Dr. Siddhartha Das our Joint Editor,** who helped me in the preparation for this journey and whose support I will always look forward to.

All the manuscripts have undergone a double-blinded review process; grammar and plagiarism check (wherever required), and separately the reference check. We have responded to all the queries of the authors through the new official email ID of the editorial team - editorjiafm2022@gmail.com.

I am most thankful to all the **reviewers** who have been phenomenal in helping me complete the review process on time. The name of reviewers who supported us, in this issue, have been added at the end of the journal. As far as possible, the overall comments given were constructive and detailed. They marked and inserted their suggestions as comments on the manuscript file or made changes in the manuscript using the track changes option. They supported with sufficient reasons and detailed suggestions for the authors so that they could improvise, revise, or resubmit their work accordingly.

I give my sincere thanks to all the **authors** for sending us articles on their researches and cases. I deeply regret and feel sorry, as many times I may not have been able to included their article in the upcoming issues or sometimes may have rejected the articles due to negative remarks from our editorial board. This was done with the sole intention to uplift the standards of the journal as we are preparing ourselves for a more robust and scientific system. We had long pending manuscripts and we are publishing the articles on a first come first basis, but sometimes due to delays in the response given by either reviewers or the author themselves, the article loses its place. Hence, it would have taken some time to respond accordingly.

This time we have rejected 5 manuscripts after suggestions and comments by reviewers, either because, the subject matter was under quality, out of the scope of the journal or many times, due to lack of corrections as suggested by the reviewers on time.

I thank **Dr. Mandar Sane; Dr. Narendra Patel & Dr. Vivek Chouksey** as Associate editors; **Dr. Richa Nigam** as Research and Statistical Editor; and **Mr. Chain Singh Lodhi** as a technical editor, for bringing up 3<sup>rd</sup> issue of volume 44 well on time.

Sincerely

Prof. Dr. Manish Nigam (M.D. LL.M.) Chief Editor Journal of Indian Academy of Forensic Medicine (JIAFM)

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#### Editorial

# The Bolam Test: A Seismic Change in the Hon'ble Supreme Court's Stand on its Acceptability

#### Dasari Harish,<sup>1</sup> Varun Modgil.<sup>2</sup>

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#### Abstract :

Since time immemorial, medical profession has been regarded as one of the noblest professions of the mankind, and hence, the society has imposed a 'Duty of Carefulness' in the strictest sense upon the medical practitioners. It is not sufficient that the medical professional acted in good faith to the best of his or her judgment and belief. He/she is expected to have the requisite degree of skill and knowledge, as per the advancements in the field. The question in every case would be whether the medical practitioner had in fact attained the degree of due care established by law.

Since its articulation in 1957, the 'Bolam test' gained much acceptance world-wide as the principle to decide the standard of 'care and attention' on part of the medical practitioner towards his patient. But slowly, with the advancement in the field and availability of 'state of the art' equipment, 'Bolam' started losing ground and the journey from 'Bolam' to 'Montgomery' has completely diluted the acceptability of the 'Bolam' in the courts as a test for the standard of 'due care and attention'.

The Hon'ble Supreme Court of India, in its latest judgments, has also changed its stand on the 'Bolam' and has said that 'Bolam' opts for the lowest common denominator, there by considerably decreasing the standard of medical care available to the patients. It said that "the 'Bolam Standard' must evolve in consonance with the advancements in the medical field, otherwise it would be inconsistent with the Article 21 of the Constitution of India."

Keywords : Negligence; Supreme court; Due care and Attention; Bolam test.

#### **Introduction:**

Medical negligence is defined as absence of due care and attention on part of the medical practitioner, during the practice of his profession, which results in injury or death of the said patient.

There are three essential components of negligence:

- The existence of a duty to take care, which is owed by the doctor to the complainant;
- The failure to attain that standard of care, prescribed by the law, thereby committing a breach of such duty;
- Damage, which is both causally connected with such breach and recognized by the law, has been suffered by the complainant.

Right from the judgment in Laxman Balkrishna Joshi vs Trimbak Bapu Godbole,<sup>1</sup> the Hon'ble Supreme Court has been stressing on the importance of reasonable degree of care, skill and attention on part of the medical practitioner, in choosing his/ her patient, informed consent, prescribing medicines, administering proper treatment and proper documentation of each and every intervention. It has elaborated on its definition and views on medical negligence, especially in Poonam Verma vs Ashwin Patel & Others, Achutrao Haribhau Khodwa vs State of Maharashtra and Ors, Jacob Mathews vs State of Punjab and anr, V. Kishan Rao vs Nikhil Super Speciality Hospital, Balram Prasad vs Kunal Saha & Ors and the Dr. S. K. Jhunjhunwala vs Mrs. Dhanwanti Kumar.<sup>27</sup>

**Corresponding Author Dasari Harish** Email : dasariharish@gmail.com Mobile No. : 9646121551 From the above judgments, it can be construed that medical negligence is an act of omission i.e. failure to maintain reasonable care and skill, or an act of commission i.e. doing something which a reasonable man exercising reasonable degree of care and caution would not do, leading to damage to the patient. The person must be doctor's patient i.e. the doctor-patient relationship must be demonstrable. It also made it clear that the standard of duty of care in medical services may be inferred after taking into account the position and stature of doctors or the hospital. Hence, degree of care is more for a specialist doctor than an MBBS doctor. If a doctor claims himself as a specialist, but it turns out that he is not, deficiency of service would be presumed by comparing his skill to that of specialist and not that of a general practitioner.<sup>8</sup>

The important question of what substantiates medical negligence has been answered to a great extent in the October 2018 Supreme Court judgment in Dr S K Jhunjhunwala vs Mrs Dhanwanti Kumar & Anr<sup>7</sup> by reiterating the role of expert medical opinion citing Bolam versus Friern Hospital Management Committee and Jacob Mathew vs State of Punjab.<sup>8,4</sup>

In the landmark case of Jacob Mathews,<sup>4</sup> the Supreme Court laid down the guidelines for prosecution of a medical practitioner, both by the police and the courts.

However, in Arun Kumar Manglik vs Chirayu Health and Medicare,<sup>9</sup> the Supreme Court ruled that the real charge of negligence stems from the failure of the hospital to regularly monitor the patient. The standard of care as enunciated by the Bolam test should evolve in consonance with the development of the science of patient care. Otherwise it becomes inconsistent

with the patient's right to life. The courts should understand that the requirement to take reasonable care is equivalent with the requirement of making adequate provision for medical care.

#### The Change in the Stand :

Justice Baron Alderson<sup>10</sup> defined negligence as: "Omitting to do something which a reasonable man of same skill & knowledge would do or doing something which a prudent & reasonable man would not do in the given circumstances." This is the basic argument in the Bolam test, which, till recently, was the accepted test for 'Due Care & Attention' in India. In the case of Bolam vs. Friern Hospital Management Committee,8 the Queen's Bench Division of the British Court held: "A doctor is not guilty of negligence if he has acted in accordance with a practice accepted as proper by a responsible body of medical men skilled in that particular art." This was accepted by the Hon'ble Supreme Court in Jacob Mathew vs. State of Punjab.<sup>4</sup> The standard of care, when assessing the practice, that was adopted, is judged in the light of the knowledge available at the time (of the incident), and not at the date of trial. When the charge of negligence arises out of a failure to use some particular equipment, the charge would fail if the equipment was not generally available at that point of time on which it is suggested as should have been used.

In this decision, the Supreme Court also observed that for inferring negligence on the part of a professional, including a doctor, additional considerations apply. A simple lack of care, an error of judgment or an accident, is not proof of negligence on the part of a medical professional. So long as a doctor follows a practice acceptable to the medical profession of that day, he cannot be held liable for negligence merely because a better alternative course or method of treatment was also available or simply because a more skilled doctor would not have chosen to follow or resort to that practice or procedure which the accused followed.

Finally, while dealing with negligence, the Supreme Court made the following observations:<sup>4</sup>

- A professional may be held liable for negligence when
- a) He was not possessed of the requisite skill which he professed to have possessed;
- b) He did not exercise, with reasonable competence in the given case, the skill, which he did possess.

The standard to be applied for judging whether the person charged has been negligent or not would be that of an ordinary competent person exercising ordinary skill in that profession. It is not possible for every professional to possess the highest level of expertise or skills in that branch which he practices.

However, the society has deviated from the paternalistic approach of patient care to the present concept of patient autonomy, as exemplified by the words of Judge Cardozo in Schloendroff vs. Society of New York Hospital<sup>11</sup> and the United Nations Universal Charter of Human Rights,<sup>12</sup> adopted by the General Assembly in 1948, which declares each human being to be born free and equal in dignity and human rights. The origin of present day bioethics stands on four principles enunciated by Beauchamp and Childress<sup>13</sup> i.e. Autonomy, Beneficence, Non-

maleficence and Equitable Justice. These have withstood the challenge for several decades and still form the basis for decision making in clinical practice and biomedical research. In the words of Judge Cardozo, "Every human being of adult years and sound mind has a right to determine what shall be done with his own body; a surgeon who performs an operation without his patient's consent commits an assault, for which he is liable."

The MCI Regulations, 2002,<sup>14</sup> as amended up to date, clearly stipulate the need to respect the patient's autonomy and doctor's obligation to adequately inform the patient for self determination. Nature of the patient-doctor relationship has to be examined in the light of education and access to the knowledge of ordinary citizen in the present day. In the light of these facts and statutory provisions, the "Bolam Test" can no longer be applied to a doctor's advice to his or her patient, unless it complies with the statutory provisions.

'Bolam' to 'Montgomery' is the new journey and the U.K. Court in Montgomery v Lanarkshire Health Board<sup>15</sup> has almost diluted the effect of Bolam Test in view of the present day advancements and availability of information to the patients and their attendants. It is thus pertinent to mention here regarding the journey from Bolam to Montgomery and how the law of consent has developed. Bolam's principle was based upon a case of Mr. Bolam who suffered from grievous injury as a result of electroconvulsive therapy (ECT) in the year 1954. He sued the hospital management committee for negligence for not administering him a muscle relaxant and not restraining him, and also not disclosing to him about the risks involved in the said treatment modality. It was held in Bolam's case that a doctor who had acted in accordance with a practice accepted at the time as proper by a reasonable body of medical opinion skilled in the particular form of treatment in question was not guilty of negligence merely because there was a body of competent professional opinion which might adopt a different technique. A defendant doctor would still stand even if another expert witness stated that the procedure should not be performed in his way with another responsible body of medical opinion approving otherwise. In 'Bolam', the experts of both plaintiff and defendant presented evidence for the different approaches but they all agreed that there was a firm body of medical opinion opposed to the use of relaxant drugs by balancing the risk of death of using the drug against the risk of fracture; and also a number of competent practitioners considered there was a lesser risk of fracture with less manual control. The plaintiff's expert admitted that he could not say that a practitioner using ECT who did not give relaxants was falling below the standard of care of a competent practitioner. Although he expressed the necessity to use some form of manual control he agreed that there was a school of thought that using more strain increased the likelihood of fracture. The expert of the plaintiff did not agree with the approach of the attending doctor of Mr. Bolam. The statement of J McNair in 'Bolam' made it clear that the doctor would not adopt a practice contrary to the substantial standard. In that case it was held that a doctor is not negligent merely because there is a body of opinion who would take a contrary view point. It does not mean that a medical man can continue with some old technique if it has been proven to be contrary to what is substantially the whole of

informed medical opinion.8

In Sidaway's case<sup>16</sup> it was adjudged that failing to disclose 1-2% risk of damage of spinal cord was not held negligent conduct, confirming the application of Bolam but there was stark difference in the judicial approach in ascertaining the relevant standard of care. 'Bolam' test should be applied to all aspects of duty of care by doctors. Lord Diplock, said "To decide what risks the existence of which a patient should be voluntarily warned and the terms in which such warning should be given is as much an exercise of professional skill and judgment as any other part of the doctor's comprehensive duty of care to the individual patient."

Bolitho<sup>17</sup> modified the Bolam test of 'standard of care.' In Bolitho, it was decreed that the court is not bound to hold that a defendant doctor escapes liability for negligent treatment or diagnosis just because he leads evidence from a number of medical experts who are genuinely of opinion that the defendant's treatment or diagnosis accorded with sound medical practice. The Court would decide whether the view of expert witness was reasonable, responsible, respectable and not dismissed as illogical. For example, it cannot be suggested that it was illogical for a doctor, a specialist, to submit patient to the invasive procedure of intubation who had a small risk of total respiratory collapse. "The courts should form an opinion of their own before accepting a body of opinion as being reasonable, responsible and respectable, and will need to be satisfied that, in forming their views, the experts have directed their minds to the question of comparative risk and benefits and have reached a defensible conclusion on the matter."17

The protection given to medical fraternity by 'Bolam' was hence, not interpreted as absolute and it was decided that the body of medical opinion ought to be respectable and responsible and experienced in the field. A careful dissection of the 'Bolam' case does enable us to appreciate the logical approach in reaching a judicial decision that is justifiable, fair and reasonable rather than a very loose standard of medical care. In 'Montgomery',<sup>16</sup> the plaintiff was not told about the risk of shoulder dystocia which would be 9-10% among mothers with diabetes. The defendant doctor agreed that there was a high risk but her reason for not discussing the risk was because the risk of grave problems for the baby resulting from shoulder dystocia was very small. In this case, the U.K. Supreme Court deviated from the earlier practice and gave a consolidated law on the 'standard of care' to be followed by the doctors with regard to duty of disclosure of information to the patient and the risk of proposed treatment and possible alternatives. After the decision of the Montgomery's case which has also described the Bolam test, the doctors are now obliged to take reasonable care to ensure that the patients are aware of any recommended treatment, its risks or any reasonable alternative or variant treatments. The conventional approach of liability in the tort of negligence is defined as breach of duty in taking reasonable care of the claimant.

In the light of these facts and statutory provisions, the 'Bolam Test' can no longer be applied to a doctor's advice to his patient, unless it complies with the statutory provisions. The information given to the patient has to be examined from patient's perspective. The information disclosed is not to be limited to the risk related information. It should include: doctor's diagnosis of the patient's condition, the prognosis of that condition with and without medical treatment, the nature of the proposed medical treatment and the risks associated with it, the alternative to the proposed medical treatment, advantages and risks of the alternatives vis a vis the proposed treatment. The doctor must ensure that the information given is in terms and at a pace that allows the patient to assimilate it, thereby enabling the patient to make an informed decision.

In Smt Vinitha Ashok vs Laxmi Hospital,<sup>18</sup> the Supreme Court ruled that even if a particular opinion is held by a group of responsible men skilled in that field, if the court is not satisfied that the opinion is reasonable and can withstand analysis of logic, the doctor can be held responsible for negligence if he followed that opinion for diagnosis and treatment.

The Supreme Court judgment in the Anuradha Saha<sup>19</sup> case is a landmark in the annals of medical jurisprudence. The apex court not only adjudicated on how to determine criminal negligence on the part of a doctor or a group of doctors in the event of a patient's death but also imposed greater responsibility on them on the universal treatment protocol. It has also reinforced a patient's right to know the line of treatment being followed by doctors, including the risks involved in the treatment.

Interestingly, though medical experts had briefed the Bench and given their evidence about Toxic Epidermal Necrolysis (TEN) and its treatment protocol, it ruled that the court was not strictly bound by the specialist advice, as such evidence was only advisory in nature under Section 45 of the Evidence Act. The court must derive its own conclusion upon considering the expert opinion, it observed. The judgment put the onus on the doctors for the patient's treatment.<sup>19</sup>

The doctors must observe the current practices regarding infrastructure, sterility and hygiene. No prescription should be given to a patient without actual examination. A doctor should not merely go by the patient's version about his/her symptoms but also make his/her own analysis, including tests and investigations wherever necessary. Doctors should not experiment unless necessary and even then only after obtaining the patient's written consent. The Bench made it clear that doctors must tell patients about the risks involved in any line of treatment they are following. It emphasized that by and large, patients are ignorant about the adverse effects of a medicine. If some reaction is anticipated, the patient must be informed clearly and all his doubts regarding the matter must be completely resolved before taking his consent.<sup>19</sup>

In Nikhil Superspeciality case,<sup>5</sup> the Supreme Court said: "Even though Bolam test was accepted by this Court as providing the standard norms in cases of medical negligence, in the country of its origin, it is questioned on various grounds. It has been found that the inherent danger in Bolam test is that if the Courts defer too readily to expert evidence medical standards would obviously decline. Bolam test has been criticized as it opts for the lowest common denominator. It should be restricted to those cases where an adverse result follows a course of treatment which has been intentional and has been shown to benefit other patients previously and should not be extended to certain types of medical accident merely on the basis of how common they are. To do this would set us on the slippery slope of excusing carelessness when it happens often enough."

Now, in Arun Kumar Manglik,9 Hon'ble Apex Court has laid emphasis on 'Patient Centric Approach' and observed that the 'Standard of Care' as enunciated in the Bolam Case must evolve in consonance with its subsequent interpretation by English and Indian Courts. Even though Bolam test "has not been uprooted" it has come under some criticism. There is an argument to the effect that Bolam test is inconsistent with the right to life unless the domestic courts construe that the requirement to take reasonable care is equivalent with the requirement of making adequate provision for medical care. In the context of such jurisprudential thinking in England, "time has come for this Court also to reconsider the parameters set down in Bolam test as a guide to decide cases on medical negligence and specially, in view of Article 21 of our Constitution which encompasses within its guarantee, a right to medical treatment and medical care." Our law must take into account advances in medical science and ensure that a patient-centric approach is adopted.

#### **Conclusion:**

Since 1957, when the 'Bolam test' was articulated, and gained acceptance as 'the test' for assessing the standard of care by a doctor towards his patient, to date, there has been a seismic shift in the way cases of medical negligence are being dealt with by the courts. Even the approach of the doctors towards their patients has changed from the previous "paternalistic" to the present "autonomy to the patient/ patient-centric". Now, the patient has to be given complete information regarding the various modalities of treatment, the possible risks involved, the alternatives available, the cost involved, etc. (Doctrine of complete disclosure) and an informed consent has to be taken before the treatment can be initiated. The principle of 'the degree of care and skill/knowledge,' as being followed by an average member of the profession has been superseded by the mandatory requirement of the medical practitioner being completely up to date with the advancements in the field. The right of the patient to know everything about his condition, the treatment being concerned and the risks involved, etc. has been upheld and has been made a mandatory duty of the medical practitioner towards his patient. Further, the courts are not bound to accept the opinion of the experts in the field in all cases and are required to form their own learned opinion of the case, taking in to consideration, all the facts involved.

This will ensure better treatment and care of the patients, but may also lead to increased instances of 'defensive medicine' and resultant escalation of the cost of medical treatment.

#### Conflict of Interest : None

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#### **ORIGINAL ARTICLE**

## A 10-year Retrospective Study of Child Homicides brought to the Mortuary of a Tertiary Care Hospital in Imphal

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#### Abstract :

Lethal violence against children can occur in a continuum of violence, representing the culmination of various forms of violence that children may be subjected to in different settings. The purpose of the present study was to identify demographic variables and various causes of child deaths, from cases brought to the mortuary of a tertiary care hospital in Imphal. Demographic profile, pattern of injuries and modes of homicide were reviewed from the autopsy reports. A total of 70 known child homicides were autopsied in the mortuary of a tertiary care hospital in Imphal between 2011 and 2020. The majority of children were between 14-18 years of age, and the most common cause of death was blunt trauma. Most of the perpetrators were unknown. There was a gradual decline in the incidence towards the later part of the study period. The rate of lethal victimization as a whole rose with age. Gender disparities in homicide rates increased sharply after the age of 14. In the neonatal period female cases were more. This study was done to analyze the causes and risk factors in order to formulate preventive measures. It is suggested that effective implementation and enforcement of laws will protect our children from lethal victimization.

Keywords : Child homicide; Cause of death; Perpetrator.

#### **Introduction:**

The United Nations Convention on the Rights of the Child (UNCRC) defines a child as everyone under 18 unless, "under the law applicable to the child, majority is attained earlier".<sup>1</sup>

Lethal violence against children can occur in a continuum of violence, representing the culmination of various forms of violence that children may be subjected to in different settings. One of the targets of Sustainable Development Goal 16 on peace, justice and strong institutions is to "end abuse, exploitation, trafficking and all forms of violence against and torture of children".<sup>2</sup>

Data on the killing of children, adolescents and young adults are quite scarce and are only available for a limited number of countries worldwide. This study was undertaken in an effort to give a regional view of the scale of this problem and shed light on the specific vulnerabilities faced by individuals affected by homicide from the very first hours of life up until early adulthood. A better understanding of the specific risks faced by those individuals will enable policymakers to devise more effective crime prevention interventions for tackling the homicide of children and adolescents.

#### Materials and Methods :

A retrospective analysis of all the cases of child homicides where the victim's age was below 18 years of age was done from the post mortem reports of the cases brought to the mortuary of a tertiary care hospital of Imphal. Cases were analyzed with respect to the age & sex of the victim, injuries present, cause of death, time of

**Corresponding Author Memchoubi Phanjoubam** Email : mem010177@gmail.com death, place of death, period of survival, place where the body was found, perpetrator if known, and the data were compared with similar studies all over the world.

#### **Results and Observations:**

An estimated total of 70 children aged 0 to 18 years lost their lives during the ten-year study period 2011-2020 (Table 1). Of these, 45 were male (64.2 %) and 25 were female (35.7 %). The total number of autopsies done during the period was 2505 and child homicides constituted 2.8 % of all these cases.

There is a gradual decline in the incidence towards the later part of the study period. Maximum incidence (18.6%) was seen in 2012 and the least (2.9%) in 2018 (Table 1).

The rate of lethal victimization as a whole rises with age. As shown in Table 2, maximum number of cases were seen in the 14-18 year age group (41 cases i.e., 58.6%) and the second highest incidence in the neonatal period (10 cases and 14.3%).

Gender disparities in homicide rates increase sharply after the age of 14 (Males 80.5% and females 19.5%). In the neonatal period female cases were 60% and males 40% (Table 2).

Regarding the places where bodies were recovered, most of the cases were found in the jungles (17 cases, 24.2%), followed by the victim's own home (15 cases, 21.4%) and river bank (13 cases, 18.6%) and the least number of cases were found in the home of the perpetrators (2 cases, 2.9%) (Table 3).

Blunt trauma was the major cause of death in maximum number of cases (26, 37.1%) followed by hypothermia and infection due to abandonment (10 cases, 14.2%) and drowning was the least common cause of death which was seen in only 1 case i.e., 1.4%. Firearms accounted for 18.4% of the cases (Table 4).

From the estimation of the time since death, the exact time of the

crime could not be ascertained in majority of the cases but 24.3% i.e., 17 cases seem to have been committed in the afternoon and 10% (7 cases) in the morning.

In 35 cases (50%), the perpetrators were unknown. In 9 cases (12.9%), police were the perpetrators and in 8 cases (11.4%), parents were the perpetrators. In 7.1% of the cases, the

 Table 1: Year wise distribution of child homicides and total number of autopsies per year.

Year	Child homicide	Total Autopsies
2011	4	313
2012	13	310
2013	12	301
2014	6	271
2015	11	231
2016	8	213
2017	3	224
2018	2	216
2019	7	232
2020	4	194
Total	70	2505

Table 2 : Age wise distribution.

Sl.No	Age	No. of	Male	Female
		cases		
1	Newborns (0-4 weeks)	10	4	6
2	Infant & Toddler (4 weeks-2 years)	8	4	4
4	Preschooler (2-5 years)	5	2	3
5	School aged child (6-13 years)	6	2	4
6	Adolescent (14-18 years)	41	33	8
	Total	70	45	25

Sl. No.	Place of occurence	No. of cases
1	Home	15
2	Home of the perpetrator	2
3	School/Temple	2
4	Public space	11
5	Jungle	17
6	Roadside	10
7	Paddy field	4
8	River bank/canal	13
	Total	70

#### Table 3 : Place of occurrence.

Table 4 : Cause of death.

Sl. No.	Cause of death	No. of cases
1	Blunt	26
2	Sharp	7
3	Firearm	8
4	Strangulation/throttling	8
5	Smothering	3
6	Hypothermia/infection/abandoned	10
7	Poison	3
8	Burn	2
9	Drowning	1
10	Undetermined	2
	Total	70

Table 5 : Types of perpetrator.

Sl. No.	Perpetrator	No. of cases
1	Parent	8
2	Relative	2
3	Neighbor	1
4	Stranger	5
5	Friend	6
6	Boyfriend	4
7	Police	9
8	Unknown	35
	Total	70

#### Table 6 : Discovery of death.

Sl. No.	Discovery of death	No. of cases
1	By police	24
2	By passerby	27
3	By neighbor	11
4	Friend	3
5	Doctor	5
	Total	70

perpetrators were strangers. In 5.7% of the cases, all adolescent girls, their boyfriends were the perpetrators (Table 5).

38 cases (54.3%) died on the spot. 22 cases (31.4%) survived for less than 1 day. 7 cases (10%) survived for more than 1 day.

In majority of the cases (27 cases, 38.6%) the deaths were discovered by passers by and in 24 cases (34.3%) by police (Table 6).

#### **Discussion :**

Violence against children differs from other crimes because of the vulnerability of its victims. Violence against children is a multidimensional phenomenon that is often underreported; it can take many forms and is influenced by a wide range of factors, such as the personal characteristics of the victim and perpetrator and their cultural and physical environments.<sup>3</sup> Such violence remains hidden in many instances till it culminates in a lethal outcome because children are often afraid to report acts of aggression.

The total number of autopsies done during the period was 2505 and child homicides constituted 2.8% of all these cases. Of these, roughly 45 were male (64.2 %) and 25 were female (35.7 %). Our finding is almost comparable with the global trend stated by UNODC (United Nations Office on Drug and Crime) Crime Trends Survey,<sup>3</sup> that a total of 205,153 children aged 0 to 14 years lost their lives worldwide as a result of homicide during the tenyear period 2008–2017. Of these, 59 per cent were males and 41 per cent were females. Over the same period, a total of 1,691,869 adolescents and young adults between the ages of 15 and 29 were intentionally killed. Around 86 per cent of these were male and 14 per cent were female. The population of the world at the time was 775 crores approximately.<sup>4</sup> Percentage of global child homicide comes to 0.0026% approximately which shows that the incidence rate in our study is higher but the sex wise distribution is almost comparable. The higher incidence rate could be due to increasing violence in the home and society, lower socio-economic

condition, insurgency which is an inherent problem in the region and poor law and order situation. However, there is a gradual decline in the later part of the study period, which could be due to increasing awareness and sensitization to the problem.

The rate of lethal victimization as a whole rises with age.<sup>3</sup> In our study, maximum number of cases were seen in the 14-18 year age group (58.6%) and the second highest incidence in the neonatal period (14.3%). The neonatal homicides could be due to lethal victimization by a parent due to family violence and mental health problems of the parents. According to a study,<sup>5</sup> the younger the child, the more likely it is to be killed by its mother, whereas fathers are more likely to kill older offspring. The risk of becoming a victim of filicide is high for children aged 1 to 5 years, but it decreases with age.

The homicides in the 14-18 year group in our study were in the hands of perpetrators outside the familial circle which is similar with the findings of other studies.<sup>6-9</sup>

In the Americas, a preponderance of male victims first manifests itself at 10 to 14 years of age and this skew becomes substantially stronger in the older age groups, while for Europe the turning point is at 18–19 years.<sup>10</sup> In the present study, gender disparities in homicide rates increase sharply after the age of 14 (Males 80.5% and females 19.5%) which is almost similar with the cited global trends. In the neonatal period female cases were 60% and males 40% which could be due to preference for male offsprings.

Regarding the places where bodies were recovered, most of the cases were found in isolated and remote areas which might have been done to delay discovery.

Blunt trauma was the major cause of death in maximum number of cases (37.1%) which could be due to the fact that blunt weapon is the most readily available means of offence. This finding is similar with a two decade long study published in Med Sci and Law.<sup>11</sup> Hypothermia and infection due to abandonment accounting for 14.2%, were responsible for the neonatal deaths which could be due to illegitimate births thereby prompting abandonment. Firearms accounted for 18.4% of the cases due to armed encounter between police and underage insurgent cadres which is a common scenario in the region.

Though the exact time of death could not be established in majority of the cases due to many factors, some of the crimes were committed early in the morning before most people were awake.

Children can be killed by family members or by non-family members.<sup>5</sup> In our study, the perpetrators were unknown in 50% of the cases. In 12.9%, police were the perpetrators and in 7.1% of the cases, the perpetrators were strangers. In 5.7% of the cases, all adolescent girls, their boyfriends were the perpetrators.

Intrafamilial child homicide may be perpetrated over long periods of time, and the act of killing is usually the culmination of pre-existing forms of violence.<sup>5</sup> In our study, parents were the perpetrators in 11.4%.

The killing of children outside the family is known as extrafamilial child homicide. In terms of factors at the community level that contribute to child homicide, violence can occur in urban are as characterized by poverty, discrimination, overcrowding, lack of education and poor standards of housing.<sup>12</sup>

Moreover, frequent use of alcohol and drugs by adolescents often leads them to become involved in violence.<sup>13</sup>

Children may also become victims of conflict,<sup>14</sup> violent extremism and organized crime, including drug trafficking. In the present study, 54.3% died on the spot, usually encounter cases and neonatal homicides due to the lethality of the weapon and the vulnerability of the victims. 31.4% survived for less than 1 day and 10% survived for more than 1 day.

In majority of the cases (38.6%) the deaths were discovered by passers by and in 34.3% by police which indicates that awareness of the public can play a major role in its prompt reporting, intervention and prevention.

#### **Conclusion :**

Ending violence against children, which is the cause of child homicide, is key to promoting just, peaceful and inclusive societies. It is the responsibility of the global community as a whole to protect our children. The findings in the present study suggest a need for better implementation and enforcement of laws to protect children from violence.

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Ethical Clearance: Taken

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#### **ORIGINAL ARTICLE**

## A Three Years Study on Histopathological Changes in Various Tissues in Cases of Snake Bite in a Mortuary

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#### Abstract :

Snakebite is a health problem mostly to the poorer rural population. Quite a good number of fatal cases are reported worldwide, even in India with annually estimated 2,00,000 on an average. Lack of rural health infrastructure, superstitious belief on black magic and dearth of proper knowledge among common people are regarded to be responsible for rise in incidences. At times diagnosis for snakebite cases becomes difficult. This is three years autopsy-based study, where it has been shown that renal pathological findings are prominent. Endocardial hemorrhage, pulmonary and cerebral edema are also associated with neurotoxic cobra and krait bites.

Keywords : Snakebite, Histopathology, Medico-legal autopsy.

#### **Introduction :**

Snake bite is a worldwide medico-legal concern. It is regarded as a neglected public health problem with high morbidity and mortality rate especially in rural tropics. Risk for snakebite cases is grossly unknown in most developing countries, with special reference to South-East Asia.<sup>1</sup> However, in Asia only; a million snake bites occur each year of which 50% are envenomed resulting in 1,00,000 annual deaths.

In India, both the incidences and mortality of snakebites are considerably high. The incidences were annually estimated 2,00,000 on an average, of them about 15,000 victims die each year.<sup>2</sup> Again, nearly 0.16 per cent/ year and 0.016 per cent/ year are rate of annual incidence and mortality respectively in West Bengal.<sup>3</sup>

Interestingly, most bites by non-poisonous snakes and 40% bites inflicted with venomous snakes do not produce features of envenoming. Common families of venomous snakes are Elapidae, Hydrophidae and Viperidae. In Indian subcontinent the major families are Elapidae which includes king cobra, common cobra and krait. Viperidae includes Russell's Viper, Pit Viper, Saw-Scaled Viper and Hydrophidae are sea snakes. The most poisonous species reported in India that needs to be mentioned are Ophiphagushannah (King cobra), Najanaja (common cobra), Daboia rusellii (Russell's viper), Bungarus caeruleus (krait), Echiscarinatae (saw-scaled viper).

Snake venom is characterized as the toxic saliva secreted from the modified parotid salivary gland. It is a clear amber colored fluid, that have low molecular weight peptides containing enzymes like proteinases, hydrolases, hyaluronidase, phospholipase, cholinesterase, ribonuclease, ATPase, etc. The toxin may be characterized as neurotoxin, haemolysin, cardiotoxin, haemorrhagins based on symptomatology. Local features are pain, swelling, discoloration, blood-stained discharge whereas, systematic manifestations are headache, vomiting, loss of consciousness including other paralytic features viz. ptosis, drowsiness, ophthalmoplegia, dysarthria, convulsions, dysphagia, bulbar paralysis, respiratory failure etc.<sup>4</sup>

The aim of the study is to investigate the histo-pathological changes of organs involved due to snakebite poisoning and to highlight the key histopathology for relevant forensic diagnosis.

#### Materials and Methods :

An autopsy based cross-sectional study was conducted between the period of February, 2011 to January, 2012. All fatal cases of snakebites (N=120) were included, whereas, cases having mixed injuries or decomposed were excluded. Tissue samples were collected from kidney, brain, liver, heart, lungs for histopathological investigations. Slides were prepared according to standard hematoxylin-eosin counter staining laboratory practices.

#### **Results:**

Distributions of pathological corroborations in fatal cases upon different species of snakebite bite have been shown in table1. In the study conducted for three years at a mortuary in tertiary centre it was found that renal haemorrhages were observed on 60% cases with Viper bites, 33.33% cases renal congestion with krait bite. 16.67% cases showed cerebral edema on both Cobra and Krait which are neurotoxic bites, whereas in only 2% cases of Viper bites cerebral edema were found. In 4% cases of viper bites endocardial changes were found. Pulmonary changes were 8% with Viper bites followed by 5.56% with Cobra.

Therefore, wide ranges of histo-pathological changes were found on various organ followed by various species bite.

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8%

Viper

2%

4%

14%

60%

Table 1: Histo- pathological corroborationsin fatal snakebite cases.



Fig 1 : Cerebral cortex showing congestion. H&E staining viewed at 40X magnification.



Fig 2 : Pulmonary edema with hemorrhage. H & E staining viewed at  $40 X \ magnification$ 

#### **Discussion :**

In our study renal hemorrhages were noted in 60% cases with Viper bites and in 16.67% with Cobra and Krait. In a similar study (2014) done by Yogesh et al,<sup>5</sup> where 45.3% of cases were reported with corticomedullary hemorrhages. In our study 33.33% of cases were reported with renal congestion in krait and for 14% of cases in Viper bites. Similarly, acute tubular necrosis was found to be similar with South Asian Hump-nosed pit viper bites.<sup>6</sup> A



Fig 3 : Renal cortico-medullary hemorrhage. H&E staining viewed under 40X magnification



Fig 4 : Glomerular hemorrhage. H&E staining viewed under 40X magnification



Fig 5 : Renal tubular hemorrhage. H & E staining viewed under 40X magnification

study done by Naqvi (2016)<sup>7</sup> showed 44% of cases associated with acute tubular necrosis.

Therefore, renal changes have been ascribed as the most common histopathological changes in snakebites. Nephrotoxicity includes vasculitis, tubular necrosis, interstitial nephritis and cortical nephritis with clinical renal manifestations have been reported in other studies<sup>8,9</sup> and is consistent to the findings in our study. Renal toxicity were reported in many studies bitten by Russell's viper where tubular necrosis, haemorrhages and renal congestion were pathologically significant.<sup>10-12</sup> Grossly, acute renal failure has been marked as the histopathological marker for viperine bitesin most of the studies.<sup>13-17</sup> In similar to the earlier studies, our study reported renal changes as the common histo-pathological findings.

In our study, 4% of viper bite cases were involved with endocardial changes. Sathis et al<sup>18</sup> highlighted the maximum cases (39.5%) with epicardial haemorrhage, and 31.6% cases for epicardial and sub-endocardial haemorrhage.

Histo-pathological changes in cerebral tissue following snakebite envenomation have not been widely studied; however, our findings are grossly similar to the study done by Nanayakkara et al.<sup>19</sup> in having congestion, inflammatory foci and necrosis in common. In our study we found nearly 16.67% of cases have cerebral changes associated with Cobra and Krait bites.

In the present study, 8% of Viper bites and 5.56% of Cobra bites were involved with edema and pulmonary inflammatory cellular infiltration which is a similar histopathology changes reported in other studies.<sup>6,20</sup>

Sathis et al<sup>18</sup> have shown histo-pathological changes among certain endocrine glands. Of them pituitary (52.6%) showed hemorrhagic infarction and 23.7% with congestion of interstitium. In 31.6% cases showed adrenal congestion and 18.4% hemorrhagic infarction. Rajagopala et al<sup>21</sup> demonstrated pituitary and adrenal necrosis with viper bites. However, in our study we have not observed other changes.

#### **Conclusion :**

Therefore we conclude from this study that endocardial changes, cerebral oedema and renal changes like congestion and haemorrhages were common in snakebite cases. However, scientific documentation and more research in this field are necessary to understand the proper histo-pathological diagnosis of fatal cases. This type of study can be utilized in further modification of management of snakebite and its complications in the clinical settings too.

#### **Ethical clearance:**

Taken from ethical committee Burdwan Medical College & Hospital (BMC&H) with number BMC/PG/1173 dated 28.02.2011.

#### **Conflict of Interest:**

The authors declare that they have no conflict of interest.

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#### **ORIGINAL ARTICLE**

## Study on Behaviour of Pellets fired from Airguns on Gelatin Block

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#### **Abstract :**

Forensic Ballistics is a branch of forensic science that deals with the science of the motion of a projectile in any given medium. It plays a significant role in the investigation of any case where firearms are involved. The impact of a projectile on targets such as the human body or animal is studied using a gelatin block. The use of gelatin blocks helps determine the terminal performance of a projectile as it simulates the soft tissues present in the human body. The present study focuses on the impact made by the projectiles fired at different ranges using Hammerli AR 207.5 Joules and Precibole NX 200 20 Joules airguns. The firing was performed using gelatin 120 bloomat different ranges (0 metres, 5 metres and 10 metres). The type of firearm and the distance from firing play a leading rolein the formation of wounds and do not depend only on the caliber of the projectiles. It was also found that despite the use of the same caliber pellets, the nature of the entry hole varied due to different firing ranges and airguns.

Keywords : Forensic science; Ballistics; Gel Block; Penetration; Track length.

#### **Introduction:**

Ballistics is a branch that deals with flight behaviour, and the impact of projectiles, especially ranged weapons like bullets, unguided bombs etc.<sup>1</sup> It deals with the science of designing and accelerating projectiles to get the desired terminal performance. A forensic ballistic expert deals with the matching of bullets, fragments, and other pieces of evidence with the weapon of alleged suspects or others involved in a case. The three main branches of ballistics are - Internal, External and Terminal ballistics. Internal ballistics deals with the mechanism of a weapon from the time the firing pin hits the primer to the time bullets leave the barrel. External ballistics deals with the flight of the projectile from the muzzle end of a weapon to the target. Terminal ballistics deals with the behaviour of the missile once it reaches the target.<sup>2,3</sup>

The firearm is a device that hurls the projectile or projectiles with force. The force is created usually due to the expansion of gases produced by the burning of the propellants. The first use or invention of firearms dates back to the 14<sup>th</sup> century. The primitive firearm includes hand canons, matchlock guns, and flintlock guns and modern firearms include pistols, rifles, double barrel rifles, airguns, grenades, and military guns.<sup>4</sup>

Wound ballistics deals with the motion or behaviour of the projectile at the target or inside the target and is concerned with the wounding phenomenon. It deals with how the projectile or the bullets cause injuries by creating destruction of the muscle tissues while entering causing an entry hole and then damaging the tissues in its travel and how it exits the body.<sup>5,6</sup> The majorly noticed aspects of wound ballistics include:

1 Temporary cavity - cavity is formed by the bullet as soon as it passes through the tissue.

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- 2 Permanent cavity- cavity caused by the bullet due to the actual destruction of the tissues.
- 3 Stellate tearing it is observed as the deep cruciform tearing formed around the entry hole of the gunshot wounds.
- 4 Tattooing unburnt particles adhere to the skin and the mark left behind is called tattooing.<sup>7</sup>
- 5 Scorching charring of the edges of the entry hole of a gunshot wound.<sup>8,9</sup>

Martin Fackler and others developed ballistic gelatin in the field of wound ballistic. Gelatin is collagen which is a type of protein composed of a mixture of amino acids, found in most connective tissues in the body.<sup>10,11</sup> Ballistic gelatin is used for the study of the terminal performance of ammunition including penetration, expansion, and cavities created by the bullets. It is shown to have very close similarities to that of human tissue which is useful in studying the permanent and temporary cavities formed.<sup>12,13</sup> It can be used to determine the depth of penetration to study survivability and lethality, which in turn can be used to improve firearms and understand the extent to which a firearm can cause harm.<sup>14</sup> There are many potential uses of ballistic gelatin such as helping law enforcement test body armour, testing service weapons, police sniper rescue team preparation, and testing hunting weapons.<sup>15,16</sup>

In the present study, the behaviour of different projectiles was studied at different ranges which can provide aid during the investigation. The impact of these projectiles was studied on the ballistic gel which is used to study wounding parameters. The objective of the current study was to understand the penetration depths and investigate the performance of various pellets and blow darts on gelatin blocks at different ranges.

#### **Materials and Methods :**

The present original research was approved by the Institutional Ethics Committee. Gel block was prepared and

pellets such as Diabolo flat head pellets of 0.177 Cal, Metal mag pointed pellets of 0.177 Cal, and Gamo country pellets with a copper flat head and a plastic body along with the Ferder Bolzen blow darts were fired from two airguns namely, Hammerli AR 20 7.5 Joules and Precihole NX 200 20 Joules at 0 metres, 5 metres and 10 metres to study the impact of the projectiles of the same calibre at various ranges which meets the FBI protocol for calibrating ballistic gelatin to match the human tissues. Each combination of weapon and pellet with range was repeated thrice to have consistency in the results. The gel blocks were photographed using Canon EOS 200D and f-stop value f/5.6 with scale.

Gelatin blocks were prepared using 120 - bloom gelatin. Gelatin blocks were prepared in 20% concentration using 80cc of water for each box of size 6"x4"x3". Gelatin powder of 20gm was dissolved in 180cc of distilled water to prepare an aqueous solution. The blocks were kept in the refrigerator for 48 hours to settle well for firing. Twelve such boxes were prepared for conducting the study by firing at different ranges namely, 0 metres, 5 metres and 10 metres. Suitable arrangements were made to keep the gel block on a rigid platform. The air gun was mounted on the gun mounting platform and was set for firing observing appropriate safety measures.

The nature of the entrance hole, exit hole, bullet track, and



Figure 1: Gamo Lethal Country pellets with copper doomed head and plastic body cal.177 when fired from HAMMERLI AR 20 of 7.5 joules (a) Entry hole and (b) Track length

temporary and permanent cavity was examined. The temporary cavity and permanent cavity were thoroughly examined. Examination of the track was done by fixing the ABFO scale from the start till the end of the pellet track. The nature of the Entrance hole and Exit hole were measured and documented through photographs with scale.

Data were verified before computerized entry and Statistical Package for Social Sciences (SPSS version 22.0) was used. A statistically significant difference was considered at p-value  $p \le 0.05$ . The four different pellets used in this study were Diabolo flat-headed pellets, Predator Metal mag pointed pellets, Gamo Lethal Country copper domed head with a plastic body and Feder Bolzen Blow Dart.

#### **Results:**

Ballistic gelatin serves as a wonderful aid in the study of terminal ballistics and wound ballistics. It plays a vital role in studying various impacts of the projectiles such as penetration power, entry and exit hole, the track travelled by the bullets, cavitation formed such as permanent and temporary cavities and deformations, mushrooming or fragmentation of projectiles or the bullets. Pellets are used for different purposes which makes it essential to determine their impact when it hits human or animal skin. This can be done using the gel block as the tissue model. The





Figure 2: Feder Bolzen blow dart of calibre 0.177 when fired from Precihole NX 200 20 Joules (a) Entry hole and (b) Track length

pellets were fired using two air rifles Hammerli AR 20 7.5 Joules and Precihole NX 200 20 Joules. The pellets were fired from air guns at three different ranges - 0 metres, 5 metres and 10 metres. The pellet track length and the entry hole dimensions were documented with scale. Statistical analysis was performed using SPSS for windows, version 22.0 Armonk, NY: IBM Crop. The significance of differences among the groups was determined by a one-way ANOVA test.

When Hammerli AR20 7.5 Joules airgun was used, Diabolo flathead pellets of calibre 0.177 were lodged into the gelatin block when fired at all three ranges. Metalmag pointed head pellets of calibre 0.177 when used, a change in the track length was observed.Gamo Country pellets with copper doomed head and plastic body of calibre 0.177 got lodged into the gel block with varying ranges (Refer Figure-1). Feder Bolzen blow dart of 0.177 Cal showed the projectile deviating from the track towards left in close contact and with the head deflecting towards left and piercing the gel block at 5 metres and 10 metres range. The close range had the highest track length (Referto Table-1).

When Precihole NX 200 20 Joules was used, Diabolo flathead pellets lodged into the gelatin blocks. When Metalmag pointed head pellets were fired, the pointed head separated from the body after travelling a distance, deviated toward the right and travelled further when fired at a range of 5metres and lodged into a gel block after travelling a distance of around 8.6 cm when fired from 10 metres. When Gamo country copper doomed head with plastic body pellets was fired, the copper head separated from the body after travelling a distance. Feder Bolzen blow dartpierced out of the gel block in a few cases (Refer Figure - 2 and Table - 2). The scatter plot in Figures - 3 and 4 show the data for the diameter of the entry hole and the pellet tracklength for testing normality between the data used.

#### **Discussion :**

Gelatin is widely used in forensic science for studying wound ballistic parameters. Diabolo flat-headed pellets are wad cutter pellets with a flat head and bevelled edges and are designed for low velocity, especially for close ranges. They are mostly used for target shooting practices and shooting competitions and leave an open clear round hole on the target. It is made up of malleable metal most often lead. Predator Metalmag pointed pellets are pointed pellets that have sharply pointed heads. It is designed so for maximum penetration capacity. These types of pellets are best used for hunting purposes. Pointed pellets have a flat body made of lead and a pointed sharp metal tip made up of brass. Gamo Lethal country copper doomed head with plastic body pellets are used for hunting purposes. It has a stable trajectory and body made up of polymer and copper heads doomed in shape. It helps in better terminal performance and vital killings. Feder Bolzen blow dart is used for hunting and poaching wild animals. They are made up of stainless steel with a sharp pointed end which can pierce into the target easily.

When Hammerli AR20 7.5 Joules airgun was used, the Diabolo flat head pellet fired from the contact range was found to have the highest pellet track length due to less energy loss in the travel from the firearm to the gelatin block. Metalmag pointed head pellets of calibre 0.177 when used, showed the pellet entered the



Figure 3: Scatter plot shows the data for the diameter of the entry hole for testing normality between the data used.



Figure 4: Scatter plot shows the data for the pellet length track for testing normality between the data used.

gelatin block travelling up to a distance and changed its course and lodged in the gelatin block facing toward the entry wound. It was noted that the track length decreased gradually with an increase in range. Gamo Country pellets with copper doomed head and plastic body of calibre 0.177 at close range had the highest track length which indicates less energy loss in the travel from the firearm to the gelatin block.

When Precihole NX 200 20 Joules was used, Diabolo flat head pellets lodged into the gelatin blocks. When Metalmag pointed head pellets were fired, pellets fired from close contact showed the highest pellet track length by the body and pointed head. Blackening was observed around the entry hole of the pellet fired from close range. When Gamo country copper doomed head with plastic body pellets was fired, the copper head separated from the body.

Levene Test was used to determine if the results are homogeneous, and the significance value must be equal to or greater than 0.05 or 5%. If the Levene test significance value is greater than 0.05 or 5%, the hypothesis will be tested using the One -Way ANOVA table, and if the Levene test significance value is less than 0.05 or 5%, the hypothesis can be justified using the Welch test table. The Levene significance value is 0.260 which is greater than 0.05, and the One-way ANOVA significance value is

#### J Indian Acad Forensic Med. 2022 July-Sept 44 (3)

ISSN: 0971 - 0973,	e - ISSN	: 0974 -	- 0848
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Range (in Metres)	Pellet Fired	Entry Hole Diameter (in Cm)	Pellet Track Length (cm)	Nature of Entry Hole	
0	Diabolo Flat Head	0.4	7.3	Circular and blackening observed at the entry hole	
0	Diabolo Flat Head	0.4	7.4	Circular and blackening observed at the entry hole	
0	Diabolo Flat Head	0.4	7.3	Circular and blackening observed at the entry hole	
0	Metalmag Pointed Head	0.4	9.3	Circular and blackening observed at the entry hole	
0	Metalmag Pointed Head	0.2	9.5	Circular and blackening observed at the entry hole	
0	Metalmag Pointed Head	0.4	9.5	Circular and blackening observed at the entry hole	
0	Gamo Lethal Country Copper Head Plastic Body	0.2	14	Circular and blackening observed at the entry hole	
0	Gamo Lethal Country Copper Head Plastic Body	0.3	14.1	Circular and blackening observed at the entry hole	
0	Gamo Lethal Country Copper Head Plastic Body	0.2	14	Circular and blackening observed at the entry hole	
0	Feder Bolzen Blowdart	0.5	10	Circular and blackening observed at the entry hole	
0	Feder Bolzen Blowdart	0.3	10.1	Circular and blackening observed at the entry hole	
0	Feder Bolzen Blowdart	0.3	10	Circular and blackening observed at the entry hole	
5	Diabolo Flat Head	0.3	7.1	Circular	
5	Diabolo Flat Head	0.3	7	Circular	
5	Diabolo Flat Head	0.3	7.1	Circular	
5	Metalmag Pointed Head	0.4	7.6	Circular	
5	Metalmag Pointed Head	0.3	7.6	Circular	
5	Metalmag Pointed Head	0.4	7.9	Circular	
5	Gamo Lethal Country Copper Head Plastic Body	0.2	12.4	Circular and blackening observed at the entry hole	
5	Gamo Lethal Country Copper Head Plastic Body	0.2	12.3	Circular and blackening observed at the entry hole	
5	Gamo Lethal Country Copper Head Plastic Body	0.2	12.4	Circular and blackening observed at the entry hole	
5	Feder Bolzen Blowdart	0.2	4.5	Circular	
5	Feder Bolzen Blowdart	0.2	4.3	Circular	
5	Feder Bolzen Blowdart	0.3	4.3	Circular	
10	Diabolo Flat Head	0.4	6.9	Circular	
10	Diabolo Flat Head	0.4	7	Circular	
10	Diabolo Flat Head	0.4	6.9	Circular	
10	Metalmag Pointed Head	0.3	8.7	Circular	
10	Metalmag Pointed Head	0.2	8.6	Circular	
10	Metalmag Pointed Head	0.3	8.6	Circular	
10	Copper Head Plastic Body	0.2	11.1	Irregular	
10	Copper Head Plastic Body	0.2	11	Irregular	
10	Copper Head Plastic Body	0.2	11	Irregular	
10	Feder Bolzen Blowdart	0.9	2.4	Straight cut	
10	Feder Bolzen Blowdart	1	2.3	Straight cut	
10	Feder Bolzen Blowdart	1	2.4	Straight cut	

Range	Pellet	Entry	Pellet	
(in	Fired	Hole	Track	Nature of Entry Hole
Metres)		(in Cm)	(cm)	
0	Diabolo Flat Head	0.4	7.3	Circular and blackening
0	Diabolo Plat fiead	0.4	7.5	observed at the entry hole
0	Diabolo Flat Head	0.4	7.4	Circular and blackening observed at the entry hole
0	Diabolo Flat Head	0.4	7.3	Circular and blackening observed at the entry hole
0	Metalmag Pointed Head	0.4	9.3	Circular and blackening observed at the entry hole
0	Metalmag Pointed Head	0.2	9.5	Circular and blackening observed at the entry hole
0	Metalmag Pointed Head	0.4	9.5	Circular and blackening observed at the entry hole
0	Gamo Lethal Country Copper Head Plastic Body	0.2	14	Circular and blackening observed at the entry hole
0	Gamo Lethal Country Copper Head Plastic Body	0.3	14.1	Circular and blackening observed at the entry hole
0	Gamo Lethal Country Copper Head Plastic Body	0.2	14	Circular and blackening observed at the entry hole
0	Feder Bolzen Blowdart	0.5	10	Circular and blackening observed at the entry hole
0	Feder Bolzen Blowdart	0.3	10.1	Circular and blackening observed at the entry hole
0	Feder Bolzen Blowdart	0.3	10	Circular and blackening observed at the entry hole
5	Diabolo Flat Head	0.3	7.1	Circular
5	Diabolo Flat Head	0.3	7	Circular
5	Diabolo Flat Head	0.3	7.1	Circular
5	Metalmag Pointed Head	0.4	7.6	Circular
5	Metalmag Pointed Head	0.3	7.6	Circular
5	Metalmag Pointed Head	0.4	7.9	Circular
	Gamo Lethal Country			Circular and blackening
5	Copper Head Plastic Body	0.2	12.4	observed at the entry hole
5	Gamo Lethal Country Copper Head Plastic Body	0.2	12.3	Circular and blackening observed at the entry hole
5	Gamo Lethal Country Copper Head Plastic Body	0.2	12.4	Circular and blackening observed at the entry hole
5	Feder Bolzen Blowdart	0.2	4.5	Circular
5	Feder Bolzen Blowdart	0.2	4.3	Circular
5	Feder Bolzen Blowdart	0.3	4.3	Circular
10	Diabolo Flat Head	0.4	6.9	Circular
10	Diabolo Flat Head	0.4	7	Circular
10	Diabolo Flat Head	0.4	6.9	Circular
10	Metalmag Pointed Head	0.3	8.7	Circular
10	Metalmag Pointed Head	0.2	8.6	Circular
10	Metalmag Pointed Head	0.3	8.6	Circular
10	Gamo Lethal Country Copper Head Plastic Body	0.2	11.1	Irregular
10	Gamo Lethal Country Copper Head Plastic Body	0.2	11	Irregular
10	Gamo Lethal Country Copper Head Plastic Body	0.2	11	Irregular
10	Feder Bolzen Blowdart	0.9	2.4	Straight cut
10	Feder Bolzen Blowdart	1	2.3	Straight cut
10	Feder Bolzen Blowdart	1	2.4	Straight cut

Table 1: Firing using Hammerli AR 20 7.5 Joules on gelatin.

Table 2: Firing using Precihole NX200 20 Joules on gelatin.

0.003 which is less than the minimum threshold i.e., 0.05. Therefore, Hammerli AR 20 7.5 J and Precihole NX200 20J airguns have a significant difference in entry hole diameter.

Results depict the Levene significance value as 0.002 which is lower than 0.05, and the Welch significance value as 0.409 which is higher than the minimum threshold i.e., 0.05. Therefore, the range has an insignificant difference in entry hole diameter.

Levene's significance value is 0.05, which is the same as the threshold, and the one - way ANOVA significance value is 0.000, which is less than the 0.05 threshold level. As a result, the pellet length track of the Hammerli AR 20 7.5 J and Precihole NX200 20J airgun differs significantly, and 7.5 J and 20 J airguns have an insignificant difference in pellet track length.

The Levene significance value was found to be 0.19, which is higher than the minimum threshold of 0.05, and the One-way ANOVA significance value is 0.007, which is lower than the minimum threshold of 0.05. There is a significant difference in pellet track length between Range (0 metres, 5 metres, and 10 metres).

The results of the experiment are in agreement with the findings, with cases that occurred in similar situations as reported in the field of ballistics.<sup>5,6</sup> The study helps in distinguishing lodged and striking bullets from tandem bullets to normally fired bullets.<sup>7,8</sup>

The results of the present study thus can help forensic investigators when different types of airguns are used and the projectile may be found in damaged, fragmented condition or cannot be recovered from the crime scene. The present study also clearly demonstrates that range has a significant difference in the pellet track length while negligible difference in the hole diameter.

#### **Conclusion :**

The impact made using airguns like Hammerli AR 20 7.5 J and Precihole NX200 20J has a significant difference with the entry hole diameter and pellet length track, while the range has a significant difference with the pellet track length but is negligible with the entry hole diameter. This could be helpful in forensic science for cases where the projectile is found in severely damaged condition, fragmented, or not recovered from the victim or the scene of a crime. There is a need for further evaluation of projectiles such as bullets to be included as they can provide useful information. There is an urgent need for devising a feasible method for understanding the impact made by projectiles using gelatin block so that analysis of entry wounds and the track length can be a useful tool for the investigators.

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#### **Conflict of Interest :**

The authors declare that there is no conflict of interest.

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#### **ORIGINAL ARTICLE**

# Accuracy of Age Estimation using Cervical Vertebral Maturation Index and Demirjian's Method : A Comparative study

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#### Abstract :

Dental age estimation is considered to be vital, as tooth development shows less variability than other developmental features. But in case of missing tooth it is not possible to estimate chronological age using dental age estimation methods. So there should be an alternate method for age estimation. The cervical vertebrae maturation index (CVMI) is one of the easiest and most commonly used skeletal maturity indices. Aim of this study is to check the accuracy of age estimation using CVMI and Demirjian's method with chronological age. It is a comparative study to check the accuracy of age estimation using Demirjians method and CVMI method with chronological age among Kannur population, of age range between 10-16 years. 100 panoramic radiographs and 100 lateral cephalograms of same patient were assessed using Demirjians and CVMI method respectively. The results were compared with chronological age and the data were analyzed. p value was less than 0.0001. The mean age difference for total sample using Demirjians method is -0.20+/-0.048 and using CVMI method is 0.63+/-0.08. In the age group of 15-16 years using CVMI method the mean difference is 1.34 +/-0.09 and the p value is <0.934 which is not statistically significant. Pearson correlation coefficient shows good correlation value for total samples. The correlation between Demirjians and Chronologic age is 0.972 and CVMI with Chronologic age is 0.919. Demirjians method is better & preferred method for estimation of chronological age. But if need arises CVMI can efficiently replace the Demirjians method till the age of 14 years.

Keywords : CVMI method; Demirjian method; Age estimation.

#### Introduction :

Age estimation techniques are valuable tools for age assessment whenever the birth certificate is not available or the available records are suspicious for some reason. They are used to determine age in medico legal and criminal scenarios such as rape, kidnapping, child marriage, illegal immigration. They are also applicable to analyze age for employment, child adoption and to determine eligibility for competitive sporting events.<sup>1</sup>

Chronological age is defined as the actual measure of time elapsed since a person's birth. To know one's age is important in the religious, social, cultural, economic, medical point of view.<sup>2</sup> Human growth and development may not completely correlate with chronological age. Chronological age alone is not sufficient for assessing the stage of development of a growing child. Variability in the morphological features, such as skeletal maturation, secondary sexual characters, and maturation of different tissue system increases from birth to adulthood.<sup>3,4</sup> There are various age estimation systems available for the determination of chronological age, dental age, skeletal age, and sexual age. Chronological age can be estimated using the skeletal maturation as an index e.g. hand wrist maturation, cervical vertebrae maturation stages, ossification stage of the medial clavicular epiphysis. Dental age is one of the few measures of physiologic development that is uniformly applicable from infancy to late adolescence. After attaining maturity, teeth continue to undergo changes, making age estimation possible in

Corresponding Author Sarannya K Email : sarannyak.ganesh@gmail.com Mobile No. : +91- 9400738272 adults. It may not be exactly correlated to the chronologic age and the timing, duration, velocity of growth can vary from person to person.<sup>5,6</sup> Dental age estimation is considered better method than skeletal age estimation.<sup>7</sup>

Demirjians method is one of the most widely used age estimation methods which include the objective criteria describing stages of tooth development, with radiographic images and standardized scores. But in case of missing tooth the age estimation is difficult.<sup>8</sup> The cervical vertebrae maturation index (CVMI) is one of the easiest and most commonly used skeletal maturity indices. The shape changes during the maturation of cervical vertebrae reflect the pubertal growth spurt and were first associated with age by Lamparski (1972). In this study we used Lamparski's modified method of CVMI by Hassel and Farman. By this study we are checking the accuracy of chronological age estimation using Demirjians method and CVMI method among Kannur population.

#### Materials and Methods :

This study was conducted in department of Oral Medicine and Radiology of Kannur dental college (Kerala). Ethical clearance for the study was obtained from the Institutional Ethical Committee. Total of 100 subject (100 digital panoramic radiograph and 100 digital lateral cephalograms of same patient) of age ranges from 10-16 years were enrolled.

Sample size was calculated using the following formula, for sample size n:

n=N\*X/(X+N-1)X=Za/2<sup>2</sup>\*p\*(1-p)/MOE.<sup>2</sup>  $Za/2^2$  is the critical value of normal distribution at a/2, MOE is the margin of error, p is the sample proportion, and N is the population size.

For radiographic procedure panoramic machine (Planmeca ProMax Panoramic X-ray machine, Finland) with kVp 66 and 7 mA for 1.8 sec in child and 70 kVp, 9 mA for 1.8 sec for adults were taken. Lateral cephalograms were taken from the same patient on the same day. For lateral cephalograms 68 kVp and 10 mA for 0.8 sec in child and 70 kVp, 12 mA for 1.0 sec were given. The image was read by AGFA CR 30-X System.



Figure 1 : Skeletal maturity stages.

#### Inclusion criteria :

- a) Patients of age between 10-16 years.
- b) Availability of Lateral cephalogram & panoramic radiographic image.
- c) Availability of complete patient record.

#### **Exclusion criteria :**

- a) Poor quality of radiographs.
- b) Any developmental disorders/syndromes, trauma or surgical treatments that could affect development and eruption of permanent teeth.
- c) History of extractions, restorative or endodontic treatment of the posterior teeth, orthodontic treatment
- d) Abnormal dental conditions (e.g., congenitally missing teeth).

The OPGs were analyzed for the developmental stages of teeth according to the criteria given by the Demirjian's method, and Lateral cephalograms were analyzed for the maturation stages of CVMI according to the criteria given by the Lamparski's modified Hassel and Farman.

#### Modified Demirjians method :

Age estimation is based on the development of the eight left permanent mandibular teeth. The calcification of teeth was divided into 10 stages and numbered '0' to '9'. Based on the calcification of teeth visible on the radiograph, each tooth is given an appropriate developmental stage. Depending on the developmental stage, each tooth is given a corresponding maturity score. Considering differences in tooth development between males and females provided separate maturity scores for each sex. The score assigned for each of the eight teeth is added and total maturity score (S) obtained.<sup>8</sup>

#### **CVMI method :**

Lamparski's modified by Hassel and Farman were utilized. On each individual lateral cephalometric radiograph of the cervical vertebrae were matched to a standard and assigned the stage which they most closely resembled<sup>5</sup> (Figure 1).

#### **Statistical Analysis :**

The data is statistically analyzed using IBM SPSS statistical analysis software. Comparison of estimated age using CVMI and Demirjians method with chronological age was performed using paired-t test. Paired sample correlation with chronological age was done using Pearson correlation coefficient.

P value = 0.0001 which is statistically significant.

#### **Results:**

In this study 100 samples were studied, where female sample size was 44 and male sample size was 56 and age ranges from 10 - 16 years (Figure 2). In the age group of 10 - 12 years total sample studied was 38, in 13-14 years age group 28 samples were available, and in 15-16 year age group the sample size was 34 (Figure 3).

By using Demirjians method the mean age for total sample size is 13.38 with standard deviation 2.04. In female and male population the mean age is 13.36 + 2.03 and 13.42 + 2.06 respectively. It shows overall overestimation of estimated age using Demirjians method (Figure 4).

When we consider the CVMI method the mean age for total sample size is 12.54 with standard deviation 1.54. In female and male population the mean age is  $12.63 \pm 1.42$  and  $12.42 \pm 1.70$  respectively (Figure 5).

When we check on each age group 10-14 years of age shows significant mean age difference between CVMI estimated age and chronological age. But when we applied to 15-16 year age group the results shows no significance (Figure 5).

Pearson correlation coefficient shows good correlation value for total samples. The correlation between Demirjian's and Chronologic age is 0.972 and CVMI with Chronologic age is 0.919. If we consider female and male population separately, the results show good correlation with chronological age by both Demirjians and CVMI method. By considering each age group, 10-14 years of age shows good correlation with chronological age in both methods. But in 15–16 year age CVMI shows null correlation with chronological age.





Figure 3 : Sample distribution in each age group.



#### **Discussion**:

Age estimation is important forensic procedure in assessing age of individual in where the chronological age is under dispute where the birth certificate is not available and records are suspect for reasons such as criminal cases. It is also used in medico legal and criminal scenarios such as rape, kidnapping, child marriage, employment, premature births, adoption, and illegal immigration. Dental age estimation is by using morphologic, radiographic, histological, and biochemical methods. Age estimation using the dentition may be grouped into 3 phrases: prenatal, neonatal and Early postnatal period, children and adolescents and adults.



with chronological age

Demirjians method is most widely used dental age estimation method in children and adolescents. This method considered as gold standard method, and is based on calcification of permanent 8 teeth on left side of mandible namely from central incisor to the third molar. However its accuracy has been seemed to vary among different population.<sup>9,10</sup>

In the condition of missing tooth it is not possible to assess age using Demirjians method. So there should be an alternative method for age estimation in this condition. The cervical vertebrae maturation index (CVMI) is one of the easiest and most commonly used skeletal maturity indices. Methods were introduced by Lamparski, who defined six stages of cervical vertebral morphology which can be applied to the second through the sixth vertebrae (C2–C6). Hassel and Farman showed that Lamparski's six-stage method for scoring CVM by evaluating the inferior border of the C2–C4 vertebra was as reliable as the hand and wrist method. During Adolescence period the rate of growth acceleration reaches a peak velocity and then decelerates until. This pattern can be found in all individuals. But there are marked individual variations in the initiation, duration, rates and amount of growth during this period of life depends on various factors.<sup>11,12</sup>

Present study compares the accuracy of age estimation using Demirjian's and CVMI method. Both method shows good prediction of the chronological age, however Demirjians method shows better accuracy in comparison.

In present study modified Demirjian method for Indian population is applied. When Demirjian method was applied to Kannur (Kerala) population, mean difference between chronological age and assessed age was minimal. Also, in the present study Demirjians method shows good correlation with chronologic age for total sample, female and male population separately & in each age group analysis.

The accuracy in current studied Kannur population shows more accuracy compared to NCR<sup>1</sup> and Banglore<sup>13</sup> population and less accuracy compared to Belgaum<sup>14</sup> and Egypt<sup>15</sup> population. Better results in Belgaum and Egyptian study population may be due to the lesser age group population 5-13 years. NCR and Bangalore study population was same as our study and our study results are better. Study by Stanley M. Garn,<sup>16</sup> in Michigan shows the influence of ancestry in the population in which they identified

the earlier permanent tooth emergence in African ancestral groups. Indian city population consists of migrant population from many regions of India, so the NCR and Bangalore results may be reflecting the average accuracy of Indian population. Our study population is completely focused on Kannur population. Better accuracy in Kannur population may be due to better socioeconomic and nutrition status.

Nystrom M et al<sup>12</sup> conducted study to check whether dental maturity charts made in southern Finland can be used without modifications in other parts of the country and found that dental maturity score differed in different region. Their findings suggested differences in dental maturity within a fairly homogeneous population, which should be considered when national charts are used.

In present study, age estimated using CVMI method shows good accuracy and correlation with chronologic age in whole study group. Subgroup analysis in male and female subjects also shows little deviation between chronological age and CVMI estimated age. CVMI method shows good correlation, in 10-14 years group however 15-16 years age group population shows no significant correlation. This may be because the cervical vertebrae reach maturity around 14 years of age, there is minimal further changes occurs after 14 years of age. So CVMI method predicts almost same age even though age varies from 14 years to 16 years.

The accuracy in current studied Kannur population shows better correlation with chronological age compared to studies done in other parts of India namely, Uttar Pradesh,<sup>17</sup> Gwalior,<sup>18</sup> Navi Mumbai,<sup>16</sup> Himachal Pradesh.<sup>19</sup> The study results of Brazilian population<sup>6,20</sup> shows different and less correlation with chronological age even though socioeconomic status and geographic condition are similar to our study population. In the Nordic<sup>21</sup> population in which the socioeconomic status and health are excellent also showed lesser correlation with chronologic age than our study. Study by R. Cameriere et al, in Italy population underlines the fact that vertebral body development across age groups did not change after 14 years of age.<sup>22</sup> Lesser correlation in other studies may be due to the inclusion of more samples in above 14 year age population.

#### **Conclusion :**

Present study compared the accuracy of Demirjian and CVMI method for age estimation in the Kannur population of age range 10-16 year old. Both methods proves to be efficient methods for age estimation based on this study, Demirjian method shows more accuracy and correlation with chronological age when compared to CVMI method. In 10-14 age category, both shows good accuracy, however in 15-16years age group, CVMI estimation is not showing enough accuracy and correlation.

In conclusion, Demirjians method is better & preferred method for estimation of chronological age. But if need arises CVMI can efficiently replace the Demirjians method till the age of 14 years. Chronological age estimation above 14 years of age using CVMI method is questionable.

Ethical Clearance : taken from Kannur Dental college, Kannur, Kerala.

#### Ref. Letter no: KDC/ETH/18/OMR12/3

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**Conflict of Interest:** The authors declares that there is no conflict of interest

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#### **ORIGINAL ARTICLE**

# **Determination of Sex Using Anthropometric Measurements of Clavicle – An Autopsy Based Study**

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#### Abstract :

Skeleton plays an important role in identification as they often survive the morphological alterations, taphonomic destructions, decay and mutilations. Clavicle which is a small long bone, has been studied with a view to determine age and sex. The studies in this aspects are minimal, this study aims to throw more light in this regard. The main objective of the study was to determine the sex of the study subjects using anthropometric measurements of the clavicle. The study was a cross sectional study done at the mortuary wing of the department of Forensic Medicine. Thirty male and thirty female dead bodies were studied after getting written informed consent from near relative of the deceased. Right clavicle was collected from each case, dried and twelve parameters from each were measured. Statistical analysis was done using SPSS 16.0. The various anthropometric measurements of the clavicle like clavicular length (CL), articular length (AL), mid shaft circumference (CC), weight of the clavicle (WC), sternal diameter (SD), acromial diameter (AD), middle diameter (MD) and conoid diameter (CD) had statistically significant difference among males and females. From the ROC curve plotted the selection points to distinguish male and female clavicles for various parameters like Clavicular length, Mid shaft circumference, Articular length, Weight of the clavicle, Sternal diameter, Middle diameter and Acromial diameter had high sensitivity and specificity.

Keywords : Right clavicle; Sex; Clavicular length (CL); Mid shaft circumference of clavicle (CC); Weight of clavicle; receiver operating curve (ROC curve).

#### **Introduction:**

Every human being has a unique set of characteristics and identity in his course of life, which is recognizable even after death. Bones reflect the basic frame work of the human body and provide valuable information about the biological identity. The 'big fours' in forensic anthropology for personal identification are sex, age, stature and ancestry.<sup>1</sup> Several long bones have been studied from time to time and different criteria have been formed to estimate age and sex from them. Skull and pelvis are widely used for sex identification.<sup>2</sup> Sex determination is more accurate with adult skeleton than with sub adults.<sup>3</sup> But there are certain bones that have not been much stressed upon, but is of great significance, the clavicle being one such bone. Gender and stature can be identified from the morphology of clavicle.<sup>4,5</sup> This study aims to determine the sex of a person from the morphology of clavicle.

Reviewing the literature, there were only a couple of studies in our population in this area. There was also a noticeable time gap since the previous study. Being a bone of definite characteristics, the probability of it being dependable based on a good evidential study is very obvious. This may help in future in the identification of sex of a mutilated body.

#### **Objective :**

To determine the sex of an individual using anthropometric measurements of clavicle.

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#### Materials and Methods :

The study is a cross – sectional study done in the mortuary wing of Department of Forensic Medicine, Government Medical College, Thiruvananthapuram, conducted for a period of one year from February 2017 to January 2018 after getting clearance from the Institutional ethical committee. The cases were sixty dead bodies brought for autopsy to the mortuary wing of the department, which were aged above 23 years. Cases with bony deformities to the clavicle and those affecting the stature of the person, those with fracture of clavicle and mutilated and decomposed dead bodies were excluded.

The preliminary parameters of the subjects like stature and gender was noted. During autopsy, the attachments of the right clavicle was cut; it was removed and then macerated to remove remaining soft tissues. Then the clavicle was air dried at room temperature for three days and measurements were taken using Vernier caliper and weight using electronic weighing balance.

The following were the study variables:

**1. Clavicular Length (CL) :** It is measured as the maximum distance between the outer most tips of the sternal and acromial ends of the clavicle placed in the anatomical position, using digital Vernier caliper ( ignoring the curves of the bone), accurate to within 0.5mm.

**2.** Articular length of the clavicle (AL) : It is the straight distance between the mid points of the sternal and acromial ends of clavicle measured with the help of a digital Vernier caliper with pointed ends, accurate to within 0.5mm.

3. Mid-shaft circumference (CC) : The midpoint of the

clavicular shaft is marked between the sternal and acromial ends of clavicle placed in anatomical postion on the osteometric board and circumference at this point is measured using a strip of graph paper marked in millimetres, accurate to be with in 0.5mm

**4. Weight of the clavicle (WC):** The completely cleaned and air dried clavicles were weighed with an electronic weighing machine.

**5. Robusticity or Robustness index (RI) :** It is the robusticity measure of the clavicle and calculated as a ratio of the mid shaft circumference to the clavicular length and multiplied by 100.

Robusticity index(RI) =  $\frac{\text{Mid shaft circumference (CC)}}{\text{Clavicular length(CL)}} \times 100$ 

6. **Product Index (PI):** It is taken as the ratio of the clavicular length and mid clavicular circumference measured in millimeters.

Product index =  $\frac{\text{Maximum clavicular length (CL)}}{\text{Mid clavicular circumference}} \times 100$ 

**7. Sternal diameter (SD) :** It is the straight distance between the highest and lowest point of sternal articular surface in the sagittal plane, measured with Digital Vernier caliper accurate to be with in 0.5mm.

**8. Acromial diameter (AD) :** It is the straight distance between the highest and lowest point of the acromial articular surface in the sagittal plane, measured with digital Vernier caliper accurate to be with in 0.5mm

**9. Middle Diameter (MD) :** It is measured as a linear distance between anterior and posterior surfaces of the diaphysis of the clavicle measured at midpoint (at the level of mid – circumference) using digital Vernier caliper.

**10.** Conoid Diameter (CD) : It is measured as a linear distance between anterior and posterior surfaces of the diaphysis of clavicle at the level of Conoid tubercle (near the acromial end) using digital Vernier caliper.

**11. Rhomboid fossa :** It is a normal variant of the clavicle characterized by a costal impression (depressed or pitted) on its inferior aspect, about 2-3mm away from the sternal end where the cos to clavicular ligament or rhomboid ligament connects it to first rib. It is generally present in both sexes and may be of large, medium or small size. Arbitarily, a length of more than 25mm in its long axis was considered as large, 15 to 25mm as medium and less than 15mm was taken as small.

#### Data analysis :

Data analysis was done using Statistical package for Social Sciences (SPSS 16.0) software. The descriptive summary for different variables in two sexes was listed. Independent t-test was applied to statistically compare the significance of differences in mean values between two sexes. ROC (receiver operating characteristics) curve was plotted to find out the selection value to differentiate between two sexes.

#### **Observations and Results :**

Socio demographic profile : The study subjects were divided

into age groups of 21-40, 41-60, 61-80 and above 80 years age group. Majority of males belonged to the age group of 41-60 years (n=14, %=46.67) and females belonged to the age group of 61-80 years (n=13, %=43.33).

**Height of the population:** The mean height of the study population was 161.70cm (sd-0.093) and the median was 161cm with a minimum height of 145cm and maximum height of 180cm. Among the males the mean height was 167.83 (sd-0.069) and median height was 169cm. Among the females the mean height was 155.60 (sd-0.070) and the median was 154cm. On analysis using independent 't' test the difference in the means of the height was statistically significant with p value <0.001.

#### Gender wise distribution of Anthropometric measurements:

The mean and median values of the anthropometric measurements of the clavicle in male population were; mean of Clavicular length (CL) 148.53mm (sd-7.82) and median 149.63, mean of Articular length (AL) of clavicle 147.57mm (sd-7.89) and median of 148.48mm. The mean Mid shaft circumference (CC) was 37.26mm (sd-2.74) and median of 26.55gm. The mean of weight of clavicle was 27.22gm (sd-4.05) and median 26.55. The mean Robusticity Index (RI) was 25.13 (sd-1.93) and median

 

 Table No.1 : Anthropometric measurements of clavicle in relation to gender (n=30 in each group)

Measure- ments	Gender	Maxi mum	Mini mum	Mean	Standard deviation	Standard error mean	t	р
CL in mm	Males	133.56	166.05	148.53	7.82	1.43	11.42	< 0.001
	females	113.05	139.70	122.44	7.02	1.28		
AL in mm	males	132.61	165.87	147.57	7.89	1.44	11.46	< 0.001
	females	111.19	138.39	121.39	6.90	1.26		
CC in mm	males	32.67	44.11	37.26	2.74	0.50	8.64	< 0.001
	females	21.24	37.85	29.77	3.88	0.71		
WC in gm	males	19.64	36.14	27.22	4.05	0.74	10.81	< 0.001
	females	8.84	25.29	16.35	3.73	0.68		
RI	males	21.99	30.56	25.13	1.93	0.35	1.56	0.222
	females	17.89	29.87	24.32	2.99	0.55		
PI	males	327.18	455.76	400.17	30.12	5.49	-1.87	0.129
	females	334.75	559.04	417.19	52.16	9.52		
SD in mm	males	19.80	28.16	24.53	2.17	0.39	6.73	< 0.001
	females	15.31	26.25	20.38	3.35	0.61		
AD in mm	males	21.03	34.26	26.39	2.92	0.53	7.41	< 0.001
	females	15.31	26.25	20.38	3.35	0.61		
MD in mm	males	9.11	15.32	12.19	1.44	0.26	7.02	< 0.001
	females	7.83	11.77	9.79	1.19	0.22		
CD in mm	males	13.02	20.46	16.68	2.02	0.37	5.85	< 0.001
	females	11.29	17.85	13.86	1.69	0.31		

Test variable	area	Std.error	Asymptotic sigb	Asymptotic 95% confidence interval		
				Lower bound	Upper bound	
CL	0.969	0.018	< 0.001	0.934	1.004	
CC	0.949	0.028	< 0.001	0.894	1.004	
WC	0.975	0.017	< 0.001	0.942	1.008	
CD	0.864	0.048	< 0.001	0.771	0.958	
AL	0.972	0.016	< 0.001	0.940	1.004	
SD	0.894	0.041	< 0.001	0.814	0.974	
AD	0.930	0.031	< 0.001	0.868	0.992	
MD	0.902	0.039	< 0.001	0.825	1.008	
Clavicular parameter	Selection point	sensititvity	specificity			
CL in cm	13.625	86.7%	86.7%			
CC in cm	3.450	90%	90%			
WC in gm	22.78	93.3%	93.3%			
CD in cm	1.490	86.7%	83.3%			
AL in cm	13.515	86.7%	90%			
SD in cm	2.248	86.7%	80%			
AD in cm	2.422	86.7%	90%			
MD in cm	1.089	90%	83.3%			

Table no 2: Area under the curve and selection point for various clavicular parameters:

of 25.02. The mean Product Index (PI) was 400.17 (sd-30.12) and median of 399.67. The mean Sternal diameter (SD) was 24.53mm (sd-2.17) with a median of 24.62mm. The mean Middle Diameter (MD) was 12.19mm (sd-1.44) with a median of 12.46mm. The mean Conoid Diameter (CD) was 16.68mm (sd-2.02) with median 16.36mm (Table no 1).

The measurements in the female study population showed that the mean Clavicular length (CL) was 122.44mm (sd-7.02) and median 120.89. The mean Articular length (AL) of clavicle was 121.39mm (sd-6.90) and median of 120.06mm. The mean Mid shaft circumference (CC) was 29.77mm (sd-3.88) and median of 30.21mm. The mean weight of clavicle was 16.35gm (sd-3.73) and median of 24.18. The mean Productivity Index (PI) was 417.19 (sd-52.16) and median of 413.65. The mean Robusticity Index (RI) was 24.32 (sd-2.99) and median of 24.18. The mean Sternal diameter (SD) was 20.79mm (sd-2.14) with a median of 21.16mm. The mean Middle diameter (MD) was 9.79mm (sd-1.19) with a median of 9.79mm. The mean Acromial diameter (AD) was 20.38mm (sd-3.35) with a median of 20.83mm. The mean Conoid diameter (CD) was 13.86mm (sd-1.69) with median of 14.27mm (Table no1).

There was difference in the means of the clavicular length, articular length of clavicle, mid shaft circumference, weight of clavicle, sternal, acromial, middle and conoid diameters of clavicle between the two groups. The difference was found to be statistically significant with a p value < 0.001 on independent 't' test. The difference in the means of Robusticity and Product





Figure 1: Graphical representation of different clavicular measurements.



Figure 2: ROC curve of Clavicular Length in males.



Figure 3: ROC curve of Weight of Clavicle (WC) in males.





index was not significant as their p values were > 0.05.

#### **Rhomboid fossa:**

Majority of the males in the study population had medium sized rhomboid fossa (65.33%) followed by small size (20%), not clear (10%) and large size (6.67). The majority of females in the study population had small sized rhomboid fossa (53.33%), followed by medium size (30%) and not clear in 16.67% cases. None of the female clavicles showed a large sized rhomboid fossa in relation to gender was found significant with p value of 0.014.

Selection points from ROC curves to find out the relation of clavicular measurements with gender:

ROC curve or Receiver Operating Characteristics curve is one of the most important evaluation metrics for checking any classification model's performance. It tells how much the model is capable of distinguishing between classes. Higher the area Area Under the Curve better the model is at distinguishing between two classes. The ROC curve was used in this study to obtain selection points or optimal cut off points (points with the highest possible sensitivity and specificity when considered together) for each clavicular measurement for the prediction of gender. The closer the curve is to the left-hand border and the top border of the ROC space, the more will be the correlation of the measurement with the gender of the individual.

#### Selection point of clavicular length (CL) in males :

The selection point was obtained as 13.625cm, with a sensitivity of 86.7% and specificity of 13.3%. Among the 30 males, 26 had values more than 13.625 and 4 had less than 13.625 that is 86.7% and 13.3% respectively. Among the 30 females, 26 had CL values less than 13.625 and 4 had more than 13.625 that is 86.7% and 13.3% respectively (Table no 2).

#### Selection point of Midshaft circumference (CC) in males:

Mid shaft circumference of clavicle had a selection point of 3.450cm with a sensitivity of 90% and specificity of 10%. Among the males, 27 males had CC values more than 3.450cm

and 3 males had values less than 3.450cm, that is, 90% and 10% respectively. Among the 30 females, 27 females had CC values less than 3.450cm and 3 females had values more than 3.450cm that is, 90% and 10% respectively (Table no 2).

#### Selection point for Weight of Clavicle (WC) in males :

In the ROC curve plotted for weight of clavicle the value of the area under the curve was near 1 and the highest level of sensitivity and specificity (93.3% each) was noted for this parameter. The selection point was 22.78gm and among the males 28 had weight above 22.78gm and 2 had weight below 22.78gm, that is, 93.3% and 6.7% respectively. In the case of females, 28 females had WC values than 22.78gm and only 2 females had values more than 22.78gm, that is, 93.3% and 6.7% respectively (Table no 2).

#### Selection point for Conoid diameter (CD) in males :

In the case of Conoid diameter, the selection point was 1.49cm, with a sensitivity of 86.7% and specificity of 83.3%. Among the males, 26 had CD values more than 1.49cm and 4 had CD values less than 1.49cm, that is, 86.7% and 13.3% respectively. Among the females, 25 had CD values less than 1.49cm and 5 had CD values more than 1.49cm that is 83.3% and 16.7% respectively (Table no 2).

# Selection points for Articular length, Sternal diameter, Acromial diameter and Middle diameter in males :

In the case of Articular length selection point was obtained as 13.515cm, with a sensitivity of 86.7% and specificity of 90%. The Sternal diameter had a selection point of 2.248cm, with a sensitivity of 86.7% and specificity of 80%. Acromial diameter had a selection point of 2.422cm, with a sensitivity of 86.7% and specificity of 90%. The Middle diameter of clavicle had a selection point of 1.089cm, with a sensitivity of 90% and specificity of 83.3% (Table no 2).

#### **Discussion**:

The observations and results of the study have clearly shown that the various Clavicular parameters measured had significant difference among males and females, among which Weight of the clavicle had a greater area under the ROC curve with selection point of high sensitivity and specificity.

The mean clavicular length from the present study 13.548cm which is in agreement the study of Dr. Gullapalli  $A^6$  who also observed it to be 14.00cm.

Regarding the anthropometric measurements of the clavicle in relation to difference in sex, various other studies from different parts of India (Patel et al, Kaur et al, Rani Y et al, Jit Singh et al, Sehrawat et al, Doshi et al, Bagal et al, Bindhu et al, Thulasi et al) show that there is not much difference in length of clavicle, but shows statistically significant difference between the sexes with a p value <0.001.<sup>5-15</sup>

The mean clavicular length in a study conducted by Alcina et al in Spanish population showed the difference between males (mean length -55.12mm and sd - 10.036) and females (mean length - 122.44mm and sd - 7.02) to be statistically significant (pvalue<0.001). The same study also showed a statistical significance (<0.001) between the midshaft circumference of

males and females15. Akhlagi et al in their study on Iranian population found that mean of maximum length of the clavicle was larger in men (p<0.001). By using clavicular anthropometric parameters, they could determine sex with 73.3% to 88.3% accuracy.<sup>16</sup>

Other anthropometric measurements measured in the study including Articular Length (AL), Weight of Clavicle (WC), Robusticity Index (RI), Product Index (PI), Sternal diameter (SD), Middle diameter (MD), Acromial diameter (AD), Middle diameter (MD) and Conoid diameter (CD) had values comparable with the study by Sehrawat et al<sup>5</sup> on north-west Indian population.

Various authors including Thulasi et al,<sup>17</sup> Sehrawat et al<sup>5</sup> have noted a distinct Rhomboid fossa in varying proportion of their samples, where as in this study majority of male clavicles showed medium sized rhomboid fossa and majority of female clavicles showed small sized rhomboid fossa. None of the female clavicles showed a large sized rhomboid fossa.

ROC curve was used in this study to obtain selection points or optimal cut off points (points with the highest possible sensitivity and specificity when considered together) for the prediction of gender. From the ROC curve plotted, the selection point of clavicular length (CL) was obtained as 13.625cm, with a sensitivity of 86.7% and specificity of 86.7%. The accuracy was 96.9% (Area under curve was 0.969), which was higher than that of the studies of Alcina et al (90.9%) and Jit Singh et al (80.8%).<sup>4,15</sup>

From the ROC curve noted for the Mid shaft circumference of clavicle the selection point was obtained as 3.450, with a sensitivity of 90% and specificity of 90%. The accuracy was 94.9% (Area Under Curve 0.949). Alcina et al observed an accuracy of 88.3% in their study<sup>15</sup> and Jit Singh et al<sup>4</sup> an area of 71.8% in their study.

Maximum sensitivity (93.3%) and specificity (93.3%) for detection of sex were observed for the weight of the clavicle, with a selection point of 22.78gm. It means values above 22.78gm represented most of the males and values below 22.78gm represented most of the females. The accuracy was 97.5%.

The other parameters like Conoid diameter, Articular length, Sternal diameter, Acromial diameter and Middle diameter had selection points with high sensitivity, specificity and accuracy (Table no 2).

Results of present study can be used very much in daily forensic Practice, even with a mutilated or skeletonized remains of a dead body. The selection points for various clavicular parameters to differentiate between males and females with high specificity and sensitivity was found out from this study. Even though a part of the clavicle is obtained Articular diameter, Sternal diameter, Middle diameter and Conoid diameter can be used to assess the gender of the person.

The present study was conducted on the clavicles of right side of 60 cases, 30 males and 30 females each. If a clavicle from left side is used the result of this study cannot be used. So it is needed to conduct the study on a large sample and to include clavicles from both sides to increase the generalizability of the result.

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#### Conflict of Interest:

The authors declare that there is no conflict of interest.

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## Pattern of Injury in Lightning Deaths- A Post Mortem Study in Southern Odisha

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#### Abstract :

Lightning is one of the most powerful natural phenomena resulting in high-voltage electrical injury. This study attempts to analyze the different patterns of injury, epidemiological profile, trend and circumstances of lightning deaths in one of the southern region of Odisha. This cross-sectional retrospective study was conducted on the 58 fatal cases of lightning strike autopsied in the department of Forensic Medicine and Toxicology of M.K.C.G. Medical College, Berhampur, Odisha during a period of 5 years (2016 - 2020). Lightning deaths constituted 0.89% of total post mortem cases with a male to female ratio, 3.46:1. Majority of victims (27.59%) were between 41-50 years, from rural background and agricultural workers. A fluctuating trend in lightning deaths is seen. 2016 and 2017 had highest incidence of lightning i.e. 31.03% each. Maximum deaths (29.31%) occurred in the month of June and between 3-5 PM (62.7%). The incidences occurred mostly (94.82%) open areas and 37.93% were working in agricultural land. Only 5.17% victims had taken shelter under trees. Burn injuries (mostly linear) were dominant (84.48%) and involved mostly the chest in 39.66% cases followed by abdomen (36.2%). Arborescent marks were detected in 8.62% cases, other injuries in 22.41% and burning and singeing of hairs in 53.45%. Clothing was torn in 13.79% of victims and ear bleeding in 15.51%. No gross internal injury was seen except SAH in 2 cases. All the victims were brought dead and cause of death was mostly due to cardiac arrest. This study will provide expertise and ideas to medical personnel and various stakeholders for prompt management, prevention of fatalities, solve medicolegal issues and policy making.

Keywords : Electrical injury; Burn; Arborescent marks.

## **Introduction:**

Lightning is one of the most powerful natural phenomena which occur commonly during thunderstorm. Cloud-to-ground (CG) lightning is an electric discharge between a thundercloud and the ground and initiated by a stepped leader moving down from the cloud, which is met by a streamer moving up from the ground; it poses the greatest threat to life and property since it terminates or "strikes" the Earth.<sup>1</sup> Out of the three main kinds of lightning it is least common but best understood. Lightning strikes between clouds and ground objects occur when the difference in electrical potential is greater than 30,000 Volts, as thus they are able to exceed the atmospheric electrical resistance, generating currents that vary from 30,000 to 100,000 Amperes, and lasting between 0.1–0.001 seconds.<sup>2,3</sup> According to the National Weather Service, in the US, lightning, can heat the air it passes through to as much as 50,000 degrees Fahrenheit, that's nearly 27,800 degrees Celsius. That's nearly five times hotter than the Sun.<sup>4</sup> Momentary heating and cooling of atmosphere in the lightning rim create vibrant or rumbling sound called thunder.

In many cultures, lightning has been viewed as part of a deity or a deity in and of itself. The Hindu god Indra, the Greek god Zeus and Thor in Norse mythology are the stark examples. In the traditional religion of the African Bantu tribes, lightning is a sign of the ire of the gods. Verses in the Jewish religion and Islam also ascribe supernatural importance to lightning.<sup>5</sup> Not only in ancient and medieval days, even in today's time lightning is singularly

Corresponding Author Abarnita Sethi Email : sethiabarnita1@gmail.com Mobile No. : +91-8847854373 responsible for sudden accidental deaths contributed by natural calamity.

Epidemiology: Lightning is a frequent occurrence worldwide with an estimated 50 occurrences per second and 20% of those resulting in ground strikes. It is impossible to know exactly, but it is estimated that worldwide there are approximately 24,000 fatalities with ten times as many injuries annually due to lighting.<sup>6</sup> The world's principal lightning hotspot is located over the southern end of Lake Maracaibo, a brackish bay in northwestern Venezuela with an average of 232.52 flashes of lightning per square kilometer per year.<sup>7</sup> According to the US National oceanic and atmospheric administration (NOAA), lightning is the second killer among the four major storm-related hazards. About 100 individuals, on average, are killed annually by lightning in the United States.8 India is more susceptible to lightning impact due to its geographical positioning, topography and climatic anomalies. There were 2,885 deaths attributed to lightning in 2017, 2,389 in 2018 and 2862 deaths in 2020 according to India's National Crime Records Bureau.9 Lightning strikes have caused 1,771 deaths between April 1, 2019 and March 31, 2020 in India, according to a report by Climate Resilient Observing Systems Promotion Council (CROPC).<sup>10</sup> A coastal state in India is not an exception and is regularly struck by thunderstorms. Statistics show that of all the calamities that befall the state at regular intervals, lightning claims more human lives (25%) than any other natural disaster. Maximum number of deaths has been reported from districts like Mayurbhanj, Ganjam, Dhenkanal and Sundargarh. It was declared as a state specific disaster by the Odisha government in 2015 and an ex-gratia assistance of 4 lakh rupees is being given.<sup>11</sup>

**Mechanism:** Lighting injuries are divided into direct strikes, side splash, contact injury, and ground current. The most common way in which people are struck by lightning is by 'ground currents'. The electrical energy, after hitting a tree or any other object, spreads laterally on the ground for some distance, and people in this area receive electrical shocks. Direct Strike occurs most often in open areas; not very common, but the deadliest. Victim is part of main lightning discharge channel. Side Flash (Or Side Splash) occurs when lightning strikes a taller object and some current



Photo 1: Linear burn injury and tearing of clothes



Photo 2: Typical arborescent mark over chest.



Photo 3: Surface burn due to Metallization of necklace.



Figure 1: Year wise distribution of cases.



Figure 2: Month wise distribution of cases.



Figure 3: Occupation wise distribution of cases.

jumps on to the victim, who ends up acting as a 'short circuit' for the energy. It occurs when the victim is within a foot or two of the struck object. Most victims are those sheltering under a tree in a rainstorm. Lightning can travel long distances in wires or other metal surfaces and provide a path for the lightning to follow. Most indoor lightning casualties and some outdoor casualties are due to conduction.<sup>12</sup>

**Injury Pattern:** Although 90 percent of people struck by lightning survive,<sup>13</sup> animals – including humans – struck by lightning may suffer severe injury due to internal organ and nervous system damage. Lightning mostly causes linear burns, surface burns and arborescent markings. The heat component of lightning may affect the clothing or the skin. Of ten times, there

are linear, first-degree burns, which may follow the skin creases. These marks may be centimeters long and generally follow the long axis of the body towards the ground. There may be superficial charring of the skin, chiefly over the trunk.<sup>14</sup> Surface burns occur due to metallic objects in the area which may get fused or become magnetized. The electrical component may cause Lichtenberg figures (arborescent or fern-like injuries) named after Georg Christoph Lichtenberg (1742–1799).<sup>15</sup> These are superficial, thin, irregular and tortuous markings on the skin

Table 1. Age and sex wise distribution of cases.	Table	1: A	ge	and	sex	wise	distribution	of cas	ses.
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Age group in years	Male	% of cases	Female	% of cases	Total	%
0-10	0	0	0	0	0	0
11-20	6	10.34	1	1.72	7	12.06
21-30	6	10.34	3	5.17	9	15.52
31-40	14	24.14	1	1.72	15	25.86
41-50	9	15.52	7	12.06	16	27.59
51-60	8	13.79	1	1.72	9	15.52
61-70	1	1.72	0	0	1	1.72
>71	1	1.72	0	0	1	1.72
Total	45	77.59	13	22.41	58	100

Table 2: Distribution of cases according to place and activity.

Place	Activity	No. of cases	% out of 58 cases
Outdoor (Open area):		55	94.83
	Agriculture work	22	37.93
	Travelling on road	7	12.06
	Open Field(standing)	6	10.34
	Attending call of nature	6	10.34
	Labour work	5	8.62
	Grazing animals	4	6.9
	Under tree	3	5.17
	Selling vegetables	2	3.45
Indoor (Closed area)		3	5.17
Total		58	100

Table 3:	Distribution	according	to	burn	injury.
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Sl. No.	Site of body	No. of victims	Total cases	=58(100%)
1	Head	Scalp	5	8.62
2		Face	18	31.03
3	Neck		12	20.68
4	Chest		23	39.65
5	Abdomen		21	36.2
6	Upper Limbs		9	15.51
7	Lower limb	Thigh	10	17.24
8		Leg	2	3.44
9		Foot	1	1.72
10	Pubic and Inguinal region		16	27.58
11	Back		8	13.79

and indicate the path taken by the electrical discharge and are pathognomonic. It appears within 1 hour and disappears in 1-2 days if the person survives.<sup>16</sup> In addition to direct damage, secondary trauma and blast effect also contributes to the increased mortality. They may be observed in the form of tearing of clothing or shoes. Blunt trauma to organs such as the spleen, liver, lungs, and bowels is possible due to shock waves or falling or being hit with an object.<sup>17</sup> The barotrauma component may chiefly injure the ear.18 The electrical component may cause cardiac arrhythmias.<sup>19</sup> Sudden death may be attributed to the direct involvement of the central nervous system causing death from paralysis of cardiac and/or respiratory centre. High-voltage electric current may cause spasmodic contraction of the cerebral vessels leading to cerebral anemia, which in turn may be responsible for stoppage of respiration and circulation. However, contraction of the heart muscle may also be due to direct effect of current on the heart. In such cases, no specific findings are to be expected.<sup>20</sup>

The spectrum of injury in lightning strike can range from no external injury to mild superficial skin burns to severe multi organ dysfunction and death. This diversity in pattern of injury and clothing give rise to suspicion of foul play, therefore diagnosis of lightning death require proper history taking, circumstantial evidence and meticulous examination. History of thunderstorm in the locality, typical nature and distribution of burns, tearing of the clothing with burnt smell is characteristic.

Therefore the objective of the study is to analyze the different patterns of injury, epidemiological profile of the victims, trend and circumstances in lightning deaths in the last 5 years in one of the southern region of Odisha. Moreover no study has been conducted on lightning death in this part of India. This study will provide expertise and ideas to medical personnel, investigating agencies and various stakeholders for prevention of fatalities; solve medicolegal issues and policy making.

#### Materials and Methods :

This cross-sectional retrospective study was conducted in the department of Forensic Medicine and Toxicology of M.K.C.G. Medical College, Berhampur, Odisha for a period of 5 yrs (1<sup>st</sup> January 2016 – 31<sup>st</sup> December 2020) after taking ethical clearance from institutional ethics committee. This is a tertiary health center present in the District of Ganjam which is situated in southern part of Odisha. This being a referral center receives dead bodies from whole of the Berhampur city, and adjacent rural areas of southern Odisha. All cases of lightning deaths coming for post mortem to the mortuary were considered for collection of the data. All the documents pertaining to aforementioned cases were perused in each and every case and the circumstantial evidences provided in the documents are taken into account for the study. The facts and findings relevant to our study like age, sex, date, time, place, religion, occupation, socioeconomic status, activity during incidence, injuries were noted down in the case record form. All autopsy cases other than suspected lightning deaths and grossly decomposed bodies were excluded from the study. All the data were analyzed and compared to findings of other researchers.

#### **Results :**

During the 5 year study period, out of 6501 autopsy cases, lightning deaths accounted for 58 cases i.e. 0.89%. All the victims were brought dead. Table 1 show that there is a 45 male and 13 female victims, showing male preponderance with male to female ratio, 3.46:1. Majority (16, 27.59%) of victims were in the age group between 41-50 years followed by 31-40 years (15, 25.86%) in. Study reflects [Figure 1] a fluctuating trend in lightning deaths in last five years. Year 2016 and 2017 both had the highest incidence (18 each, 31.03%) of lightning deaths. Figure 2 reveals most cases were in the beginning of monsoon season in the month of June which represented the highest number of cases i.e. 17 (29.31%). Maximum number of deaths occurred during between 3-5 PM (36, 62.7%) followed by 5-8 PM (12, 20.69%) and 12 noon -3 PM (7, 12.07%). According to our data (Table 2) lightning strike incidence occurred mostly (55, 94.82%) in open areas where people were working in agriculture land (22, 37.93%) followed by people present on road (7, 12.06%) and only 3 victims (5.17%) had taken shelter under trees. All the victims were from Hindu community, rural background, and low socioeconomic status. Figure 3 shows majority of them were agricultural workers (farmers) i.e. 23 out of 58 cases (39.66%). Linear burn was the most common pattern seen in 49 cases (84.48%). Photo 1 shows linear burn injury and tearing of clothes. Table 3 reveals burns involving mostly chest (23, 39.66%), followed by abdomen (21, 36.2%). In 05 out of 58 cases typical arborescent mark of lightning was observed in the body of victim as shown in Photo 2. Surface burn due to metallization (Photo 3) was found in 7 (12.06%) cases. Other associated injuries like abrasion contusion and laceration mostly over extremities were noticed in 22.41% cases. Only 9 (15.51%) cases presented with ear bleeding with rupture of tympanic membrane. In 31 (53.45%) cases burning and singeing of hairs was found, out of that pubic hair was mostly involved i.e. 18 cases (31.03%) followed by scalp hair (14,24.13%) and body hair (9, 15.52%). In two cases Sub arachnoid haemorrhage was also found, Petechial hemorrhage was seen in heart in 27 (46.55%) cases and brain in 6 cases (10.34%). No other gross internal injury was found. Clothing was torn in 13.79% victims. Cardiopulmonary arrest following lightning was most common (49, 84.48%) cause of death.

#### **Discussion**:

In our study the incidence of lightning deaths is 0.89% of all autopsies which is slightly more than study by Ban Goswami etal<sup>21</sup> where lightning death cases were 0.54% out of the total 1109 autopsy conducted. Study by Manukonda R.V. etal (2018)<sup>22</sup> shows male predominance, with a male to female ratio of 7:1 which is double to that of our finding (3.46:1), this shows female are also predominant agricultural workers in this region. Study by Shrigiriwar MB<sup>23</sup> and Ban Goswami R etal<sup>21</sup> revealed equal number of male and female deceased was found, however the female victims were predominant over male in studies by Gadge SJ<sup>24</sup> and Shrigiriwar MB (2013). In our study maximum number of victims (27.59%) were in the age group 41-50 years, which differs from study by Shrigiriwar MB (2013) (21-31years),<sup>23</sup> Gadge SJ,<sup>24</sup> Guntheti BK and Singh UP (2015),<sup>25</sup> Manukonda RV

etal  $(2018)^{22}$  and Ban Goswami R et al<sup>21</sup> where most cases were between 31-40 years. In our finding most of the victims belonging to rural background and low socioeconomic status matches with that of Gadge SJ<sup>24</sup> this is because most cases occur in rural area where people do agricultural work in open area.

According to 'the accidental deaths in India' report, in 2018-19, India<sup>10,25</sup> reported a total of lightning deaths, up from 2,357 deaths in the previous year. This is contradictory to our finding where cases have grossly decreased. However in India in 2019 and 2020, death has reduced to 1771 and 1697 respectively, which is slightly similar. This trend is similar to ours as we find a decreasing trend in lightning deaths in last one year which tallies with the state data also. This may be attributed to preventive measures like early lightning warnings taken by the government. As per US NOAA data, only about 20 % of lightning victims die, this is also in concurrence with study by Guntheti etal<sup>25</sup> which showed, 89.47% cases of lightning strike were brought dead to hospital. This is in contrast to our findings where all the victims were brought dead to the hospital. This may be due to the fact that there are advance and prompt resuscitation facilities in US also that we have considered only autopsy data and not studied the survivor of lightning strikes.

In our study most of the cases occurred in open field or outdoors, which matches with the study of Chao TC et al (1981),<sup>26</sup> Ban Goswami R et al,<sup>21</sup> Elsom DM et al.<sup>27</sup> This is contrast to the findings of Shrigiriwar MB; most of the cases victims were standing /sitting under tree, followed by working in field. This is due to the fact that most people were struck by direct effect or ground current easily under open sky due to absence of any barrier. Chao TC et al (1981)<sup>26</sup> had mentioned that no death due to lightning occurred in well protected places whereas in our study 3 deaths one have occurred indoor. Two cases were in verandah and another in a place inside metallic gates. The person was repairing some electrical appliances with the plugs on and got struck by lightning. Elsom DM et al<sup>27</sup> in his study reveals that apart from the rare risk of lightning entering the building through an opening such as a door or window, most indoor victims receive an electrical charge through indirect means involving electrical wiring or plumbing which conduct electricity from a nearby strike. Common culprits to be avoided are corded phones, computers which are plugged to the electrical mains and radiators.<sup>27,28</sup> Present study shows that incidences occurred mostly in open areas (55,94.82%) where people were working in agriculture land (22 cases, 37.93%), it coincides with the study of Gadge SJ and Shrigiriwar MB (2013), Guntheti BK and Singh UP (2015).<sup>25</sup> As agricultural works are mainly outdoor activities and early monsoon is the time sowing, thus they become more susceptible. Most of the cases happened during June followed by July months which is monsoon season; it matches with the study of Gadge SJ and Shrigiriwar MB (2013) and Guntheti BK and Singh UP (2015). Our finding is similar to the data from CROPC, that deaths from lightning strikes are common in India and the South Asian region in May and June.<sup>10</sup> Maximum cases (36, 62.7%) occurred between 3-5 pm which is similar to study by Guntheti BK and Singh UP (2015) and Gadge SJ and Shrigiriwar MB (2013) where cases occurred mostly in afternoon this may be

due to the fact that this is the working hour in day time.

The mechanism of injuries may include electrical injury, burns from heat, and mechanical trauma.<sup>1</sup> Our study also reveals this. We found burn injury as predominant which is consistent with the findings of Gadge and Shrigiriwar, and Guntheti BK. Arborescent mark is one of the pathognomonic finding in death due to lightning, which was found in 5 cases (8.6%) in our study in contrast, Guntheti BK<sup>25</sup> found them in 68.42% cases and Ban Goswami<sup>21</sup> in 83.3% cases. Burning and singeing of hairs was seen in 50% cases by Ban Goswami which almost matches our finding 53.45%. A study by Manukonda et al<sup>22</sup> showed specific findings ranging from petechial hemorrhages on the heart, lungs and brain to fracture of bones whereas our study shows Petechial hemorrhage in 27 (46.55%) cases in heart and 6 (10.34%) cases in the brain and No other gross internal injury was found. In few victims (13.79%) clothing were torn which contradicts to findings by Shrigiriwar etal,<sup>23</sup> they found it in most cases.

#### **Conclusion :**

Lightning is a characteristically high-voltage electrical injury resulting in high rates of morbidity and mortality. The physical injuries may resolve completely or it may lead to long-term effects. Mechanism of infliction of injury is complex but needs understanding by the medical personnel and investigating agencies. In most cases victims die immediately after lightning effect, but in some cases person survives they need immediate resuscitative measures. Such deaths are preventable with better rural health care facilities and public awareness of safety measures and government policy for thunderstorm warnings through media. People are advised to go indoors in a storm. Taking shelter under a tree, or shed can increase risks. Even indoors, electrical fittings, wires, metal and water must be avoided. When inside, avoid using electrical appliances and telephone wire should be unplugged. This study points out data which will provide expertise and ideas to various stakeholders for prevention of fatalities, solve medicolegal issues and policy making in this dreaded natural calamity.

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#### **ORIGINAL ARTICLE**

## Sequential Blood Lactate Measurement as Death Alarm for the Patient with Sepsis

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#### Abstract :

The lactate levels in the blood are raised in septicemia, signifying reduced oxidative phosphorylation, which secondarily causes hypoxic hypoxia and stagnant tissue hypoxia. Hence, a high rise of the lactate level in blood may be a valuable forecaster of mortality of patients suffering from severe infection along with some biochemical and clinical related factors. Therefore, in the current study, we evaluated the relationship between serial blood lactate levels and mortality among patients with life-threatening sepsis infections admitted to the Critical Care Centre. It was a cross-sectional study. In this descriptive study, we have included 50 septicemic patients above the age of 18 years. At admission, 24 hours and 72 hours, we monitored the blood's lactate levels. Grouping of the patients as survivors and non-survivor was done based on their clinical status for four weeks. To test the difference in mean blood lactate levels among survivors and non-survivors, student's t-test was applied. The statistical analysis was made with Microsoft Excel and SPSS version 20. A p-value of less than 0.05 was considered significant. In the current study, 23 were survivors, and 27 were non-survivors after 28 follow-ups. The mean lactate range for the 23 survivors ranged from 0.43 mmol/l to 5.69 mmol/l, whereas for non-survivors, it was 1.64 mmol/l to 6.14 mmol/l. The mean value of lactate for the survivors and non-survivors during admission time, at 24 hours and 72 hours were 0.9545±0.45798 vs 2.5204±1.51498, 1.2461±1.21360 vs 2.5107±1.63678 and 1.5496±1.66788 vs 2.7904±2.00160. The differences between the mean lactate values between survivors and the fatal group at different time intervals were highly significant. The result reveals serial blood lactate levels as a significant predictor of mortality in patients with sepsis.

Keywords : Mortality predictor; infection; intensive care unit (ICU); survivors.

### **Introduction:**

Septicemia is a severe ailment because of detrimental microbes developing in a systemic inflammatory response syndrome.<sup>1</sup> As a result of the body's response, the vital parameters start malfunctioning, leading to organ failure and may even cause death.<sup>2</sup>

The biochemical and clinical markers of those patients with severe infection can be evaluated to measure the seriousness, predicting morbidity and mortality. Those markers can predict hospital stay duration, the cost involvement, and the specific management it needs. Though many, lactate levels in the blood come closest in the alarming outcome of the patients.<sup>3</sup> Blood samples were taken via a forearm venous catheter and whole blood samples were analyzed using the criterion/reference enzymatic method.

The greater blood lactate level with life-threatening infection reflects hypoxic and stagnant hypoxia.<sup>4</sup> In the Critical Care Centre (CCC), the lactate blood level echoes tissue oxygen perfusion and the stage of cellular hypoxia.<sup>5</sup>

In the in-patient in CCC with sepsis, evaluation of lactate has been used to indicate tissue hypoxia.<sup>6,7</sup> Therefore, the standard

**Corresponding Author Putul Mahanta** Email : drpmahanta@gmail.com Mobile No. : 9435017802 practices endorse immediate resuscitation of septic patients if lactate level goes >4 mmol/l in the initial phages,<sup>1</sup> considered 'golden hours'.<sup>8</sup>

Hence, the current study objects to determine the association of consecutive blood lactate levels with the patient's mortality with sepsis in the CCC so that severeness and outcome of the patient can be revealed to the attendant of the patient for acceptance of the result or to refer the case to a better-equipped centre.

#### **Materials and Methods :**

The current prospective research was performed in the department of Anesthesiology in the CCC at a tertiary care hospital in India's north-eastern region. Fifty patients above 18 years were studied. The Institutional Ethics Committee of Assam medical college and hospital vide ref: AMC/EC/PG/101has given the ethical approval. Before collecting the samples, we obtained informed consent from the capable patients, otherwise obtained from the legal guardians.

Blood lactate levels were monitored and recorded at regular intervals, i.e., on admission time, at 24 hours and 72 hours. Data thus collected were presented as frequency, percentage and mean and standard deviation. The patients were followed up for 28 days and categorized as survivors or non-survivor, depending on the outcome. The statistical analysis was done using Microsoft Excel and statistical package for social sciences for windows version 22. The association between categorical variables were assessed

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using the Chi-square test. The differences in mean blood lactate levels were tested using an unpaired t-test. The p-value of less than 0.05 was considered significant.

#### **Results:**

## Details of study participants:

Among the 50 participants, 29 (58%) were male, and 21 (42%) were females. The study participants' mean age ( $\pm$ standard deviation) was 45.06 ( $\pm$  3.26) years. The majority of the cases, 19 (38.0%), belonged to the higher age group of 46-60 years, followed by 30-45 years of patients for 15 (30.0%) cases, as shown in Table 1.

Among the 50 patients included in the study, 23 were survivors, and 27 were non-survivors during 28 days of follow-up. The mean  $(\pm)$  age of non-survivors was 44.35 (11.64) years, and in survivors, it was 36.60 (9.28) years. This result reveals that the non-survivors were from the high age group compared to the survivors.

## Distribution of lactate value among survivors and non-survivors:

The mean lactate value ranged from 0.43 mmol/L to 5.69 mmol/Lamong survivors. The majority, 16 (69%) of the surviving patients, had a lower lactate value of 0-2mmol/L. While the mean lactate range amongst the non-survivor was found to be between 1.64 mmol/L to 6.14 mmol/L. The majority, 13 (48%), of the non-survivors had a higher lactate value of >4mmol/L, as shown in Table 2.

#### Serial lactate levels among patients at different time intervals:

Table 3 represents the changes in patients, survivors and nonsurvivors at different lactate range at various time intervals. A gradual decrease in the number of patients with lactate range 0-2 mmol/L was observed during the 72 hours, from 26 patients at the time of admission to 20 patients at 72 hours. Simultaneously, an elevation in the number of patients with lactate  $\geq 2 \text{ mmol/L}$  was observed with increasing time. Patients with > 4 mmol/L lactate value increased significantly from 4 numbers at admission to 10 at 24 hours and up to 18 numbers at 72 hours. A significant (p-value for Chi-square test<0.016) association was observed between various time intervals and several patients at different lactate levels.

## Mean lactate levels at different time intervals among survivors and non-survivors:

The mean lactate value at the time of admission was found significantly higher (p-value<0.001) among non-survivors as compared to that of survivors (2.5204 1.51498 vs 0.9545 0.45798). Similarly, the mean lactate values were higher among non-survivors at 24 hours (2.5107 1.63678) and at 72 hours (2.7904 2.00160) than those of the survivors (1.2461 1.21360 at 24 hours and 1.5496 1.66788 at 72 hours) and the variance was significant (p value<0.05), as shown in Table 4.

#### **Discussion :**

A relationship of raised lactate level of blood with tissue hypoxia secondary to severe infection is established in the current study agrees with another research outcome,<sup>9</sup> reflecting a high level of

Table 1: Details of the study participants.

Age group	Frequency	Percentage
< 30 years	8	16.0
30-45 years	15	30.0
46-60 years	19	38.0
> 60 years	8	16.0
Sex		
Male	29	58.0
Female	21	42.0

Table 2 : Number of survivors and non-survivors in different lactate range.

	Survivo	or	Non- s	urvivor
Lactate Value (mmol/l)	Number (n)	Percentage (%)	Number(n)	Percentage (%)
0–2	16	69.00	13	48.00
2.1–4	4	17.00	8	29.00
> 4	3	14.00	6	23.00
Total	23	100.00	27	100.00

 Table 3: Patients, both survivors and non-survivors, at different lactate ranges in the different intervals

Lactate value (mmol/l)	On admission	At 24 hours	At 72 hours	p-value
0-2	26	22	20	0.016
2.1-4	20	18	12	
>4	4	10	18	

Table 4 : Mean Lactate value among survivors and non-survivors.

Lactate	Outcome	Number (n)	MeanSD (mmols/l)	p-value
Admission	Not Survived	27	2.5204 1.51498	0.000
	Survived	23	0.9545 0.45798	
24 hours	Not Survived	27	2.5107 1.63678	0.004
	Survived	23	1.2461 1.21360	
72 hours	Not Survived	27	2.7904 2.00160	0.023
	Survived	23	1.5496 1.66788	

lactate as a hypoxia marker where the researcher had compared the mean lactate values (in mg/dl) between survivors and non-survivors among patients with a sepsis like the current research.<sup>9</sup>

The patient who survived has a lower mean lactate value, which reaches normal in 36 hours. In the current study, the non-survivors showed constant higher mean lactate values at different time points than the survivors, agrees to a review.<sup>10</sup>

The current study reported a significant relationship (p-value < 0.005) between survivors and non-survivors with lactate clearance between the two groups agreed on a review.<sup>11</sup> The lactate clearance had a vital inverse relationship with mortality. The results of the said study matched the results of our research, where we noticed that the mean arterial blood lactate range among non-survivors was increasing at the given intervals.

Another study<sup>12</sup> found that non-survivors groups had significantly higher lactate levels than the survivors' groups which concur with the current results.

A study established<sup>13</sup> the linear relationship between increased lactate and mortality. In the agreement of this study, our research also revealed the increased arterial blood lactate, which was substantially linked with the high death incidences. Our study had a similar agreement with analysis,<sup>14</sup> where the patient group with more lactate levels showed higher mortality than the group with the lower lactate level.

Our observations of the association of high mortality with raised lactate levels were also consistent with the results obtained in another similar study.<sup>15</sup> The author in the said review reported 12% mortality with a 2-4 mmol/L lactate and a higher mortality rate of 40.7% with a lactate level >4mmol/L. In distinction, another review<sup>16</sup> reported insignificant differences in lactate during the initial period between the two groups. However, the reduction of lactate blood levels within the first 24 hours was more significant in the survivor than in the non-survivor. The results of the study matched the results of our research.

Based on the current hospital-based observational study results, we can draw the insight that serial lactate monitoring improves the accuracy of mortality prediction in sepsis patients. It would be prudent to point out that recovering from such an attack takes a long time. With a patient with sepsis, the lactate values should generally be monitored for more extended periods. Although their hemodynamic stability appeared stable, the patient may be experiencing ongoing occult hypoperfusion, which would raise blood lactate levels. Regular lactate analysis, however, would be influenced by things like test availability and price.

#### Limitation of the study:

The limitation of the study is the small sample size, which would have resulted in a less precise estimation of the serial serum lactate level accuracy. Secondly, as only one CCC was used for this investigation, it is possible that the findings cannot be applied to other facilities specializing in treating sepsis patients. Also, the follow-up time was only 28 days. Larger multicentre studies with longer patient follow-up may help obtain a more generalized insight into the topic.

#### **Conclusion :**

The current study showed an upsurge of sepsis patient numbers with higher lactate blood levels at different intervals, particularly in the non-survivors groups. Significantly, the mean lactate levels were substantially higher among non-survivors than survivors throughout the additional time breaks, indicating a significant association between high lactate levels resulting from low lactate clearance during treatment and patient mortality with septicaemia.

Thus, we can conclude that serial blood lactate levels are a potential factor in predicting sepsis patients' mortality.

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#### **ORIGINAL ARTICLE**

## **Determination of Sex from Hyoid bone – Is it Feasible?**

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## Abstract :

Identifying an individual is a priority from womb to tomb. Historically, human identification is one of the most challenging subjects that man has confronted. Alves identity is a set of physical characteristics, functional or psychic, normal or pathological, that defines an individual. Among various parameters of human identification, sex determination is an important first step in the development of a biological profile, as methods to estimate other components of the profile depend on sex. Sex determination is one of the key questions addressed when formulating this profile – its knowledge immediately eliminates 50% of the population from the process of identification. In this study we took seven linear measurements of hyoid bone to determine the sex. Among the seven linear measurements Total Hyoid Length (THL) and Body Length (BL) were considered to be significant in predicting the sex of the individual ('p' value < 0.05). The discriminant equation derived gives an accuracy of 62 % and the measure of agreement of Kappa between the cut-off value derived from the equation and actual sex was 0.24 (Statistically insignificant).

Keywords : Hyoid bone; Identification; Sex determination; Linear measurements.

#### **Introduction:**

Identifying an individual is a priority from womb to tomb. Identification is defined as "determination or establishment of the individuality of a person whether living or dead and it is exact fixation of the individuality".<sup>1,2</sup> Historically, identifying human is one of the toughest challenges that man has confronted.<sup>3</sup> Investigating officers and forensic specialists are concerned with identifying a dead body especially in cases of explosion, severe accidents, and other mishaps where it will be a challenge. Complete identification also known as absolute identification means the absolute fixation of the individuality of a person with respect to their name, age, sex, address, occupation etc. Partial identification or incomplete identification implies the ascertainment of only some facts about the identity while others like race, age, sex and stature etc. remain unknown.<sup>3</sup>

According to Alves identity is a set of physical characteristics, functional or psychic, normal or pathological, that defines an individual. Among various parameters of human identification, sex determination is an important first step in the development of a biological profile, as methods to estimate other components of the profile depend on sex. Sex determination is one of the key questions addressed when formulating this profile – its knowledge immediately eliminates 50% of the population from the process of identification. This study was undertaken to determine sex based on various linear parameters of hyoid bone.

#### Aim & Objective:

• To determine sex based on various linear measurements of hyoid bone

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#### This aim will be achieved by the following objective:

- To measure various linear parameters of the hyoid bone to determine the sex.  $^{\scriptscriptstyle 4}$ 

- a. THL Total hyoid length
- b. THW Total hyoid width
- c. BH-Body height
- d. BL-Body length
- e. CHI Height of greater horn
- f. CL-Length of greater horn
  - BT Thickness of the body

#### Materials and Methods :

This study was conducted in the department of Forensic Medicine and Toxicology, Kasturba Medical College, Manipal, from September 2014 to September 2016. This study consists of 100 hyoid bones of male and female cadavers of known age, brought for medico-legal autopsy to department of Forensic Medicine and Toxicology, Kasturba Medical College, Manipal. Institutional ethical committee clearance was obtained before starting of the study. Written informed consent was taken from the relatives of the deceased before taking the hyoid bone samples.

The dissection was performed in the mortuary attached to department of Forensic Medicine and Toxicology, Kasturba Medical College, Manipal. During the process of post-mortem a block of 12 to 20 cm high is placed below the shoulder of cadaver, which allowed the head to fall back thus extending the neck. The skin is held with a toothed forceps and with a sharp, long handled scalpel, layer by layer flap dissection was performed. The subcutaneous dissection was carried up to the lower border of the lower jaw, well laterally on the sides of the clavicle and neck. The deep cervical fascia is incised and reflected from the cervical muscles and the sub mandibular gland.<sup>5</sup> The sternocleidomastoid muscle is freed from its clavicular and sternal attachments, separated from its underlying fascia and reflected on each side. The omohyoid, sterno-thyroid and thyrohyoid muscles are exposed, inspected and reflected on each side.

The thyroid gland and the carotid sheaths are freed by blunt dissection from their investing connective tissue. The larynx, trachea, pharynx and oesophagus are mobilised and pulled away from the prevertebral tissue by blunt dissection. The hyoid bone is removed from the neck structures; the soft tissues of the neck was cleared and looked for any fractures of hyoid bone.<sup>5</sup> If there were no fractures or injuries noted further dissection was done to clear the soft tissue and maceration was performed till all soft tissue detaches from the bone.

The sample size for this study was calculated based on comparison proportion formula, and it was estimated to be of 90 (45 males and 45 females) and five bones were taken from hanging cases in each sex (total 10 bones) as a control group. Total of 100 hyoid bones were studied. They were numbered at the time of retrieval from body and tagged throughout to reduce the objective errors which would cause undue confusion with other hyoid bones. After maceration procedure they were cleaned, dried and packed in a separated polythene zip lock cover and labelled with corresponding post-mortem number. The various linear measurements were obtained using digital Vernier calliper.

For determination of sex, the following 7 linear measurements will be taken with the help of Digital vernier caliper.<sup>4</sup>

- 1. THL Total Hyoid Length (It is measured as the distance from the midpoint of the distance between the left and right greater cornua's tips to the most anterior point of the body of the hyoid as shown in Figure No. 1A)
- 2. THW Total Hyoid Width (It is measured as the maximum distance in the posterior ends between the two lateral edges of the greater cornua as shown in Figure No. 1B)
- 3. CHIdx, CHIsin The height of greater cornua (It is measured as the distance between the lower edge and upper edge at the anterior end of the greater cornua or the distance from the lower to upper edge of the fusion line connecting the right or left greater cornua with the hyoid body as shown in Figure No. 1C)
- 4. CLdx, CLsin The length of greater cornua (It is measured as the distance from the central part of the anterior end to the distal tip or the distance from the distal tip of the greater cornua to the central part of the fusion line as shown in Figure No. 1D)
- BL Body Length (It is measured as the distance between the body of hyoid in its lateral edges as shown in Figure No. 1E)
- 6. BH Body Height (It is measured as the distance in the mid sagittal plane between the lower edge and upper edge of the body as shown in Figure No. 1F)
- 7. BT upper anterior-posterior thickness of the body [It is measured as the distance between the most posterior point

of the hyoid body (as a rule located in the upper portion) to the most anterior end as shown in Figure No. 1G]

The fused bones measurements were taken as it is, whereas the unfused bones' measurements were taken after fixing the bone in its anatomical position using quick fix (Fevikwik) adhesive so as to take the measurements without any difficulties or any errors. The unit of measurement is millimetre (mm).

#### Inclusion criteria:

Hyoid bones obtained during the autopsy of individuals between 20 to 70 years of age.

## **Exclusion criteria:**

Fractured hyoid bone by any means like strangulation, hanging, traumatic or artefacts were excluded from the study.

The data obtained were entered into the excel sheet. For statistical analysis the samples were classified in to five groups of 10 years interval. This data was analyzed using Statistical Package for the Social Sciences (SPSS) version 26.



Figure 1 : Depicting the method of measuring various linear parameters



Figure 2 : ROC curve after substituting the values obtained from the derived formula

## **Results**:

In this study a total of 100 subjects, comprising of 50 males and 50 females in the age group of 21 - 70 years, were examined. Descriptive statistics and results of comparison by t-test for male and female linear measurements acquired are depicted in Table No. 1.

Using Canonical Discriminant Functions Coefficient, a formula was derived to determine the sex of the individual based on the linear parameters acquired from hyoid bone

Sex = BL + (0.521) CHI + (0.419) THW + (0.347) THL + (0.33) BT + (0.273) CL + (0.045)BH

#### **Relative Operating Characteristic (ROC) Curve:**

It is a basic diagnostic tool of evaluation. The curve is drawn by plotting the True Positive Rate (TPR) against False Positive Rate (FPR) at different threshold settings.

After substituting the values obtained from the derived formula, the ROC curve was drawn. This ROC curve is depicted in Figure No. 2

The cut-off value is derived based on the ROC curve.

If the value is > or = 61.63 mm, the sex of the individual is male.

If the value is  $\leq 61.63$  mm, the sex of the individual is female.

The measure of agreement of Kappa between the cut-off value derived from the equation and actual sex was 0.24 (Statistically insignificant).

The classification of sex according to the study and comparison with the actual group is depicted in Table No. 2.

Overall, in 62% of the cases, the sex of the individual were determined correctly.

Diagnostic accuracy of the cut-off value derived from the equation has been depicted in Table No. 3. The sensitivity and specificity of this method stands at 80% and 44% respectively.

#### **Discussion:**

In daily forensic practice identification of the dead is invariably a

 Table 1 : Descriptive statistics and results

Linear	Male (N = 50)		Female $(N = 50)$		t	p value
measurement	Mean	SD	Mean	SD		
Total Hyoid Length	37.04	3.34	35.50	3.95	2.09	0.04
Total hyoid width	39.29	5.94	37.99	6.59	1.03	0.31
Height of greater cornua	6.83	0.98	6.62	1.28	0.94	0.35
Length of greater cornua	30.50	2.87	29.36	3.40	1.81	0.07
Body Length	23.98	3.50	22.43	2.90	2.41	0.02
Body Height	10.34	1.58	10.02	1.33	1.10	0.28
Body Thickness	2.49	0.73	2.26	0.63	1.66	0.10

tedious task, which is mandatory as per the prevailing social regulations and laws of the land. Availability of antemortem and postmortem information plays an important role in smoothening this tough task. Nevertheless, these classic identification features have been made impossible with advanced stages of decomposition.<sup>6</sup>

To determine sex from the hyoid bone a set of the above said seven linear measurements were used in our study. Similarly, Urbanová et al has conducted a study to determine the sex from the hyoid bone.<sup>4</sup> In our study the descriptive statistics and results of comparison by t-test showed statistically significant association of sex with Total Hyoid Length (THL) and Body Length (BL) (p value <0.05 for both) as shown in Table no 1. On the contrary Urbanová et al, in their study they found statistically significant association in all the seven linear measurements (p value <0.05). However, in Odabasi et al a set of 33 astrometric measurements of the hyoid bone were used to determine sex of the individual.<sup>7</sup> Kim et al tried to determine the sex used a set of 34 measurements of photographs of hyoid bone using a computer program.<sup>8</sup> Kindschuh et al in their study used the two-way ANOVA to explore the differences in the hyoid bone with respect to sex and ancestry.9

The ROC curve for each linear measurement were plotted and looked for sensitivity and specificity. The Area Under the Curve (AUC) was highest for Body length (BL) i.e., 0.623, however Body Thickness (BT) has the highest sensitivity of 66% among all the parameters used in the study. The maximum specificity was observed in Total Hyoid Length (THL) i.e., 74%. Whereas the least Area Under the Curve (AUC) was observed with the Body height (BH) i.e., 0.567 and lowest specificity was observed in Body Length (BL) i.e., 38%, the lowest sensitivity was observed in Total Hyoid Length (THL), Total Hyoid Width

Table 2 : Classification results of the study

Sou		Predic	T ( 1		
Sex		Female	Male	Total	
Count	Female	22	28	50	
	Male	40	10	50	
Percentage (%)	Female	44 %	56 %	100 %	
	Male	80 %	20 %	100 %	

Diagnostic accuracy	Value	95% CI
Sensitivity	80%	66.28% to 89.97%
Specificity	44%	29.99% to 58.75%
Positive Predictive Value	58.82%	51.86% to 65.45%
Negative Predictive Value	68.75%	53.79% to 80.61%
Accuracy	62%	51.75% to 71.52%

(THW), Height of the greater cornua (CHI) were 50%.

A discriminant equation was derived, and it shows an overall accuracy of 62% (80% males and 44% females) in predicting the sex with respect to the actual classification, whereas in a study conducted by Urbanová et al, Kim et al, Kindschuh et al and Komenda S et al showed an accuracy rate of 84% (non-fused bones) to 92% (fused bones), 88.2%, 82.2 to 85.2% and 88.9 to 96.4% respectively.<sup>4,8-10</sup> However, in Odabasi et al study, it has been observed that 92.5% males and 78.1% females were classified correctly.<sup>7</sup>

The measure of agreement of Kappa between the cut-off value derived from the equation and actual sex was 0.24 (Statistically insignificant). Hence in this study the hyoid bone failed to prove its value in discriminating the sex through various linear measurements. The small sample size could have been a limitation to prove the significance in discriminating the sex of the individual by linear measurements used in this study when compared to other studies mentioned in the literature for discriminating the sex of the individual based on hyoid bone measurements.

#### **Conclusion :**

Among the seven linear measurements THL and BL were considered to be significant in predicting the sex of the individual ('p' value < 0.05). The discriminant equation derived gives an overall accuracy of 62% and the measure of agreement of Kappa between the cut-off value derived from the equation and actual sex was 0.24 (Statistically insignificant). The limitation of this study is the sample size is small to come to a strong conclusion. Future studies with considerable larger sample size are required to get a reliable conclusion.

## Conflict of Interest : None.

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#### **ORIGINAL ARTICLE**

# Profile of Medico-legal cases Autopsied at S.S.I.M.S & R.C, Davangere : A Retrospective study

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#### Abstract :

Autopsy means post mortem examination of a dead body. In all unnatural and suspicious cases, the Medico-legal autopsy is mandatory. Conducting the Medico-legal autopsy is an integral part of the department of Forensic Medicine and Toxicology to aid in the administration of justice. Study of profile of Medico-legal autopsies may help us to understand the magnitude of the medico-legal deaths occurring at that particular region and also to know the prevalence of age, sex and the distribution of cases. This retrospective study has been conducted in the department of Forensic Medicine and Toxicology, S.S.I.M.S & R.C, Davangere from January 2015 to December 2020 comprising of 1004 autopsied cases. Out of 1004 cases 71.5% were males. Road traffic accident with 528 cases being the most prevalent type of death followed by burns and poisoning. 21-30 years age group is the most affected population. Rural residents are more compared to urban.

Keywords : Medico-legal autopsy; Road Traffic Accident; Rural; 21-30 years age group.

#### **Introduction :**

Autopsy means to see for oneself. Autopsy also goes by name necropsy or just postmortem examination. Necropsy is most accurate term for the investigative dissection of the dead body, but the term autopsy is commonly used and is more popular term amongst the doctors. Postmortem examination is an alternative term used but suffers from lack of precision about the extent of examination. In some countries, many bodies are disposed of only with external examination without opening the body, in such scenario; it is called as postmortem examination.<sup>1</sup> An autopsy is frequently done in cases of sudden death where a doctor is unsure about the cause of death or when death is believed due to an unnatural cause.<sup>2</sup> The objective of medico-legal autopsy is to establish the identity of a body, when not known; to find out the cause of death, time since death, nature and manner of death, whether it was homicidal, suicidal or accidental. In addition, the question of live birth and viability assumes the importance in case of infant deaths.3 In all such cases, complete autopsy is mandatory, which should include opening all body cavities and thorough examination of all organs of the head, chest and abdomen.<sup>4</sup> The present Study was aimed to analyze the pattern of medico-legal cases, which were autopsied at our institute and to compare the results with available literature. This could help us to know the distribution of cases for medico-legal autopsy in relation with age, sex, religion, geographic at our region.

#### Aims and Objectives:

1. To Analyze the pattern of medico-legal cases autopsied at our institute.

Corresponding Author Pravinkumar N. Kamaradgi Email : pravinnk18@gmail.com Mobile No. : +91-9886047275 2. To Understand the distribution of autopsied medico-legal cases with respect to age, sex, religion and geographical region.

#### **Material and Methods :**

The present study is a retrospective study of medicolegal autopsies performed at S.S. Institute of Medical sciences and Research Centre, Davangere, Karnataka, India. The study period was from January 2015 to December 2020. During the study period, the total no. of medico-legal autopsies performed were 1004. Data were collected and tabulated using a pre-designed format from post mortem registers/records, inquest papers and post mortem reports maintaining at most confidentiality. The data was tabulated using Microsoft Office Excel Worksheet and analysis was done using Epi-Info software (version 7.2.4).

#### **Results:**

From the observation made from the table no.1, out of 1004 medicolegal autopsy cases conducted 71.5% (718 cases) of the victims belong to male sex and 28.5% (286 cases) were females.

From the table No 2, the age wise distribution was made and the highest number of cases were seen in the age group of 21 to 30 years with 283 cases followed by 31 to 40 years with 215 cases and the least number of cases were observed in the age group of 81 and above with 11 cases.

Table No 3 will demonstrate the distribution of cases based on the religion. The Hindu religion constitute the major group with 92.9 % (933 cases), followed by Muslim religion with 6.4% (64 cases), Christian religion with 0.6 % (06 cases), least being the Sikh with 0.1% (01 case).

From table 4 we can illustrate the distribution of type of cases with respect to year. With respect distribution of cases based on its type, road traffic accident cases being the most prevalent with 528 cases (52.6%) and forms the major chunk of the cases followed by burns with 194 (19.4%) cases and poisoning with 134 (13.3%) cases. These 3 types of cases constitute the major portion when compared with others. Bee sting, firearm injury and scorpion bite cases were the least type with the contribution of one case each to the study sample. When we look at the year wise distribution, cases in 2016 were high as compared to the other years which were included in the study.

From table no 5 we can understand the distribution of cases with respect to different age group. 21 to 30 years age group is the most vulnerable study group with respect to all type cases especially the road traffic accident, burns and poisoning are highest in this age group followed by 31 to 40 and 41 to 50 years age group. Least number of cases recorded in lowest and highest age group that is less than 10 years and more than 81 years respectively.

Table no 6 exhibit the distribution of type of cases with respect to gender. The male population being the prevalent group with 718 cases as compared to females with 286 cases respectively. Male is the most vulnerable group with respect to all type of cases especially the road traffic accident, poisoning, assault, electrocution and snake bite. But if you look at the occurrence of burn cases the female being the most susceptible group as compared to males.

#### **Discussion :**

Our study included 1004 medico-legal autopsied cases

Table 1 : Sex wise distribution of Case	s.
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Sex	Frequency	Percent
Female	286	28.5
Male	718	71.5
Total	1004	100.0

Table 2 . A go wise distribution of asses

Table 2 . Age wise distribution of cases.						
Age	Frequency	Valid Percent				
< 10 years	28	2.8				
11 to 20	95	9.5				
21 to 30	283	28.2				
31 to 40	215	21.3				
41 to 50	144	14.4				
51 to 60	134	13.4				
61 to 70	72	7.2				
71 to 80	22	2.2				
81 and above	11	1.1				
Total	1004	100.0				

Table 3 : Distribution of cases according to religion.

Religion	Frequency	Percent
Christian	6	0.6
Hindu	933	92.9
Muslim	64	6.4
Sikh	1	0.1
Total	1004	100.0

comprising 71.5% males and 28.5% female; the proportion is similar findings were seen in the following studies. Anand Mugadlimath et al studied 64 cases out of which 39 (61%) were male and 25 (39%) were females.<sup>5</sup> Dileep Kumar R et al did a study of total 173 cases in which 126 (72.83%) were males and 47 (27.16%) were female.<sup>6</sup> Trangadia MM et al have done a study in which male cases were predominated over female cases which were 5967 (72.77%) and 2232 (27.23%) respectively.<sup>7</sup> Radhakrishna KV et al did a study of profile of medicolegal autopsy in which male population with 74.62% outnumbered females.<sup>8</sup> The reason might be males being the major bread earners involving in various occcupations, spending most time in travelling and majority of females being the homemaker.

Out of 1004 autopsies, majority of the cases were encountered in the age group of 21 to 30 years, followed by 31 to 40 years owing to the crucial period of earning years of life (Table No 5). This predominant feature is in correlation with other studies done by different authors.<sup>5-11</sup>

Religion wise distribution of our study showed 92.9% Hindus, followed by 6.4% Muslims, 0.6% Christians and 0.1% Sikh. This is the most common feature with reference to the most of the studies as we have the same religion distribution in the population.

Our study depicted 78.2 % cases are from rural and 21.8% from urban regions. This is also in correlation with most of the studies (7 & 11) and is in contradiction with a study done by Jitendra Tomar et al, in which rural population contributed 29.98 % and compared to urban with 70.02 %.

In our study, deaths due to road traffic accidents (52.6%) are

Type of case	2015	2016	2017	2018	2019	2020	Total	Percentage
Assault	2	2	2	1	2	4	13	1.3%
Bee Sting	0	0	0	0	0	1	1	0.1%
Burns	30	57	44	20	25	20	196	19.4%
Drowning	1	0	0	3	0	0	4	0.4%
Electrocution	2	1	3	1	5	1	13	1.3%
Fall from height	4	14	3	3	11	13	48	4.8%
Fall of Stones	1	0	1	0	0	0	2	0.22%
Firearm Injury	1	0	0	0	0	0	1	0.11%
Hanging	1	4	3	1	4	6	19	1.9%
Natural Death	3	0	6	1	0	5	15	1.5%
Poisoning	22	27	15	15	15	40	134	13.3%
Railway accident	1	0	1	1	0	0	3	0.3%
RTA	110	122	91	77	53	75	528	52.6%
Scorpion bite	1	0	0	0	0	0	1	0.1%
Snake Bite	8	5	4	2	0	5	24	2.4%
Suffocation	0	0	0	2	0	0	2	0.2%
Total	187	232	173	127	115	170	1004	100%

Table 4 : Year-Type of case distribution.

Type of case	<10	11 - 20	21 - 30	31 - 40	41 - 50	51 - 60	61 - 70	71 -80	>81	Total	%
Assault	0	0	3	2	4	1	2	1	0	13	1.3%
Bee Sting	0	0	0	1	0	0	0	0	0	1	0.1%
Burns	7	27	63	51	14	17	10	5	2	196	19.3%
Drowning	2	2	0	0	0	0	0	0	0	4	0.4%
Electrocution	1	2	4	2	0	3	1	0	0	13	1.3%
Fall from height	2	2	11	9	11	6	6	1	0	48	4.8%
Fall of Stones	0	0	1	1	0	0	0	0	0	2	0.2%
Firearm Injury	0	0	0	1	0	0	0	0	0	1	0.1%
Hanging	0	5	6	3	2	1	1	1	0	19	1.9%
Natural Death	0	1	3	3	5	2	1	0	0	15	1.5%
Poisoning	4	18	40	22	19	24	4	2	1	134	13.4%
Railway accident	0	0	1	0	1	1	0	0	0	3	0.3%
RTA	10	36	147	108	84	76	47	12	8	528	52.6%
Scorpion bite	0	1	0	0	0	0	0	0	0	1	0.1%
Snake Bite	2	1	4	10	4	3	0	0	0	24	2.4%
Suffocation	0	0	0	2	0	0	0	0	0	2	0.2%
Total	28	95	283	215	144	134	72	22	11	1004	100%

Table 5 : Age-Type of case distribution.

Table 6	:	Sex-Type	of	case	distribution

	Sex		<b>T</b> ( 1	<b>D</b>	
Type of Case	Male	Female	Total	Percentage	
Assault	2	11	13	1.3	
Bee Sting	0	1	1	0.1	
Burns	129	67	196	19.4	
Drowning	0	4	4	0.4	
Electrocution	1	12	13	1.3	
Fall from height	6	42	48	4.8	
Fall of Stones	1	1	2	0.2	
Firearm Injury	0	1	1	0.1	
Hanging	10	9	19	1.9	
Natural Death	3	12	15	1.5	
Poisoning	37	97	134	13.3	
Railway accident	3	0	3	0.3	
RTA	89	439	528	52.6	
Scorpion bite	0	1	1	0.1	
Snake Bite	5	19	24	2.4	
Suffocation	0	2	2	0.2	
	286	718	1004	100	

highest followed by burns (19.4%), poisoning (13.3%), fall from height (4.8%) so on and the male gender being most affected group for road traffic accident with 439 cases as compared to 89 cases in females. This finding in our study is identical to most of the other studies.<sup>5-7, 9-11</sup> This is because, the men will be the most frequent travelers on the road for their daily work and also sometimes due to lack of protective measures, which makes them more susceptible.

Not only in road traffic accidents, in majority of the cases like poisoning, electrocution, fall from height, snake bite etc, male outnumbered females. This is because they expose themselves to the threat depending on the occupation in which they get involved; this makes them vulnerable to various kinds of fatalities.

In our study the case fatality with burns is highest in females with 129 cases as compared to 67 cases in males. This is in correlation with a study done by Yadav et al, in which 82 cases of burns were present in females as compared to males with 57 cases.<sup>12</sup> Either it could be accidental, as females are exposed to flames while cooking or suicidal as they have easy accessibility to any pyrogenic substances in the house.

## **Conclusion :**

This study has been conducted at S.S. Institute of Medical Sciences and Research Centre, Davangere comprising of 1004 medicolegal autopsy cases during the period from January 2015

to December 2020. The following conclusions were drawn from our study.

- 1. In gender wise distribution the male were more affected as compared to females.
- 2. Our study showed 78.2 % cases are from rural areas and 21.8% from urban areas.
- 3. The people in their 3rd decade of life were more affected as compared to the other age groups.
- 4. Road traffic accident contributed the highest number of deaths as compared to the other types in our study. The cause for road traffic accident cause could be multifactorial, however in some cases the death could have been prevented by following the traffic rules with proper protective gears.
- 5. Deaths due to burns are more common in females as compared to males.

**Ethical Clearance :** Prior permission was not taken from the IERB as it was a record-based study without involving any live subjects or experimentation.

#### Conflict of Interest : Nil

#### Source of Funding : Nil

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#### **ORIGINAL ARTICLE**

# A Comparative Analysis of Pattern of Homicidal Deaths among Males and Females in a District of West Bengal

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#### Abstract :

An observational, cross-sectional study was undertaken among all cases of unlawful homicidal deaths during one year in Malda district of West Bengal to find out the pattern of homicidal deaths, to compare the differences between male and female homicidal deaths and also to find any relationship with social and demographic factors. It was found that most of the female victims are in reproductive age-group and they were most commonly killed by manual and ligature strangulation whereas the male victims of homicide were mostly in economically productive age group and they were most commonly killed by mechanical injuries like incised wound, penetrating wound, head injury and gunshot injuries. The difference between males and females regarding cause of death was significant. The antecedent history of illicit sexual relations leading to homicide was significantly more among females. It was also seen that illicit sexual behaviour led to homicide in most of the unmarried or divorced female victims whereas in case of married woman, illicit sexual behaviour of the husband led to homicide victims. So awareness should be built-up among unmarried, separated and divorced woman against illicit sexual relationship. Adult and earning male members of the family should be cautioned about debt traps and also should be made aware about procedures of legal action to be taken in case of property dispute with relatives and neighbours.

Keywords : Malda; Homicide; Illicit sexual relation; Strangulation.

#### **Introduction:**

Homicide means killing of a human being by another human being. It can be classified as lawful homicide and unlawful homicide.1 Lawful homicide is sub-classified as justifiable and excusable which include homicide to maintain law and order and to administer justice, homicide due to accidents, homicides as a result of adverse effects following a proper therapeutic procedure and homicide by an insane person. Unlawful homicide includes murder, culpable homicide amounting to and not amounting to murder, rash or negligent act causing homicide. In case of unlawful homicide both mens rea, that means the intention or knowledge of wrong doing that constitutes part of a crime, and actus rea, that means the criminal act, must be present. In this study, we are concerned about the unlawful homicide cases. National Crime Records Bureau (NCRB), India, in 2021 has enumerated that there was 29, 193 murders in India in the year 2020. About 7 percent of the total number of murders in India during that period was recorded from West Bengal.<sup>2</sup> The motives behind all those murders were also published in NCRB report which were important to make people aware regarding some dangerous activities with others those might result in some fatal outcomes.<sup>3</sup> Police personnel involved to maintain law and order, judges, criminal lawyers and doctors especially from the disciplines of forensic medicine and psychiatry must be aware about these motives so that they can either restrain the persons atrisk to commit homicide or they can guide the potential victims to save themselves from falling prey to any heinous or violent act

Corresponding Author Dr. Arindam Chakrovarty (Assistant Professor) Email: drachakrovarty@gmail.com Mobile No. : +91-9433230081 that may cost their lives. The present study was intended to throw some light on the pattern of homicidal deaths seen in the mortuary of the Department of Forensic Medicine and Toxicology (FMT), Malda Medical College, the only medicolegal (ML) autopsy centre of Malda district of West Bengal where about 1596 ML autopsies were done during the period under study from a total population of 39.89 lakhs in that district. So it will help to give us exact idea about pattern of homicides in that district as well as in the state of West Bengal and India in general.<sup>4</sup> The aims and objectives of this study was to find out the age distribution of the homicide victims, to compare the causes of homicides among males and females and also to find out relationship of some major antecedent history that led to homicidal deaths among different sexes.

#### **Materials and Methods:**

An observational epidemiological study with cross-sectional design was undertaken from December, 2019 to November, 2020 among all medicolegal (ML) autopsy cases performed at the mortuary of Department of Forensic Medicine and Toxicology, Malda Medical college where homicide could be mentioned in autopsy report as manner of death. A prior approval was obtained from the Institutional Ethics Committee (IEC). The inquest report of the ML autopsy case as prepared by the investing officer (I.O.) of police was examined, the ML autopsy of the dead body was performed, significant autopsy findings were collected from there by the autopsy surgeon, the I.O. and the nearest relatives of the deceased and witnesses, if available, were interviewed to elicit any relevant past history that led to homicidal death. Biological samples collected from dead bodies were also sent for chemical examination at Forensic Science Laboratory (FSL) to corroborate some of the autopsy findings. Then the autopsy reports, where homicide as manner of death could be mentioned were included in the study. Data collected by these methods were presented in tabular form and analysed using appropriate statistical methods.<sup>5,6</sup> Lawful homicides, skeletonised dead bodies, bodies with advanced decomposition where manner of death could not be opined and where the opinion of the autopsy surgeon was kept pending till receipt of chemical examination report from FSL had been excluded from the study.

#### **Results:**

It was seen that about 56 percent of the male homicide victims belonged to the age group 18 to 50 years which corresponded to the economically productive age group and 90 percent of all female victims were in the age group 18 to 50 years which corresponded to reproductive as well as economically productive age group (table 1).

Also by calculation, it could be said that the prevalence of homicide in Malda district was about 0.01 per thousand populations and total homicidal deaths constituted about 1.6 percent of all unnatural deaths in Malda district during that period.

It was found that 70 percent of all female victims of homicide were mostly killed by manual and ligature strangulation and 30 percent were killed by physical and mechanical injuries. About 81 percent of all male victims were killed by deep incised, chop or stab wounds, injuries including head injuries and gunshot wounds and about 19 percent were killed by strangulation (Table-2).

Now we are giving brief accounts of some sensational homicide cases with photographs.

A dead body of an unidentified woman presented in pugilistic attitude due to burn. On autopsy examination it was revealed that she was sexually assaulted as there were multiple antemortem lacerated injuries on vulva, then strangulated by ligature and subsequently burnt after death to destroy the evidences (Fig-1 and Fig-2). The charred dead body was identified by relatives after ten days. The murderer was then arrested and subsequently was sentenced for life imprisonment by the court after about two years.

A male dead body with a penetrating stab wound from the posterior aspect of left lung after getting assaulted physically due to property dispute with neighbours (Fig-3).

A completely naked dead body of a male government employee, who was about to retire from service within a few days, was recovered from his quarter after he sent all his family members and packed and sent all personal belongings with them to his ancestral home in anticipation that he would also join them there after retirement. Opinion was given as a case of homicidal manual strangulation by the autopsy surgeon. In the course of investigation, it was found that the victim used to force a man to have homosexual relationship with him for a long time and used to blackmail him with some photographs of their previous homosexual acts. To take revenge and to come out from the clutches of that person the man came to his quarter with an accomplice and manually strangulated him till death. Both of the murderers had been sentenced for life imprisonment (Fig-4).

Table-1: Distribution of victims of homicide according to age-group & sex

(11-20).								
Age (years)	Male	Female	Total					
<18	1(6.2)	1 (10)	2 (7.7)					
18-50	9 (56.3)	9 (90)	18 (69.2)					
>50	6 (37.5)	0 (0)	6 (23.1)					
Total	16 (61.5)	10 (38.5)	26 (100)					

\*Figures in parentheses indicate percentage

Table-2 : Causes of homicidal deaths among both sexes	(n=26).*
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Cause	Male	Female	p-value (fisher exact test) <sup>5</sup>	df	Whether significant	OR with 95% CI6
Strangulation (Both manual & ligature)	3 (18.8)	7 (70)	0.0152	1	Yes	10.1111 (1.5972 to 64.0075)
Other causes <sup>++</sup>	13 (81.2)	3 (30)				
Total	16 (61.5)	10 (38.5)				

\*Figures in parentheses indicate percentage

<sup>++</sup>Other causes include deep incised, chop or stab wound, blunt trauma causing head injury, other injuries and gunshot wounds

Table-3: Major antecedent history leading to homicide (n=26).*						
	Male	Female	p-value (fisher exact test) <sup>5</sup>	df	Whether significant	OR with 95% CI6
Illicit sexual relationship of the deceased or spouse of the deceased (if married)	2(12.5)	8(80)	0.001	1	Yes	28 (3.2816 to 238.9082)
Other#	14 (87.5)	2 (20)				
Total	16 (61.5)	10 (38.5)				

\* Figures in parentheses indicate percentage

# Other antecedent history includes disputes from property or monetary transactions in males and dowry death in females.

Table-4: Major antecedent history leading to homicide in relation with marital status among females (n=10).\*

	Married	Unmarried/Divorced	Total
Illicit sexual behaviour of herself	2(33.3)	3(75)	5(50)
Illicit sexual behaviour of her husband	3(50)	Not applicable	3(30)
Monetary/property dispute/dowry deaths	1(16.7)	1(25)	2(20)
Total	6 (60)	4 (40)	10(100)

\*Figures in parentheses indicate percentage

In this study, it was also observed that 80 percent female victims had antecedent history of illicit sexual relationship leading to homicide whereas about 88 percent of male victims mainly had history of property and monetary disputes leading to homicide. (Table-3)

Illicit sexual behaviour by themselves led to homicide in 75 percent of unmarried and 33 percent of married women whereas 50 percent of married women were murdered as a consequence of illicit sexual relations of their husbands. About 17 percent of married woman were killed as a fall out of dowry demands (Table-4).



Fig-1: A body of a female in pugilistic attitude with post mortem burn after strangulation.



Fig-2: Fractured right greater cornu of hyoid in strangulation.



Fig-3: A dead body of a male with penetrating injury left lung.

#### **Discussion:**

It was seen that as most of the homicide victims were in economically productive age group and almost all female victims were also in the reproductive age group.



Fig-4: Extravasation of blood in subcutaneous tissue at neck in manual strangulation.

It was found that significantly more female victims of homicide were killed by manual and ligature strangulation and significantly more male victims were killed by deep incised or penetrating wounds, injuries including head injuries and gunshot wounds. So it was evident that female victims could easily be overpowered by force whereas male victims were killed with the help of either a sharp-cutting weapon, or a hard blunt weapon or a firearm and not infrequently evidences of struggle were also found on the body of the male victim.

In a study on ML autopsy between 1999 to 2003 at Kualalampur on homicidal dead bodies it was seen that most of the victims were in the age group 20-39 years and most injuries were caused by sharp weapons followed by blunt trauma and firearm injuries which are in conformity with the present study.<sup>7</sup>

A study at Penang Hospital, Malaysia on 65 autopsied dead bodies in homicide cases between 2007 to 2009 homicide rates ranged between 0.01 per 1000 to 0.09 per thousand population which was in conformity with this study but the death from asphyxia was slightly less than the present study.<sup>8</sup>

In a study at V.N. Medical College, Yeotmal, Maharastra, India during 1998 to 2000 about 241 homicide cases were autopsied with homicide rate of 0.05 per 1000 population which is quite high in comparison to the present study. Major causes identified were blunt trauma, sharp trauma, burning and strangulation which is almost similar to the present study.<sup>9</sup>

In a study on 511 homicidal autopsy cases in Paris, France between 1994 to 2008 it was seen that asphyxia is the cause of death in only 13 percent cases which is far less than the present study.<sup>10</sup>

In a study in Adana, Turkey among 620 homicidal autopsies it was seen that 73 percent of the population were in the age group 21 to

50 years which conforms to the present study.<sup>11</sup>

In a study on unnatural deaths in women of reproductive age group at GWD hospital, Mangalore, Karnataka, India only 15 homicidal cases were identified and most of the homicidal deaths were due to blunt trauma, ligature strangulation and deep sharp-cut injuries.<sup>12</sup>

In the present study, significantly more female victims had an antecedent history of illicit sexual relation which had led to their murder whereas significantly more male victims had antecedent history of property or monetary dispute which resulted in homicide.

Moreover, among the females, most of the unmarried women having illicit sexual relations were murdered whereas married women were mostly murdered as a consequence of illicit sexual relation of their husbands. So it can be opined that unmarried woman of reproductive age group should be cautious before getting involved in physical relationship. Otherwise, they may be trapped in strained interpersonal relationship leading to a fatal end. About 67 percent of married females became victims of domestic violence at their in-laws houses either due to dowry disputes or as a consequence of illicit sexual relations of their husbands.

Six cases of murder were reported in a case series in Malaysia where condom or other contraceptives were found at the crimescene that points to the association of illicit sexual relation leading to homicide which is also found significantly in this present study.<sup>13</sup>

In US, 174 homicidal deaths were recorded during pregnancy from all states between 2011 to 2015 establishing violence against women of reproductive age which is also found in this present study.<sup>14</sup>

In a study conducted on 57 ML autopsy cases of homicidal manner by Forensic Medicine department, Ramaiah Medical College, Bangalore, Karnataka, India during 2005-2007, it was found that 68.4 percent of all homicide death victims belong to age group 20 to 49 years which is supported by the present study. But asphyxia deaths constituted only 21 percent which was lower than the present study.<sup>15</sup>

In a study conducted in Sri Lanka on female homicide cases 70 per cent belong to the age group 21 - 60 years which supports the observation of the present study but death from neck compression is far less than the present study.<sup>16</sup>

In a study conducted in Chandigarh, India most of the homicidal deaths among females were due to burn injuries whereas no death from antemortem burn was not found in present study.<sup>17</sup>

In a study at Bangalore, India, most of the victims belong to 3<sup>rd</sup> and 4<sup>th</sup> decade age group and sharp cut followed by blunt injuries mostly caused death which partially support the present observations.<sup>18</sup>

In a study at Meerat, U.P. most of the homicide victims were male, head injury and other injuries were mostly responsible for death and monetary or property dispute mostly led to homicide that supports the present study.<sup>19</sup>

In a study at Telangana, most of the murders were caused by deep sharp cut injuries followed by blunt trauma which is also supported by the present study.<sup>20</sup>

## **Conclusions :**

As male victims of homicide mostly belonged to the economically productive age group and they were mostly killed by mechanical injuries as a consequence of property or monetary disputes, so advice should be given to avoid physical confrontation to solve any property or financial disputes like unpaid debts and to take legal help instead of that to solve the problem. Recommendations should be sent to the authorities for arranging regular psychological counselling and easy access for free legal help at the community level to resolve any matter of property or financial dispute. Almost all female homicide victims belong to the reproductive age group, majority of them being married woman, mostly being subjected to domestic violence either due to dowry demands or due to illicit sexual relationships of their husbands who desperately tried to remove the thorn on their way by killing their wives. So stringent legal actions should be taken against domestic violence at the in-law's house so that everybody understands that no one would be spared from the clutches of law if any incident of torture of bride is reported to police and judiciary. Illicit sexual relation was found among most of the unmarried and divorced female victims. So awareness should be generated among general population including the young, unmarried, separated or divorced women regarding dangerous outcome of illicit sexual relations citing the instances of fatal outcome in those cases as depicted along with photographs in this study. The punishments given to the perpetrators of those crimes should also be circulated through mass-media to alert everyone regarding the outcome of committing such type of crimes. Autopsy surgeons should be cautious while doing medicolegal autopsies of deaths due to asphyxia in females as most commonly females were killed by manual and ligature strangulation and in many occasions the identity of the victim remained unknown where no antecedent history could be collected. They should examine the dead body thoroughly and meticulously and collect samples for chemical examination and DNA profiling from it before giving opinion about manner of death.

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#### **ORIGINAL ARTICLE**

# Utilization of serum chloride level from post mortem blood in determination of time since death- a critical analysis

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#### Abstract :

The potential to unravel many unfolded medico legal mysteries lies within the post mortem clocking. Despite the large amount of research undertaken, the post mortem interval remains one of the most challenging variables to be quantified and established. The aim of our project was to study the pattern of serum chloride (cl-) concentration change after death and to correlate it with post mortem interval. Post mortem blood samples collected from external jugular vein of total 150 subjects with documented time of death, were analyzed in a period of one & half years during January 2020 to June 2021 to assess the changing pattern of cl- concentration with respect to their time since death. Serum cl- concentration was found to be decreased almost linearly with progression of time within 6-33 hours after death. Coefficient co-relation of mean post mortem cl- concentration and time since death was (-0.94). Average decrease rate of serum cl- concentration was found to be 0.85 meq/L per hour. The present study also showed that 95% confidence limit of over  $\pm$  17.18 hours limits the usefulness of this method in estimating time since death.

Keywords : Post mortem interval; Serum chloride (cl-) concentration; Time since death.

#### **Introduction:**

Determination of time since death or post mortem interval is an integral part of medico legal investigations. Post mortem interval (PMI) is defined as "amount of time that has elapsed since the death of decedent".<sup>1</sup> Where the manner of death is homicidal, estimated accurate PMI always opens the door of many unsolved mysteries. The medico legal experts rely on various subjective methods of observing the external as well as the visceral somatic changes in the dead body. No objective and accurate method has been unequivocally accepted. No one can deny, in spite of tremendous progress in forensic science over the past few decades, time since death (TSD) is still a "dark spot".<sup>2</sup> The search for newer and more objective parameters and their validation continues.

An accurate estimation of PMI requires the evaluation of parameters that correlate with time after death.<sup>3</sup> This definition fits well in postmortem changes of biochemical & morphological parameters, since each changes has its own time factor. These changes begin immediately after death, initiating at the cellular level and subsequently evolving to hemolysis, discolouration, swelling and putrefaction. During human decomposition, several biochemical & morphological changes take place in all body tissues due to absence of circulating oxygen and the consequent cessation of aerobic respiration, altered enzymatic reactions, cessation of anabolic production of metabolites, cessation of active membrane transport and changes in the permeability of cells and diffusion of ions.<sup>4-7</sup> Biochemical & morphological profiles from different body fluids can provide insights into the

Corresponding Author Bhaskar Jyoti Debnath Email : bhaskarjyotidebnath@gmail.com Mobile No. : +91-9007107660 changing metabolic environment of the host. A key advantage of blood from a forensic perspective is that it is a remarkably uniform biofluid, which is largely unaffected by confounding factors such as age, gender, diet, diurnal cycle and stress, making it ideal to use for PMI determinations.<sup>5</sup> In view of this, the present study was undertaken and post mortem chloride concentration of blood serum was chosen as a possible marker for estimation of TSD.

Over the last few decades, some progress in PMI estimation has been made using biochemical parameters at cellular level of blood, supported by different statistical approaches. These methods have been shown to be more accurate in PMI estimation, since the effect of external conditions is less relevant than in the currently used traditional methods.

It is well known that whatever parameters we use, they are subjected to a wide range of variations and are affected by various factors like condition of the body, place, environmental condition, cause of death, diseases etc.<sup>8</sup> So the parameters should be modified depending upon difference in place, seasons, individual characteristics so that TSD can be calculated in a precise narrow range in a particular case.

#### **Materials and Methods :**

After getting the clearance from Institutional Ethics Committee, the present study was conducted for one & half years as a prospective analytical study over 150 cases from January, 2020 to June, 2021 in the Raiganj Govt. Medical College & Hospital Police Morgue attached to the Department of Forensic Medicine & Toxicology. Stratified random sampling method was chosen to select the study population. One date had been selected by lottery method from each 10 days interval of entire study period. All cases had been accepted on that specific date if satisfied the

#### inclusion criteria.

Post mortem blood was collected by ten cc syringe & needle from external jugular vein of each dead body included under study population before autopsy in a blind trial & error method. Total study population was divided into ten groups based on blood collection time i.e. 6, 9, 12, 15, 18, 21, 24, 27, 30 & 33 hours after death. Each group comprised of 15 cases. Blood samples collected in clotted vials were centrifuged @3000 rpm for 3-4 minutes to segregate serum from cellular parts and serum chloride concentrations were measured by Roche-9180 electrolyte analyzer in ion selective electrode method and derived values were recorded.

After receiving the details, post mortem examination was

Table 1: Frequency Distribution of study Population in Different age groups.

Age Range (Years)	No. of Cases	% of Total Population
1-20	13	8.67
21-30	25	16.67
31-40	24	16.00
41-50	27	18.00
51-60	22	14.67
61-70	19	12.67
>70	20	13.33

Table 2 : Comparative study	of mean seru	im cl- concentration	(meq/L)
in males & fem	ales with nrog	ression of TSD	

TSD (hours)	Serum Cl- in males	Serum Cl- In females	Two-tailed P value of Student t test
6	96.71	96.63	0.9771
9	92.43	93.13	0.8391
12	91.44	86.83	0.3323
15	87.22	83.00	0.4069
18	86.43	85.63	0.7386
21	83.00	83.00	1.0000
24	81.78	91.00	0.0681
27	78.33	86.33	0.1302
30	82.38	77.00	0.3592
33	79.00	75.00	0.4749

Table 3 : Mean serum cl- concentration for different TSD in the study sample.

TSD (hours)	No. of Cases	Mean serum Cl- concentration (meq/L)	Standard Deviation (meq/L)
6	15	96.7	5.68
9	15	92.8	6.27
12	15	89.6	8.69
15	15	85.5	9.26
18	15	86.0	4.41
21	15	83.0	4.72
24	15	85.5	9.68
27	15	81.5	9.92
30	15	81.7	7.43
33	15	78.5	7.04

conducted and cause of death was determined. All the findings thus obtained were noted down in a separate proforma for each case. Then the master chart was prepared. The statistical analysis of the data collection was done and presented in the form of tables & graphs.

**Inclusion Criteria :** All institutional death cases where TOD (Time of Death) were documented.

**Exclusion Criteria :** Dead bodies with external signs of decomposition or Rigor Mortis (RM) passed off fully, Dead bodies of Newborns & Infants , Charred Bodies, Anemia, Nutritional deficiencies, Known cases of blood dyscrasia and violent asphyxial death cases

## **Results :**

In our study, total population size that fulfill all the inclusion & exclusion criteria was 150. Minimum and maximum age of the study population was 11 years & 81 years respectively. Maximum cases(27 cases) were found in 41-50 years age group and least cases (13 cases) were found in youngest age group i.e. 1-20 years. Mean age of the study population was 45.62 years and median was 44 years. (Table 1)

Total male population was 99 & female population was 51. Polytrauma was found to be the cause of death in maximum cases i.e. in 35 cases (23.33% of total study population).

In case of both genders, estimated mean post mortem cl-(Chloride) concentration was maximum at 6 hours (96.71 meq/L in male, 96.63 meq/L in female). As time progressed, mean clconcentration was also changed and hold lowest value when TSD was 33 hours (79.00 meq/L in male, 75.00 meq/L in female). P value was >0.05 at all intervals. That means as such no statistically significant difference exists between the mean clconcentration of male & female blood serum at different intervals after death. So, irrespective of gender, we can compare the recorded values of mean cl- concentration measured at different intervals after death from the pooled sex population (Table 2).

Mean Cl- concentration was highest i.e. 96.7meq/L at 6 hours & lowest i.e. 78.5 meq/L at 33 hours. ANOVA Test was performed using calculated mean cl- concentration values of all specific time intervals and P value is 0.000. So the difference among mean cl-concentration of each group is statistically significant. But standard deviation of these mean cl- concentrations subsequently increased with progression of TSD (Table 3).

A linear regression formula was derived for estimating TSD (X) from Postmortem serum cl- concentration (y) as  $X = 167.78 \cdot (Y) / 0.58$ . Pearson's correlation coefficient (r) = -0.94, implied a strong negative correlation between the two. (Figure 1)

Mean of X=19.5 hours Mean of Y=86.08 meq/L

Standard deviation (SD) of X = 8.59 hours, Standard deviation (SD) of Y=6.83 meq/L

95% Confidence limit of X=Mean+2SD of X

Regression coefficient =  $r \frac{SD \text{ of } X}{SD \text{ of } Y}$ 

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= -0.94 X(8.59/6.83)

=-1.18

This means that a decrease of chloride values of 1 meq/L will indicate an increase of 1.18 hrs in the postmortem interval and 95% confidence limit for all cases will be  $\pm 17.18$  hrs.

Thus average rate of decrease of serum chloride was calculated as 0.85meq/L per hour.

## **Discussion :**

Serum, one of the major parts of blood, exchanges substance continuously with the interstitial fluid through the pores of capillary membrane and with the intracellular fluid through the pores of the cellular membrane.<sup>9</sup> Some of those exchanges are energy dependent called active transport and some others are passive transport. cl- is the major extracellular anion that differs considerably owing to the activity of various transporters, channels and ATP driven membrane pump in the living period. After death, there will be cessation of active membrane transport and loss of selective membrane permeability. The passive transport becomes prevalent and biochemical homeostasis of blood is thoroughly disrupted. That results in electro-chemical gradient dependent increased intracellular shifting of cl- and ultimately decreases serum cl- concentration after death, the autolysis of capillary membrane is also responsible for its fall.

Schleyer et al published an article in which it was stated that the rate of post mortem plasma chloride fall is between 0.25-1 meq/L per hour.<sup>10</sup> Coe et al found that serum chloride concentration decreased linearly at the rate of 0.95 meq/L per hour in first 24 hours of post mortem period in there research.<sup>11</sup> A highly significant correlation between post mortem serum cl-concentration & TSD was also documented in our study and the average rate of fall was 0.85meq/L per hour. Quiredo et al. observed that the chloride concentration decreased rapidly during the first 24 hours following death.<sup>12</sup> Highly significant linear relationship was observed between the post mortem rat plasma



Figure 1: Correlation between post mortem mean serum CI- concentration in meq/L (Y) and TSD in hours (X)

chloride concentration and PMI up to 96 hours. The study also demonstrated that because of similarities in rat and human blood, the relationship between plasma chloride concentrations can be applicable to humans.

The present study showed that 95% confidence limit of over +17.18 hours limits the usefulness of this method in estimating TSD. Certain factors have become apparent behind the marked variation in the confidence limits derived from various investigators while studying correlation between TSD and electrolytes concentration in serum. These factors can be external such as sampling techniques, different sample size, analytical instruments and environmental temperature during death or internal factors such as age of the individual, the duration of terminal episode, manner of death, electrolyte imbalance and presence of uremia at the time of death.<sup>13</sup> So, it is expected, these above mentioned unavoidable confounding factors play a key role for 95% confidence limit of over +17.18 hours in our study.

We all know in biology, variability is the rule & stability is the exception. Postmortem serum chloride concentration may be influenced by various pre-morbid conditions such as dehydration, dyselectrolytemia, NaCl poisoning, salt water drowning etc. These factors may also cause limitation to use serum chloride concentration as a TSD marker.

#### **Conclusion :**

It's a high time to search other possible objective biological parameters for estimation of PMI. Post mortem serum clconcentration has the potential to play an optimistic role in this context. According to our study findings, post mortem serum clconcentration formulated a linear regression curve with TSD and the average rate of fall was 0.85 meq/L per hour. 95% confidence limit of over  $\pm 17.18$  hours limits the usefulness of this method in estimating TSD. The role of various confounding factors needs to be evaluated more precisely before its use in practical field. However, its use should be adjuvant to other methods. Also one should keep check on method of analysis & other possible confounding factors, as these may lead to erroneous results in some cases.

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#### Conflict of Interest: None.

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#### **ORIGINAL ARTICLE**

## Pattern of Snake Bite Cases Admitted at a Tertiary Hospital, Khammam

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#### Abstract :

In tropical regions of the world, most snakebite cases are caused by four (Big four) venomous snakes. This is a hospital-based prospective study conducted from April 2020 to March 2021 at the Emergency Department, Mamata General Hospital attached Medical College, Khammam Telangana, India. All the patients irrespective of age and sex, who reported a history of snakebite were included in the study. There was a total of 50 snake bites among which males were 39 (78.00%) and 11 (22.00%) were females, with male to female ratio of 3.54. The highest incidence of snake bites was observed in 31-40 years; most of the victims were illiterate. The majority of the victims were from rural areas 44 (88.00) as compared to urban areas 6 (12.00%). The most vulnerable occupations were people involved in agricultural activities 36 (72.00%). The study group was predominately bitten outdoors46 (92.00%). The maximum cases of snake bites were recorded in the rainy season and the peak incidence of snake bites was recorded in the night time. Fang marks were recorded in 45.38% of the cases.16.9% of them were reported to a hospital within an hour of the bite. 33.03% reported within 24 hours of the bite. The most common areas of bites were lower limbs 28 (56.00%). Most of the patients could not identify the snake 40 (80.00%) and among identified poisonous snakes 10 (20.00%). Viperidae (hemotoxic) and Elapidae (neurotoxic) type were 28 (56.00%) and 20 (40.00%) respectively. The majority of victims were treated with ASV48 (96.00%) and most of them survived 44 (88.00%).

Keywords : Snake; Snakebite; Patterns; Rural; Envenomation.

#### **Introduction:**

Snakebite is a serious public health issue worldwide, especially in the Indian subcontinent. The study on the pattern of snake bites is essential to provide information to the concerned authorities to manage snake bites appropriately. There are more than 3500 species of snakes but only about 250 are venomous. India is inhabited by more than 60 species of venomous snakes of which only four have been popularly known to be poisonous to humans; spectacled cobra(Naja naja), common krait (Bungarus caeruleus), saw-scaledviper (Echis carinatus) and Russel's viper (Daboia russelii).<sup>1</sup> In India, the mortality due to venous snake bites is 35000-50000 per annum according to World Health Organization. According to WHO, there are more than a 2.5 million venomous snake bites worldwide each year with more than 1,25,000 deaths. Envenomation in India is estimated to be at 81,000 per year, which is the highest in the world.<sup>2</sup> The burden of human suffering caused by snake bites remains unrecognized, invisible, and unheard by the global public health community, the problem is so underrated that it was only added to WHO's a list of neglected tropical diseases in April 2009.<sup>2</sup> The most common poisonous snake among them is the common krait. Bites may be inflicted in the confines of home by peri-domestic species such as cobras which may live in roof spaces or under the floor and by kraits which enter human dwellings at night in search of their prey and bite people walking along paths in the dark.<sup>3</sup> Snakebite is an important and serious occupational, and medical problem in many parts of India. However, reliable data for morbidity and mortality are not available since there is no proper reporting system.<sup>3</sup> The high rate of mortality in India is due to climatic

**Corresponding Author Dr. Bharath Kumar Guntheti** Email : bk62743@gmail.com Mobile No. : 9908339507 factors, the rural predominance of population, illiteracy in rural areas, and agricultural dependence. This is especially true in rural areas where snake bites are common but there is limited access to health care and antivenoms.<sup>4</sup> The increased mortality and morbidity are due to the inadequate training of the primary health care workers, society, the practice of ASV, improper first-aid measures, delay in transport, and poor quality of health care services.

#### **Materials and Methods :**

The hospital-based prospective study was conducted at the Emergency Department, Mamata General Hospital attached Medical College, Khammam, Telangana, from April 2020 to March 2021

The study was approved by Institutional Ethics Committee. All the patients irrespective of age and sex, who reported a history of snake bites were included in the study. The main aim is, to study the epidemiology of snake bite poisoning including sex, age groups, the place of incidence, time and site of the bite, seasonal variation, patterns of bite, type of biting snake, immediate manifestation, hospital stay, treatment received, and outcome. To suggest measures to prevent deaths from snakebite poisoning.

**Study design :** Data collection of the study comprised 50 patients with a history of snake bites, were studied, from the time of reporting to the hospital and follow-up till the outcome from the hospital. At the time of admission, preliminary data of each case, such as age, occupation, educational status, marital status, domicile, and other demographic details were entered in a proforma, and circumstances involving bite, type of biting snake, the time and site of the bite, the symptoms and signs noticed on hospital admission and the treatment instituted was recorded. In most cases, the history was elicited from the patient except when compromised severely by symptoms. Eventually, the proxy

history was given by the patient relatives; however, it was authenticated by the patient on recovery.

#### **Results :**

A total of 50 snake bite cases among which males were 39 (78.00%) and females were 11 (22.00%). The highest incidence of snake bite was observed in the age group of 31- 40 years 22 (44.00%) followed by 21-30 years 10 (20.00%) and least in 41- 50 years 6 (12.00%) as shown in table 1. The majority of victims belonged to rural areas 44 (88.00%) as compared to urban areas 6 (12.00%) and 38 (76.00%) had low economic backgrounds and 24 (48.00%) were illiterates. The most vulnerable occupation group were people involved in agricultural activities 36 (72.00%) followed by housewives 7 (14.00%) and students 4 (8.00%) as shown in table:2

The maximum number of cases were reported during the rainy season 28 (56.00%) as compared to other seasons which is depicted in chart 2.96 (67.1%) victims were bitten during the night as compared to 32 (64.00%) day time 18 (36.00%) as shown in table 3.

Fang marks were recorded in 45.38% of the cases.16.9% of them

Table : 1 Age & Gender.

Age in years	Males	Females	No of cases	%
0-10	1	-	1	02.00
11-20	5	-	5	10.00
21-30	6	4	10	20.00
31-40	17	5	22	44.00
41-50	4	2	6	12.00
51-60	4	-	4	08.00
> 60 yrs.	2	-	2	04.00
Total	39	11	5	

Table : 2 Occupation Wise.

Occupation	No of cases	%
Farmer	36	72.00
Housewife	7	14.00
Students	4	08.00
Others	3	06.00
Total	50	

Table :	3	Seasonal	Variation
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Season	No. of cases	%
Summary	12	24.00
Rainy	28	56.00
Winter	10	20.00
Total	50	

were reported to a hospital within an hour of the bite. 33.03% reported within 24 hours of the bite. According to table: 5,37 (74.00%) cases were bitten on the lower extremity followed by 11 (22.00%) on the upper extremity, and 2 (4.00%) on the trunk, and the head and neck. 48 (96.00%) patients were bitten by venomous snakes as compared to 2 patients (4.00%) who were bitten by non-venomous snakes. Among 48 venomous snake bites, 6 patients expired during the hospital stay. The most common type of venom was hemotoxic observed in 28 (56.00%) cases followed by neurotoxic venom in 20 (40.00%) cases as shown in table:6. The average duration of hospital stay varied from 3 to 7 days 28 (56.00%). 40 (80.00%) identified biting snakes were cobra and viper while 10 (20.00%) remained unidentified.

### **Discussion :**

A total of 50 cases were identified as snake bites during the study period. The incidence is slightly more because this area is a tribal district and agriculture-related work is the main occupation of the local people. Similar observations were made by others.<sup>4-8</sup>

In the present study, the maximum number of victims belonged to 31-40 years age group. The most common age group of snake bites was 31-40 years 22 cases (44.00%) followed by 21-30 years, 10 cases (20.00%), and 41- 50 years with 6 cases (14.00%). The probable reason for predominance in working age group 31-40 yr. Snakebite is more common in the young age group as they are involved in agricultural activities and thus risk-involved population. This indicates a high social and economic burden on the victim's family as well as the society. Which was consistent with the studies conducted by other authors.<sup>5-8</sup>

Table: 4 Time of Snake Bite.

Time of Snake Bite	No.of cases	%
Day	18	36.00
Night	32	64.00
Total	50	

#### Table: 5 Pattern of Site of Snake Bite.

Site of Snake Bite	No. of Cases	%
Upper Limbs	12	24.00
Lower Limbs	28	56.00
Face & Neck	5	10.00
Trunk	3	06.00
Other Sites	2	04.00
Total	50	

#### Table: 6 Type of Snake Bite.

Type of Snake Bite	No. of Cases	%
Haemotoxic	28	56.00
Neurotoxic	20	40.00
Non -Poisonous	2	04.00
Total	50	

Males were predominant in 39 (78.00%) as compared to females in 11 cases (22.00%), with a male to female ratio of 3:54. This was due to more active involvement by males in outdoor agriculture activities, and fieldwork than females. The male dominance of the snake bite cases was to the studies conducted previously.<sup>5-8</sup>

The majority of victims were from rural areas 44 (88.00%) as compared to urban are as 6 (12.00%) as the snakes are in abundance in rural areas and the people living there come across snakes in their life very often due to their living conditions, habits working and walking barefooted. Similar observations are found in studies by authors.<sup>9,10</sup>

The most vulnerable occupation group were the people involved in agriculture activities 36 (72.00%) followed by housewives7 (14.00%); students 4 (8.00%) and others 3 (6.00%) which was similar to studies done by other authors.<sup>7-11</sup> Majority population, be longing to agriculture are more prone to accidental contact with snakes while working in the field barefoot. Thus, snakes could have possibly been trodden upon by the victims. This increases the likelihood of farm workers encountering these snakes.

The majority of victims were bitten between 6 pm to midnight 32 (64.00%) as compared to daytime18 (36.00%). Similar studies conducted in other parts of the country showed a relatively higher incidence of snake-bitten cases between 6:00 PM and midnight as







found in our study.<sup>12-14</sup> This is mostly because of poor visibility working in fields during late evening and night hours and accidental stepping on the snake and leading to the encroachment of snakes into human dwelling places thus making them more vulnerable.

In our study, 46 (92.00%) incidents took place in the agricultural fields indoors and 4 (8.00%) incidents at the house.<sup>12-14</sup> This may be attributed to their lifestyles involving outdoor activities or occupation as agriculture.

The maximum number of snakebite cases was reported during the rainy season, accounting for 28 (56.00%) cases. Similar observations were found in studies.<sup>3,4,9,15</sup> Because of the flooding of the habitats of the snakes and other rodents and insects are more during this time, dwellings increase the chances of their encounter with humans mostly ending in biting them in defense.







Chart : 5 Type of Snake Bite.

Fang marks were recorded in 45.38% of the cases. Coming to the pattern of bites based on the area of the body, the lower extremities were found to be the most common site with bites being observed mainly on the dorsum of the left foot in 20 (40.00%) of the cases followed by the dorsum of the right foot in 17 (34.05%) of the cases, as compared toupper extremities 11 (22.00%) and head & neck 2 (4.00%) in descending order. The site of snake bite was found to be the lower limb in 37 (74.00%) and upper limb in 11 (22.00%) of the cases. The lower extremity as the most common site for snakebite has been observed in similar studies.<sup>15,16-20</sup> This suggests that the site of snake bite is predominately determined by accidental or inadvertent contact of the reptile during the activity. This could be a result of walking barefoot and accidentally stepping on a snake due to poor visibility during dusk. The bites over the upper limbs mostly occurred while handling vegetation or during unskilled handling of snakes.

A very small percentage of victims were bitten over the face, neck, or trunk Bites on the head & trunk mostly occur when nocturnal species bite people while sleeping. The most frequent location of snake bites were the foot and ankles of lower limbs 37 (74.00%) and hands of upper limbs 11 (22.00%).

Venomous snakes prefer to enter agricultural land where prey is abundant, 48 (96.00%) patients were bitten by venomous snakes as compared to 2 patients (4.00%) who were bitten by non-venomous snakes and among these 48 venomous snake bites, 6 (12.00%) cases expired during the hospital stay which is similar to the study conducted by other researchers.<sup>16-20</sup>

The most common type of venom was hemotoxic observed in 28 (56.00%) cases followed by neurotoxic venom in 20 (40.00%) cases. The incidence of Viperidae snake bites was found to be similar to studies conducted in other studies.<sup>18-20</sup> Most of the snake bites in India are a result of bites of Cobra, Russel's Viper, and Common Krait.

Duration of hospital stay, the average duration of hospital stays varied from 3 to 7 days 28 (56.00%). Asimilar conclusion has been reported in studies conducted earlier.<sup>21</sup>

In 40 (80.00%) cases, the snake that bit was identified while in 10 (20.00%) cases, it remained unidentified. Identification of the species is vital for specific management but unfortunately, it is not possible in most cases as the victims are frightened, anxious, and ignorant.

The majority of the cases were administered ant-snake venom (ASV) on admission i.e., 48 cases 96.00%) and most of them survived i.e., 44 (88.00%). Management should be started immediately to be effective. The mortality rate was 0.12 % and the leading cause of death was renal failure 3 (6.00%) followed by respiratory failure 2 (4.00%). The mortality rate in similar other studies varied from 3.6%. These observations are consistent with most of the authors.<sup>18-22</sup>

## **Conclusion :**

Most of the bites were viperine followed by elapids. Most of the bites have occurred during the night time. To impart knowledge about the prevention of snakebite, early hospitalization, and the first aid measures to the young people, rural farmers, and field workers as they are more prone to snake bites. In poisonous snake bites, early administration of Anti-Snake venom will result in fewer complications and mortalities. The stated snakebite cases were due to non-poisonous bites which required only assurance and first aid. It is compulsory to educate people about poisonous and non-poisonous snake bites through community health education programs.

Rendering to this study, snake bites were more common in rural areas and among people who are engaged in agricultural activities, so health education programs should be directed to educate rurally farmers about the use of long boots to prevent snake bites.

#### **Recommendations:**

People must be advised to use protective measures like long pants and gumboots while working outdoors. Availability of prompt transportation facilities, and anti-snake venom during the early crucial hours. Quick transport, correct first aid measures, and training can drastically bring down this neglected tropical health problem.

#### Conflict of Interest : None

Source of Funding : Self-funded

**Ethical Clearance :** The study was approved by Institutional Ethics Committee.

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#### **ORIGINAL ARTICLE**

## A study on Pattern and outcome of Poisoning cases in Tertiary care Hospital in South India

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## Abstract :

Poisoning is the fourth common reason of mortality in India. Familiarity of common configuration of poisoning in a specific area will aid in prompt identification and management of cases, therefore reducing the frequency of death and morbidity. So, the aim of this study is study the pattern of all poisoning cases admitted to the hospital. 277 victims who were admitted in emergency triage due to poisoning in 1 year were included for the study. Data pertaining to age, sex, and toxic substance were analyzed. Age group was divided into 3 categories 15-40 yrs, 41-65 yrs and 66-90 yrs. Later the results were analyzed. Age group 15-40 years was more commonly involved. Males outnumbered females. Oral ingestion of poison was predominately seen. Most common poisoning was the organophosphorous insecticide poisoning which was seen in 24.18% of cases. Early care in a tertiary care center after identifying the poison may benefit in reducing death due to poisoning in India.

Keywords : Insecticides; Poisons; Tertiary care centers; Drug overdose; Hospitalization.

#### **Introduction:**

Poison is an element that can harm or injure the body and threatens a person's life when he/she comes in contact with it in any way either by consumption, breathing or intimate contact.<sup>1</sup> Acute poisoning is said when the person is exposed to toxic substance for less than 24hrs.<sup>2</sup> Acute poisoning is the reason of substantial death and morbidity in whole world either because of accidental exposure or due to suicidal reasons. According to World Health Organization (WHO), worldwide in a year there are more than three million cases of acute poisoning with 2, 20,000 deaths.<sup>3</sup> It has been estimated that, in India five to six people die every year in lakh of population due to acute poisoning.<sup>4</sup> Quick industrial development, introduction of different variety of medicines for management and enormous use of pesticides in farming has amplified the occurrence of poisoning.<sup>5</sup> In India, as farming is the chief livelihood, pesticides and other fertilizers are largely used and therefore poisoning with such stuffs are very common.<sup>6</sup> Poisoning is one of the chief reason of admitting in hospital in emergency and is a main community health problem.<sup>7</sup> Poisoning consumes not only the important health provision resources but it also leads to substantial morbidity and mortality.<sup>8</sup> Numerous aspects which affect the result of poisoning include the amount of poison which the patient has ingested, how fast the patient seeks the medical clinical care and the accessibility of effective medical management.9 Clinical and toxicological diagnostic and management amenities are most of the time insufficient due to the shortage of skilled employees therefore it require strengthening at the national level for early prevention, diagnosis and management. Additionally, the deficiency of data on the constituents of different products which are available in the market also leads to problem to strategize and create national

Corresponding Author Chandni Gupta E-mail : chandnipalimar@gmail.com Mobile No. : 9886738555 poison guidelines and control programs and to deliver on time and trustworthy source of information to doctors and other medical personnel and first responders on the suitable management.<sup>10</sup> Awareness of common configuration of poisoning in a specific area will aid in fast identification and management of cases, therefore reducing the rate of death and morbidity. So, the aim of this study is study the pattern of all poisoning cases admitted to the south Indian tertiary care hospital.

## Materials and Methods :

It was a retrospective study. 277 victims who were admitted in emergency triage due to poisoning in 1 year were included in the study. Ethical clearance was taken from the institutional ethics committee (IEC 399/2017). Out of 277 victims there were 153 males and 124 females. Data pertaining to age, sex, toxic substance (type of poison and route of ingestion) were collected. Age group was divided into 3 categories 15-40yrs, 41-65yrs and 66-90yrs. Regular statistics was done to analyze the results.

#### **Results:**

Poison consumed mostly by the victims of age group of 15-40yrs 71.84% (199). Oral ingestion of poison was predominately seen 275 cases. Only 2 patient got poisoned by spraying of pesticides. Most common poisoning was the organophosphorous insecticide poisoning which was seen in 24.18% of cases, followed by Drug overdose which was seen in 20.9% of cases.

Data of Poisoning in different age group is shown in Table 1. Type of poison consumed by the patients is shown in Table 2.

Organophosphorous poisioning was most common in males (71.65%), females (28.35). Most common age group involved was 15-40 yrs (68.6%) followed by 41-65 yrs (23.88%), then 66-90yrs (7.46%). Paraquat poisoning was most commonly seen in males (69.5%), females (30.43%). Most common age group involved was 16-40yrs (78.26%), followed by 41-65yrs (17.39%), then 66-90yrs (4.34%).

Rat poison poisoning was equally seen among both males and females (50%). Most common age group involved was 16-40yrs (78.94%), followed by 41-65yrs (18.42%), then 66-90yrs (2.63%). Phenol poisoning was most commonly seen in females (60%), males (40%). Most common age group involved was 16-40yrs (60%), followed by 41-65yrs (20%), then 66-90yrs (20%).

Drug overdose poisoning was most commonly seen in females (60.34%), males (39.65%). Most common age group involved was 16-40yrs (68.96%), followed by 41-65yrs (20.68%), then 66-90yrs (10.34%). Oleander poisoning was seen only in males. It was seen only in 16-40yrs of age group.

Cannabis poisoning was also seen only in males. It was also seen only in 16-40 yrs of age group. Kerosene poisoning was most commonly seen in females (60%), males (40%). Most common age group involved was 16-40yrs (60%), followed by 41-65yrs (40%). Acid poisoning was most commonly seen in females (62.50%), males (37.5%). Most common age group involved was 16-40yrs (75%), followed by 41-65yrs (25%).

Alcohol poisoning was most commonly seen in females (58.33%), males (41.66%). Most common age group involved was 16-40yrs (91.66%), followed by 41-65yrs (8.33%). Pyrethrin poisoning was most commonly seen in females (66.66%), males (33.33%). Most common age group involved was 16-40yrs (66.66%), followed by 41-65yrs (33.33%). Unknown poisoning was most commonly seen in males (58.69%), females (41.30%). Most common age group involved was 16-40yrs (69.56%), followed by 41-65yrs (23.91%), then 66-90yrs (6.52%).

Miscellaneous poisoning was most commonly seen in females (75%), males (25%). Both age groups 16-40 yrs and 41-65 yrs were equally seen. Bifux, boom flower, sophra root extract, oil, camphor, hydrogen peroxide (12.5%) and Dettol was (25%).

Table 1. Showing the different age groups of patients.

Age Groups (years)	Number of patients (%)
15-40	71.84
41-65	22.02
66-90	6.13

	• •
Type of poison	Number of patients (%)
Organophosphorous compounds	24.18
Paraquat	8
Rat poison	13.7
Phenol	1.8
Drug overdose	20.9
Oleander	0.72
Cannabis	0.72
Kerosene	1.8
Acid	2.88
Alcohol	4.33
Pyrethrin compounds	1.08
Miscellaneous*	2.88
Unknown	16.6

Table 2. Showing type of poison consumed by the patients.

\*Boom flower, camphor, sophra root extract, Bifux, Hydrogen peroxide.

## **Discussion :**

Now a days worldwide poisoning is a most common medicosocial problem.<sup>11</sup> Depending upon the socioeconomic aspects and due to cultural diversity the type of poison which is taken will differs in various parts of the world and can even differ in various segments of the same country. Treatment of such severely ill patients will significantly improve if the general reasons of poisoning are appropriately stated.<sup>12</sup>

Ramesha KN et al found that the occurrence was mostly seen among males (75.4%) compared to females (24.3) even in our study poisoning was mostly seen in males (55.2%) than females (44.8%). They found that most cases of acute poisoning were occurring in 20 to 29 year age group (31.2%) then in 12 to 19 year age group (30.2%). In our study we found that most of the poisoning cases were of age group of 15-40yrs 71.84% (199). In their study they found that most cases of poisoning (36.0%) were due to organophosphorus compound (OPC) even in our study most of the poisoning was due to organophosphorous compounds (24.18%).<sup>13</sup>

Maharani B and Vijayakumari N Studied 150 cases of acute poisoning due to medicines and chemicals. They found that in all the cases the route of exposure was oral but in our study only 2 patient got poisoned by spraying of pesticides rest all took poison orally. They found that poisoning was more common in males (92 cases) as compared to females (58 cases) in our study also poisoning was mostly seen in males (55.2%) than females (44.8%). In their study peak occurrence of poisoning was mostly seen in the age group of 21-30 years (47 cases). In our study we found that most of the cases were of age group of 15-40yrs 71.84% (199). In their study Organophosphorus compound was the common reason of poisoning (58.66%) even in our study most of the poisoning was due to organophosphorous compounds (24.18%).<sup>5</sup>

Jesslin J et al studied a total of 1045 poisoning cases. Deliberate poisoning was most commonly seen in males (60.2%). In our study also poisoning was most commonly seen in males (55.2%) than females (44.8%). They found occurrence of total poisoning cases were more due to pesticides (39.5%) then by drugs (26.1%), household stuffs (22.1%), environmental poisoning (12.1%) and heavy metals (0.2%).<sup>14</sup> In our study the more common cause of poisoning was the organophosphorous insecticide poisoning which was seen in 24.18% of cases, followed by Drug overdose which was seen in 20.9% of cases.

Abubakar S et al studied 165 patients of poisoning. They found most of the (43.6%) poisoning cases were seen in the age group (21-30) but in our study most of the cases were seen in the age group of 15-40 yrs 71.84% (199). In their study, most of the poisoning cases were due to organophosphorus (33.3%) and drug overdose (20%).<sup>11</sup> In our study also most common reason of poisoning was the organophosphorous insecticide poisoning which was seen in 24.18% of cases, followed by Drug overdose which was seen in 20.9% of cases.

Prajapati T studied 366 cases of acute poisoning. In their study 70.8% were males and 29.2% female. In our study also poisoning was mostly seen in males (55.2%) than females (44.8%). In their

study the most of the (45.08%) cases were from age group of 21-30 years but in our study we found that most of the cases were of age group of 15-40 yrs 71.84% (199). In their study the most common type of poisoning was due to pesticide in 33.9% cases, then due to household chemicals 26.8%.<sup>15</sup> In our study also most common poisoning was the organophosphorous insecticide poisoning which was seen in 24.18% of cases, followed by Drug overdose which was seen in 20.9% of cases.

Poisoning remains a significant technique of deliberated selfharm and carries a noteworthy impression on death and mortality. The configuration and degree of poisoning have various dimension and it requires approach in various sector to prevent this problem. Awareness and knowledge about the possible harmfulness of regularly used insecticides and drugs will benefit in decreasing the problem of poisoning.<sup>11</sup>

## Acknowledgement Section :

We acknowledge the Medical superintendent of Kasturba Hospital for allowing us to go through the accident register which was maintained under the clinical forensic medicine unit.

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#### **ORIGINAL ARTICLE**

# Smoking, Alcohol and Coronary Artery Occlusion – A Morgue Based Study

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#### **Abstract :**

The occlusion of the coronaries is an important factor in development of ischemic heart disease and occurrence of myocardial infarction. Smoking and alcohol are known risk factors in the pathogenesis of atherosclerosis and subsequent development of coronary artery occlusion. The present study was conducted at Police Mortuary attached to the Department of Forensic Medicine and Toxicology, R.G. Kar Medical College & Hospital, Kolkata. The dependent variable was the occlusion of the coronary arteries and the independent variable were the history of smoking addiction, history of alcohol addiction, history of coronary vascular disease in both cases of smoking addiction and alcohol addiction. The study also has its foothold in the Department of Pathology at the same institute. Of all the 50 cases autopsied, history of addiction of smoking or alcohol or both was present in 40 cases (80% cases) and absent in 10 cases (20% cases). Out of the total 36 cases of alcohol addiction, 28 cases (77.78%) had a history of coronary vascular disease, whereas 8 cases (22.22%) had no history of coronary vascular disease. Among the 27 cases having both alcohol and smoking addiction, critical narrowing (>60% blockage) was seen in 16 cases (59.26% cases) whereas in 11 cases (40.74% cases) non-critical narrowing (<60% blockage) was seen. The severity of occlusion is more in cases having concomitant addiction of both smoking and alcohol.

Keywords : Coronary artery occlusion; Smoking; Alcohol; Vessel pathology; Autopsy study.

#### **Introduction:**

Coronary artery occlusion can be in the form of atherosclerosis, thrombosis or aneurysm. The occlusion of the coronaries is an important factor in development of ischemic heart disease and occurrence of myocardial infarction. Smoking and alcohol are known risk factors in the pathogenesis of atherosclerosis and subsequent development of coronary artery occlusion.<sup>1</sup> In the present study an attempt is made to study the association between coronary artery occlusion found on autopsy and history of smoking, alcohol and coronary vascular disease.

#### Materials and Methods :

The present study was conducted at the Police Mortuary attached to the Department of Forensic Medicine and Toxicology, R.G. Kar Medical College & Hospital, Kolkata. A part of the study was also carried out in the Department of Pathology at the same institute. The study period was from 1<sup>st</sup> April, 2016 to 31<sup>st</sup> October, 2016. The study cases included the selected deceased from medicolegal autopsies showing coronary artery occlusion on histopathological examination. It was performed at the said study place during the above mentioned period. The autopsy cases on decomposed bodies, grossly mutilated bodies and subjects with known chronic conditions not related to the cardiovascular system were excluded from the study. The dependent variable was the occlusion of the coronary arteries and the independent variable were the history of smoking addiction, history of alcohol addiction, history of coronary vascular disease in both cases of smoking addiction and alcohol addiction. The

Corresponding Author Vikas Gurbani Email : vikas.gurbani@gmail.com Mobile No. : +91-7507828000 extent of coronary artery occlusion was determined by histopathological examination at the Department of Pathology. The results of the different variables are tabulated and analyzed and compared with available literature.

#### **Results :**

Of all the 50 cases autopsied, history of addiction of smoking or alcohol or both was present in 40 cases (80% cases) and absent in 10 cases (20% cases). Among the cases, 31 cases (62%) had a history of smoking addiction and 36 cases (72%) had a history of alcohol addiction. Addiction of both alcohol and smoking was present in 27 cases (54%) out of the total 50 cases. Out of 31 cases of smoking addiction, 24 cases (77.42%) had a history of coronary vascular disease and 7 cases (22.58%) had no history of coronary vascular disease. Out of the total 36 cases of alcohol addiction, 28 cases (77.78%) had a history of coronary vascular disease, whereas 8 cases (22.22%) had no history of coronary vascular disease. Among the 27 cases having both alcohol and smoking addiction, critical narrowing (>60% blockage) was seen in 16 cases (59.26% cases) whereas in 11 cases (40.74% cases) non-critical narrowing (<60% blockage) was seen.

#### **Discussion :**

**Table-1** shows that in 80% of the cases of coronary artery occlusion, history or either smoking or alcohol or both. A study <sup>2</sup> has reported that smokers have 70 percent more coronary artery disease mortality than their non-smoking counterparts. Another study <sup>3</sup> has concluded that smoking and alcoholism can accelerate the development of atherosclerotic lesions, though they are not atherogenic on their own. **Table-2** demonstrates the type of addiction present. A study <sup>4</sup> has reported that as many as 80% of alcoholics smoke, and 30% of smokers are alcoholics. **Table-3** 

highlights the distribution of cases of smoking addiction according to the history of coronary vascular disease. 77.42% cases of smoking have a history of coronary vascular disease. A study<sup>5</sup> has reported that smoking has exposure-related enhancing effect on the extent of coronary artery occlusion. Another study has found higher incidence of atherosclerosis and subsequent coronary vascular disease in smokers (79.16%) when compared to non-smokers (53.84%). A study<sup>5</sup> has found a significant increase in the severity of aortic atherosclerosis with increasing use of cigarettes measured by both intensity (packages per day) and duration (number of years of smoking). Table-4 shows the distribution of cases of alcohol addiction according to the history of coronary vascular disease. In 77.78% cases of alcohol addiction, history of coronary vascular disease is present. Another study<sup>3</sup> has shown that incidence of atherosclerosis was greater in alcoholics (78.26%) than in non-alcoholics (55.55%). Table-5 represents that in 59.26% cases having critical narrowing of coronary arteries on examination, addiction of both alcohol and smoking was present. A study<sup>6</sup> has concluded that there is relatively little evidence that the two (smoking and alcohol) act synergistically or that the effects are worse when smoking and drinking occur together than would be expected from their independent effects. A study<sup>7</sup> showed that alcohol

Table 1 : History of addict	tion (smoking/alcohol/bot	h) among the deceased.
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	No. of Cases	Percentage of Cases
H/o Addiction present	40	80%
No H/o Addiction	10	20%
Total	50	100%

Table 2 : Type of Addiction.				
	No. of cases (Total - 50)	Percentage of cases (Out of 50)		
Smoking	31	62%		
Alcohol	36	72%		
Both (concomitant addiction)	27	54%		

 Table 3 : Distribution of cases of smoking addiction according to history of Coronary vascular disease (CVD).

	No. of cases	Percentage of cases
History of CVD	24	77.42%
No History of CVD	7	22.58%
Total	31	100%

#### Table 4 : Distribution of cases having alcohol addiction according to history of Coronary vascular disease (CVD).

	No. of cases	Percentage of cases
History of CVD	28	77.78%
No History of CVD	8	22.22%
Total	36	100%

 Table 5 : Severity of Coronary artery occlusion in cases with addiction

of both shloking and alcohol.				
	No. of cases	Percentage of cases		
Critical narrowing/blockage	16	59.26%		
Non-critical narrowing/blockage	11	40.74%		
Total	27	100%		

**COLOUR PLATE - 1** 



Thrombosis Atherosclerosis Calcification

**COLOUR PLATE - 2** 



Atherosclerosis Thrombosis Tunica Media

consumption has an attenuating dose-related effect, offsetting the increased coronary occlusion associated with smoking.

#### **Conclusion :**

The incidence of coronary artery disease is found to be higher in cases addicted to smoking and alcohol. Coronary artery occlusion with critical narrowing (>60% blockage) is more common in cases addicted to both - smoking and alcohol. The severity of occlusion is more in cases having concomitant addiction of both smoking and alcohol.

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

Conflict of interest : None to declare

Source of funding : None to declare

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#### **ORIGINAL ARTICLE**

# Study of Diurnal Variation of Stature among MBBS students in a Medical College of Andhra Pradesh

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#### Abstract :

Diurnal variation in stature is one potentially significant source of error in the evaluation of short term height. Diurnal decrease in stature may affect the reliability of height measurement. The aim of the present study was to establish diurnal variation of stature, and to study the degree of differences in daily height measurement. A total batch of 201 students of  $2^{nd}$  MBBS from our institute was selected for the study. But, on the day of the study, 4 students did not show up because of some medical and personal reasons. Hence, the study was conducted over the remaining 197 students. The heights of the participants were measured twice in a day. The first measurements were taken between 08:00 AM to 09:00 AM, and the second measurements between 04:00 PM to 05:00 PM. The data collected was thoroughly screened and subjected to statistical analysis. Results revealed diurnal variation in height among each individual and also significant difference in diurnal variation of stature between male and female. There is a definite variation i.e., decrease in height of an individual during the course of the day. There is also a gender difference in this variation of height i.e., males show greater height loss compared to females.

Keywords : Diurnal variation; Stature; MBBS students; Analytical cross sectional study; Anthropometric research.

#### **Introduction:**

Stature has always been an important parameter for the fixation of identity. Apart from fixation of identity, height is also an important criterion for many recruitments in both Public & Private sectors. Height remains constant after complete fusion of growth plates. Though constant, height is not fixed throughout the day, minor variations are observed. These changes attributed to changes in length of the disc spaces, joint spaces and muscular activities (act in myosin framework). There are many instances where due to shortage of couple of centimetres in height, candidates have been disqualified for the jobs. Height is also used for Medico legal quantitative measures, like in the case of identification of unknown bodies. In this regard, there is a need to standardize the height measurement of an individual taking into account, the diurnal changes.

Aims & Objectives: To establish and confirm,

- 1. The diurnal variation of stature
- 2. The diurnal stature variation among the genders.

The diurnal stature variation in relation to the height of the participant.

#### Materials and Methods :

Approval from the Institutional Ethics Committee, has been obtained. Confidentiality and privacy of data will be maintained at all stages.

• **Study settings** The study was done in the department of Forensic Medicine of our Medical College.

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- **Study design** The preferred study design for this research is analytical cross sectional study, as the study variable and the outcome can be studied at a single point of time, and can be analysed statistically.
- **Operational definitions** Human height or stature is the distance from the bottom of the feet to the top of the head in a human body, standing erect.
- **Sample size** A total batch of 201 students of 2<sup>nd</sup> MBBS from our institute were selected for the study. On the day of the study, 4 students did not show up because of some medical and personal reasons. Hence, the study was conducted over the remaining 197 students.
- **Sampling strategy** Probability sampling, as the selection procedure ensured that each participant of the batch has an equal chance of being selected for the study. Orthopedically handicapped students were intended to be excluded, but among the selected study population, there were no such participants.
- Study procedures The heights of the participants were measured twice in a day. The heights were measured using a stadiometer. The heights were measured to the nearest 0.1 cm. The participants were made to stand bare foot with their feet together on the base of the stadiometer. The participants' heads were fixed at Frankfort horizontal plane. The heads were held erect with eyes looking forward, the lower margin of the eye socket and the superior notch of the tragus of the ear were in horizontal plane. The first measurements were taken between 08:00 AM to 09:00 AM, and the second measurements between 04:00 PM to 05:00 PM. Measurements were made by single observer to avoid observer bias. In order to avoid the measurement bias, separate sheets were used for charting morning and evening

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heights, so that this blinding makes the observer unaware of the morning heights while measuring the evening heights.

• Data Analysis : The data has been statistically using SPSS – 25 software.

#### **Results :**

Out of the 197 students who participated in the study, 72 participants were male students, while the remaining 125 participants were female students. The mean height of all the male participants whose heights were measured at 8 am on the day of the study was calculated to be 172.13 cm. The mean height of all the female participants whose heights were measured at 8 am on the day of the study was calculated to be 157.16 cm. The mean height of all the participants i.e., both male and female, whose heights were measured at 8 am on the day of the study was calculated to be 162.63 cm. The mean height of all the male participants whose heights were measured at 4 pm on the day of the study was calculated to be 171.19 cm. The mean height of all the female participants whose heights were measured at 4 pm on the day of the study was calculated to be 156.61 cm. The mean height of all the participants i.e., both male and female, whose heights were measured at 4 pm on the day of the study was calculated to be 161.94 cm. Out of 197 participants, 160 participants [81.2%] showed decrease in height, 26 participants [13.2%] showed increase in height, whereas 11 participants [5.6%] did not show any change in height. Out of 72 male participants, 62 participants [86.2 %] showed decrease in height, 5 participants [6.9%] showed increase in height, whereas 5 participants [6.9%] did not show any change in height. Out of 125 female participants, 98 participants [78.4%] showed decrease in height, 21 participants [16.8%] showed increase in height, whereas 6 participants [4.8%] did not show any change in height.

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Gender	Number of participants	Mean of the Heights (in Cm)		Mean variation in heights [in cm]	Standard Deviation [SD]
		8 AM	4 PM		
Males	72	172.13	171.19	0.96	6.35
Females	125	157.16	156.61	0.84	6.72
Total	197	162.63	161.94	0.88	9.70

Table 1: Mean	heights and	standard	deviation	of the heights.

Table 2: Types of variation in heights among the study population.

Gender	Decreas e in height	Increase in height	No change in height	Total
No. of Male participants	62	5	5	72
No. of Female participants	98	21	6	125
Total	160	26	11	197

Table 3: Mean and standard Deviation of the decrease in the heights.

	Male	Female	Total
No. of participants	62	98	160
Mean decrease in the heights [in cm]	1.1	0.86	0.95
Standard deviation of the decrease in the heights	0.80	0.77	0.79

The mean decrease in height among the total participants was calculated to be 0.95 cm. Standard deviation of which is calculated to be 0.79. The mean decrease in height among the male participants was calculated to be 1.1 cm. Standard deviation of which is calculated to be 0.80. The mean decrease in height among the female participants was calculated to be 0.86 cm. Standard deviation of which is calculated to be 0.77. Based on the average Indian height of males (177 cm) and females (162 cm), all the participants were divided in to three groups. Among the first group of male students, who are below the height of 172 cm, the mean decrease in height was calculated to be 0.87 cm. Among the second group of male students, who are within the height range of 172 to 182 cm, the mean decrease in height was calculated to be 0.92 cm. Among the third group of male students, who are within the height range above 182 cm, the mean decrease in height was calculated to be 1.05 cm. Among the first group of female students, who are below the height of 157 cm, the mean decrease in height was calculated to be 0.64 cm. Among the second group of female students, who are within the height range of 157 to 167 cm, the mean decrease in height was calculated to be 0.80 cm. Among the third group of female students, who are within the height range above 167 cm, the mean decrease in height was calculated to be 1.1 cm.

For the ease of analysis and interpretation of the data, the heights of the total participants have been sub-stratified in to 3 groups. Among the first group of students, who are within the height range between 140.1 cm and 160 cm, 65 participants showed decrease in height, 18 participants showed increase in height, whereas 4 participants showed no change in height and the mean decrease in height was calculated to be 0.65 cm. Among the second group of students, who are within the height range between 160.1 cm and 180 cm, 87 participants showed decrease in height, 8 participants showed increase in height, 8 participants showed increase in height, more and 180 cm, 87 participants showed decrease in height, 8 participants showed increase in height, whereas 7 participants showed no change in height and the mean decrease in height was calculated to be 0.87 cm.

Table 4: Distribution of participants as per variation in heights.

Height Range (in Cm)	Total	Increase in height	No change in height	Decrease in height	Mean decrease in height(in Cm)
140.1 - 160	87	18	4	65	0.65
160.1 - 180	102	8	7	87	0.87
180.1 - 200	8	0	0	8	0.88
Total	197	26	11	160	

Table 5: Distribution of participants as per heights: Male.

Height Range (in Cm)	Total	Mean decrease in height (in Cm)
Less than 172	30	0.87
172 - 182	28	0.92
More than 182	4	1.05

#### Table 6: Distribution of participants as per heights: Female.

Height Range (in Cm)	Total	Mean decrease in height (in Cm)
Less than 157	46	0.64
157 - 167	47	0.80
More than 167	5	1.1

Among the third group of students, who are within the height range between 180.1 cm and 200 cm, all the 8 participants showed decrease in height and the mean decrease in height was calculated to be 0.88 cm. The data was analysed using Anova test and unpaired t-test, both of which showed a very statistically significant p-value (p < 0.05).

From above results, it is evident that out of the 197 participants, 160 participants [i.e., 81.2 %] showed decrease in height, which is a significant number indicating that there is a diurnal decrease in stature. Out of 72 male participants, 62 participants [86.2%] showed decrease in height, and the mean decrease in heights was calculated to be 1.1 cm. And out of the 125 female participants, 98 participants [78.4%] showed decrease in height, and the mean decrease in heights was calculated to be 0.86 cm. Which indicates that there is a gender variation in the diurnal decrease in stature i.e., diurnal decrease in stature is more in males when compared to the females.

Based on average Indian height of males (177 cm) and females (162 cm), all the participants were divided in to three groups as short, normal, and taller groups. Among the male population, who are within the height range below 172 cm, the mean decrease in height was calculated to be 0.87 cm. While, the other group of students, who are within the height range of 172 cm to 182 cm and last group above 182 cm, the mean decrease in height was calculated to be 0.92 cm and 1.05 cm respectively. This indicates that the diurnal decrease in stature is more in taller participants when compared to the shorter participants among males. Among the female population, who are within the height range below 157 cm, the mean decrease in height was calculated to be 0.64 cm. While, the other group of students, who are within the height range of 157 cm to 167 cm and last group above 167 cm, the mean decrease in height was calculated to be 0.80 cm and 1.1 cm respectively. This indicates that the diurnal decrease in stature is more in taller participants when compared to the shorter participants among females.

Also there is gender variation in height loss among the three groups. i.e. female population show more variation in height loss and there is a greater loss in height compared to males. Among the total number of students, who are within the height range between 140.1 cm and 160 cm, the mean decrease in height was calculated to be 0.65 cm. While, the group of students, who are within the height range between 180.1 cm and 200 cm, the mean decrease in height was calculated to be 0.88 cm. This indicates that the diurnal decrease in stature is more in taller participants when compared to the shorter participants.

#### **Interpretation :**

Out of the 197 participants, 160 participants [81.2%] showed decrease in height, which is a significant number indicating that there is a diurnal decrease in stature.

Out of 72 male participants, 62 participants [86.2%] showed decrease in height, and the mean decrease in heights was calculated to be 1.1 cm. And out of the 125 female participants, 98 participants [78.4%] showed decrease in height, and the mean decrease in heights was calculated to be 0.86 cm. Which indicates that there is a gender variation in the diurnal decrease in stature

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Among the female population, who are within the height range below 157 cm, the mean decrease in height was calculated to be 0.64 cm. While, the other group of students, who are within the height range of 157 cm to 167 cm and last group above 167 cm, the mean decrease in height was calculated to be 0.80 cm and 1.1 cm respectively. This indicates that the diurnal decrease in stature is more in taller participants when compared to the shorter participants among females.

Also there is gender variation in height loss among the three groups. i.e. female population show more variation in height loss and there is a greater loss in height compared to males.

Among the total number of students, who are within the height range between140.1 cm and 160 cm, the mean decrease in height was calculated to be 0.65 cm. While, the group of students, who are within the height range between180.1 cm and 200 cm, the mean decrease in height was calculated to be 0.88 cm. This indicates that the diurnal decrease in stature is more in taller participants when compared to the shorter participants.

#### **Discussion**:

Stature is usually expressed as a fixed value for every individual, though minor differences are noted in a 24 hour daily cycle. From the present study, it is clear that there is decrease in height by the end of the day and that decrease in height is due to changes in elasticity of inter vertebral discs, reduction in joint spaces and arrangement of acto-myosin complex in the process of muscular contraction of skeletal muscles and by the effect of gravity.<sup>1</sup> Astronauts show an apparent decrease in height of few centimetres as soon as they land, due to the effect of gravity.

The greater decline in height has been isolated to lumbar region which possess thickest inter vertebral discs. The decrease in height represents equilibrium between mechanical pressure (dehydration) and swelling pressure of hydrophilic proteoglycans (water absorption) created in the inter-vertebral disc spaces.<sup>2</sup> Diurnal decline in stature is a crucial phenomenon, which can be considered for the assessment of growth in every individual particularly in children.<sup>3</sup>

In 1936 De Puky in his study showed age related variations in disc hydration and dehydration which partly explains the role of age showing variations in height loss. On an average, a person is 1% shorter by the evening compared to morning and the value varies in children (2%) and old age (0.5%).<sup>4</sup>

In the present study there is a loss of 0.97 cm, by the end of evening which was similar to the study conducted by Buckler (1978) which showed a range of 0.8 cm to 2.8 cm variation in height. He further explained that the change in height is not always continuous throughout the day, nor are the measurements necessarily identical at similar times on consecutive days. <sup>5</sup> The same was observed in a study conducted by Ashizawa and Kawabata (1997) over two siblings daily (morning and evening heights recorded) for a period of one year. They found a shortening of 10 mm on an average during the course of a day. They also attributed diurnal variation in stature to shortening of trunk length during day time.<sup>6</sup>

Since the length of the body is dominated by spinal column as 33.33% and of this 30% constitutes inter vertebral discs. The decrease in height majorly occurs at the spinal column and the greatest loss in height takes place at the lumbar region which possesses thickest inter-vertebral discs.<sup>2</sup>

The present study group includes 197 healthy participants of 17-19 years age group. Out of 197, 160 students showed decrease in height, 26 students showed increase in height and 11 students showed no change in height. From the results it is evident that a significant number of participants show decrease in height. The decrease in height is due to their upright posture during the course of the day and due to their physical activity. These finding were comparable to the findings of Siklar et al (2005) study which determined 0.5 cm reduction in stature among children aged 3 to 15 years.<sup>7</sup> Krishnan and Vij (2007) in their study on a 9 year old child measured readings 4 times in a day for 56 consecutive days and found a decrease of 1.95 cm height.<sup>8</sup>

The study participants who showed increase in height (26 students), when questioned about their physical activity, answered that they have rested for a while indicating rest creates relaxation of inter vertebral disc spaces. Since the mechanical pressure depends on BMI, gravity, occupational exposures and physical activity. Fluid expelled out of nucleus pulposus due to compressive loads on the spine. The amount of height loss is directly proportional to amount of fluid loss.<sup>2</sup> Swelling pressure during recumbence leads to loading of inter vertebral discs where fluid gets absorbed, that subsequently results in increase in height. Disc response elastically to loading and unloading pressures for short periods of time as in vibrations or shocks. However, if the load is applied for a long time, creep deformation of annulus fibrosus along with fluid loss occurs.<sup>2</sup> However gain in stature occurs after short naps and also due to lying down posture according to Kobavashi and Togo, 1993.<sup>9</sup> But, according to Fairbank [1998] the diurnal variation in height is mainly due to fluid loss from the intervertebral disc rather than postural changes.<sup>10</sup>

The minimum height of study population is 142.1 cm and the maximum height is 192.5 cm, showing a mean loss of 0.97 cm by the evening. Usually there is much loss in height during the earlier part of the day, but in the present study we want to consider the variations till evening since every individual were into physical activity till evening. To show that physical activity plays an important role in height variation in an upright position, we have chosen to measure the heights of study group which contain

students only and their physical activity is mainly long standing upright in the clinical posting. According to Voss and Bailey there is no further apparent decrement in height, once the person is up for 6 to 7 hours after rising from his bed. Usually during the first one hour after rising there is 54% loss in height, during first 4 hours there is 83% loss in height, has been observed. The lost height is regained in the first half of the night by 71%. There is a mean circadian variation loss of 1.1 %.<sup>3</sup>

In the present study males show greater loss of heights than females, the marked decrease in height among males may be attributed to their built, weight, greater activity and more muscle mass. The small diurnal variation in stature among females compared to males could not be properly explained by Krishnan and Vij, however they assumed that genetics might be a probable reason considering the fact that the females were more canalised than their male counterparts.<sup>11</sup> Also males are more muscular and generally heavier with less fat content compared to females. Thus males show greater variation in stature body compressive force under the influence of gravity. Frederick Vuvor and Obed Harrison in their study measured average loss of height was 1.61 cm, and the age, sex, BMI and total calorie intake influence the height loss along with type of occupation and profession.<sup>11</sup>

Also the variations in height loss depends on the climatic conditions, because in almost all the western studies the mean height loss is 1.5-3 cm, but in most of the Indian studies the mean height loss is 0.5-1 cm. in the present study, similar observations were observed just like other Indian studies like Krishnan and Vij, Jinu Merlin Koshy et al.<sup>1</sup>

In the present study, It is clear that tall people show greater loss in height compared to shorter people. This may be due to more disc compression of IV disc space in tall people due to their general body built. According to Todd Sinnett et al, you are tallest when you wake up and you may be as much as one cm shorter by the end of the day.<sup>12</sup> Most hand ball and basket ball players shrink even up to 3 inches after training and matches

#### **Conclusion :**

Our study concluded that there is a diurnal decrease in stature, which is more evident in males when compared to females; and also more evident in taller people than the shorter people. Thus, this study leads us to think about -

- 1. The standardisation in the measurement of height.
- 2. The accountability and significance of diurnal variation in height.

**Recommendations :** The present study and its data can be used for further extensive study examining this phenomenon of diurnal variation in stature in relation to age, gender, BMI and ethnicity.

Author contributions : All the authors and the corresponding author have equally, actively and substantially contributed to the conception and design of the work; acquisition, analysis and interpretation of the data for the work. All of us have equally contributed during the drafting of the work and revising it critically for important intellectual content. All of has approved this final version of the manuscript, to be sent for publishing. All of us have the agreement to be accountable for the all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

**Conflicts of interest :** There are no financial, personal, social or other interests that directly or indirectly influence the conduct of the author with respect to this manuscript.

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# Scope and Relevance of Forensic Odontology in India – A Review

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#### Abstract :

Forensic odontology (FO) encompasses processing, review, evaluation and presentation of dental evidence to provide scientific and objective data to legal processes. Identification is based on information collected from the remaining dental, oral and para-oral structures. It is considered one of the most authentic methods of identification as teeth survive in the body even after exposure to extreme conditions and even after death of an individual. In the revised Bachelor of Dental Surgery Course Regulations (2007), the Dental Council of India included it as part of the curriculum for third and final year students. The importance of teeth and associated structures in forensics has gained importance in recent years. This article summarizes the history, scope, current scenario of forensic odontology in India. An electronic database search was done on search engines PubMed and Medline and 24 articles were reviewed.

Keywords : Forensic odontology; Dental identification; Personal identification.

#### Introduction:

"Forensis" is a Latin word which is derived from the term "forum" which denotes a location where legal disputes are debated.1 Keiser-Nielson (1980) defined Forensic Odontology (FO) as "The branch of forensic medicine which in the interest of justice deals with the proper handling and examination of dental evidence and with the proper evaluation and presentation of the dental findings."<sup>2</sup> Forensic odontology plays a pivotal part in personal identification in disaster management, physical abuse cases involving bite marks, criminal and natural deaths. It can also help in the process of identification when the body is damaged beyond recognition by the kin as is often in the cases of drowning, burns, and road traffic accidents.<sup>3</sup> Certain dental structures like pulp, enamel and dentin remain preserved within the tooth, even after an individual's body tissues have been decomposed. Teeth are considered a good source of genomic DNA, which can be extracted from these calcified structures and comparing with existing ante-mortem or paternal DNA aiding in identification.4

#### **Materials and Methods:**

An electronic database search was done on search engines Pub Med and Medline and 24 articles were reviewed.

**Global Historical Aspects:** The origin of forensic odontology is often said to have been started in the Eden's garden. According to the Christian scripture - Old Testament, Adam was persuaded by Eve to put a bite mark on the forbidden apple in the Eden's garden. Although there is no evidence of record or proof of this as there were no Forensic Odontologists during that time period.<sup>5</sup> The first use of personal identification with the help of dentition in India was in 1193 – King Jayachandra of Kannauj was killed on the battleground, his corpse was identified based on artificial teeth present in his mouth.<sup>6</sup> The first-ever recorded case of medico-

Corresponding Author Mr. Hussain Ali John Email : iamalijohn@gmail.com Mobile No. : +91 8806352352 legal identification of a deceased by means of dental evidence was that of Dr. Joseph Warren. Following his death in the battle of bread hill in New England, he was identified by a dentist, Paul Revere in 1775.<sup>7</sup>

In 1897, a short article written by Dr. Oscar Amoeda who is widely regarded as the father of Forensic Odontology was published in the Dental Cosmos. It was written after the tragedy of the fire in Bazaar De La Charité, Paris which led to 126 deaths. In the article, he described the identification procedures used and devised a system that could be replicated in the future.<sup>7</sup> In 1945, the Soviet troops found the badly burnt body of Adolf Hitler and his spouse Evan Braun. The body was later identified by Hitler's dentist Dr. Hugo Johannes Blaschke with the help of previously kept records and frontal sinus x-rays.<sup>7</sup>

After the tragedy caused by the Indian Ocean tsunami in 2004, 92% Thai individuals and 80% non-Thai individuals were identified successfully by Forensic odontologists based on dental information.<sup>8</sup>

**Scope:** The science of Forensic Odontology has a broad application; it has been proven useful in personal identification in disasters and also in criminal cases by analyzing bite marks and lip prints.

**1. Personal Identification :** Establishment of a person's individuality is called identification. Confirming the identity of the deceased person is the most important part of the investigation when human remains are found. It is required for both legal and humanitarian purposes.<sup>9</sup>

**Age Estimation:** Estimation of age greatly helps in the process of personal identification, tooth germ appearance, remnants of mineralization, status of growth of unerupted teeth, formation rate of hard structures like enamel, dentin and neonatal line, crown attrition, and transparency of root dentin are some of the factors that aid in age estimation.<sup>3</sup>

Sex Determination: Molecular and morphological analysis is usually employed for sex determination in cases of personal identification. Morphological analysis can be utilized for both, the hard or soft tissues of the oral cavity. While hard tissue analysis makes use of the morphology of the tooth, soft tissue analysis includes chelioscopy (study of lip prints) and rugoscopy (study of palatine rugae present on the hard palate).<sup>10</sup>

**Race Determination :** Determination of race of an individual from morphology of teeth is considered debatable but certain common morphological characteristics of the tooth have been seen in certain races. Cusp of Carabelli, hypocones, peg shaping of teeth and taurodontism are some of the features that can give us a clue regarding the ethnicity of the dead and help in the identification process.<sup>11</sup>

**Molecular Analysis :** DNA profile is a ciphered set of numbers that reflects a person's genetic makeup, which can also be used as the person's identifier.<sup>3</sup> The pulp present in the root and coronal portion of the teeth comprises of, fibroblasts, odontoblasts, undifferentiated components of the mesenchyme, nucleated blood cells and endothelial cells that provide ample sources of genetic material. Odontoblastic processes within the dentinal tubules, accessory canal's soft tissue, cellular cementum, fibres of PDL and adherent bone are some of the locations that are used infrequently.<sup>12</sup> The preferred method of extracting the DNA from the tooth is considered to be horizontal sectioning of the cervical portion of the tooth.<sup>3</sup>

Co-comparison of ante-mortem and post-mortem records: Application of radiology in Forensic Odontology includes: Identification of victims, post-mortem analysis, age estimation of adults, non-accidental injuries of children and legal matters. The radiographic methods and techniques employed for identification are extraoral radiographs, intraoral radiographs.<sup>13</sup> Identification is done by comparing ante-mortem and post-mortem radiographs. Correlation is done on the basis of arrangement and number of teeth (missing, rotated or having gaps between them, supernumerary teeth, impacted teeth), caries and bone loss of the periodontium, crown restorations, osteopathology, anatomic osseous landmarks.

Various new methodologies like, Identification of skull by its suture patterns, person identification by means of subtraction radiography and standard bite wing film. Determination of sex is also done by lateral cephalometry.<sup>14</sup>

**2. Crime Investigation :** Apart from identifying the deceased, a Forensic Odontologist also plays a crucial part in crime investigation.<sup>9</sup>

**Bite Marks :** A 'Bite mark' may be defined as a mark made by teeth either alone or in combination with other mouth parts.<sup>15</sup> These are caused by particular objects indicating that bite marks are a form of pattern injury. Bite marks are obtained on various types of food substances, chocolate, chewing gum, fruits, vegetables.<sup>16</sup> Bite marks are more prevalent in crimes of sexual assault involving homosexual males.<sup>17</sup>

The dentition of each person is unique and since bite marks are inflicted by teeth, they become of great importance from a forensic odontologist's point of view.<sup>11</sup> Along with fingerprints, the bite marks made by humans is utilized as a means for

identification as these are exclusive for every individual.<sup>16</sup>

**Lip Prints :** Similar to fingerprints, lip prints are also unique. Furthermore, lips also possess furrows which can be classified. Lip prints are procured from various objects at the scene of crime. This can aid in identifying possible suspects and aiding specific investigations.<sup>18</sup>

**Dental Charting :** Dental professionals are expected by law and duty to produce and maintain adequate patient records. The successful identification of a victim depends on the availability of accurate and comparable antemortem and postmortem data.<sup>19</sup> Data documentation by dentists may prove valuable in forensic identification if recorded methodically. The recording system also serves as a basis for future reference when required in consumer court.<sup>19</sup>

#### **Discussion :**

**Current Scenario in India :** The Indian Association of Forensic Odontology (IAFO) was formed in 2000 and registration was done in the year 2001, since the subsequent year it has organized national conferences annually which has given a major boost for the speciality in India.<sup>21</sup> In 2007, Dental Council of India (DCI) included Forensic Odontology in the curriculum for the third and final year students in the revised Bachelor of Dental Surgery Regulations 2007 which enabled its exposure to students at the undergraduate level which is a remarkable step towards furthering of the subject.

According to Dr. Ashith B. Acharya, routine use of forensic odontology is not a reality in India at its current state, he argues that it is wrong to assume that every medico-legal case will be requiring a detailed medical investigation, let alone for forensic odontology. For this to become a reality in India, perpetual efforts by individual dentists who are interested in the field are required along with efforts of existing organizations like the IAFO. Contribution of the media and interaction with law enforcement agencies, judiciary, and the forensic fraternity at various forums and events like conferences, educational programmes, and hands-on workshops is required.<sup>21</sup>

While Dr. Ajit Dinakar asserts that the need for skilled forensic dentists has increased at both macro and micro level in the country but at the macro level, the need for forensic odontologists in the country must be quantified and at the micro level, the skills required by a forensic dentist who will eventually be hired by the army, legal firm, crime laboratory or any law enforcement agencies must be properly defined. As there is a lack of postgraduate training program in the country, there are very few dental practitioners in India who have received formal education in Forensic Odontology. Most of them have received it from countries like Australia or the United Kingdom.<sup>22</sup>

Many institutes and universities in India like JSS University – Mysore, D.Y Patil University – Navi Mumbai, and SDM College of Dental Sciences in Dharwad have started offering forensic Odontology courses in the form of a master's degree, fellowship, and PG Diploma respectively. Gujarat Forensic Science University (GDSU) has also started a postgraduate programme in 2014 offering M. Sc in Forensic Odontology.<sup>23</sup> Independent crime laboratories can also aid in estimating the capacity of absorbing newly skilled forensic dentists and also help students get a proper idea of potential opportunities.<sup>18</sup> In developed countries, the real-world application of forensic odontology (FO) has attained meaningful progression but in countries like India which is still to develop, the same level of importance is yet to be achieved.<sup>24</sup>

#### **Conclusion :**

Forensic Odontology is a specialized branch of forensic medicine that aids legal investigations by providing objective and scientific data through evaluation of dental and oral structures. Dental evidence is considered authentic and reliable because teeth remain intact even after decomposition of the body. This evidence can help identify the deceased person or assist investigators in lining up potential suspects especially in cases of sex crimes where lip marks or bite marks have been found at the crime scene. The first recorded medico-legal case of person identification done by means of dental evidence was in 1775 and since then the field has gained considerable recognition, but in India, it still remains at a very nascent stage. Its inclusion in the undergraduate curriculum and formation of The Indian Association of Forensic Odontology (IAFO) has given a major boost to the field but its use still remains limited which has resulted in restricted employment opportunities. A few courses on Forensic Odontology are offered in certain universities in India but there is still a lack of a postgraduate degree that would solidify its place as a proper speciality. Persistent efforts by dentists interested in the field, organizations like the IAFO, and the law authorities would help forensic odontology gain the same recognition and importance as it has earned in developed countries.

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#### Conflict of Interest - None

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#### **REVIEW ARTICLE**

# **Modern Mortuary Complex Plan in Covid-19 Era**

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#### Abstract :

The COVID-19 pandemicis the most burning health emergency worldwide now a days and all health professionals are called to give support in the diagnosis, treatment of patients and management of dead bodies affected by this disease. Different modes of transmission of corona virus is well established, however aerosol generating procedure has significant importance for mortuary during autopsy. The risk of infection can be minimized by using standard universal precautions for autopsy dissection procedure, applying high bio-safety levels, using negative pressure and laminar flow system for ventilation, UV irradiation for sterilization, virtual autopsy etc. The aim can be achieved by constructing the mortuary complex in more planned way like area division, ventilation planning, environmental disinfection, individual protection, autopsy procedure, virtual autopsy, preservation and transportation of dead body and waste disposal management. The present manuscript describes in detail about modern mortuary complex during the pandemic era of covid-19.

Keywords : Covid-19; Ventilation; Virtual autopsy; BSL-3; Bio-safety.

#### **Introduction:**

Since the virus's discovery in China, it has spread rapidly over the world,<sup>1,2</sup> prompting the World Health Organization to declare the COVID-19 outbreak a pandemic on March 12, 2020. However, more than 1.5 million people have died worldwide, with roughly 1.5 lakh in India.<sup>3-5</sup> As a result, the world was confronted with a serious and urgent public health emergency. Such a public health disaster is neither the first nor the last in the globe, but as human mobility increases, the world has become a global village, raising the likelihood of a pandemic in the future.6 While SARS-CoV-2 spreads, the number of people who die continues to rise over the world. COVID-19 is spread through droplets and fomites when an infector and an infectee come into close, unprotected contact.<sup>2,7-9</sup>COVID-19 has not yet been reported to spread through the air, however it is possible if certain aerosol-generating procedures are performed in health care facilities, such as in mortuaries during autopsies.7,10,11

Health professionals working in various fields, particularly those dealing with dead bodies, were similarly affected by morbidity and death. Even after taking all measures, doctors and other mortuary staff who perform autopsies are exposed to potentially significant and dangerous health hazards from organs, fluids, and secretions.<sup>12</sup> In such scenarios, in both medico-legal and non-medico-legal cases, unique procedures in a properly equipped mortuary are required.<sup>13</sup>

The Health and Safety Executive's (HSE) Advisory Committee on Dangerous Pathogens regulates the classification of infectious risks in all areas of medicine (ACDP).<sup>3</sup> SARS-CoV-2, unlike other Coronavirinae, is classified as a Hazard Group 3 (HG3) organism, which includes SARS and MERS agents.<sup>14</sup>

Even from HG3 group infections, the risks to mortuary staff can be reduced by following standard universal precautions for autopsy dissection, using high bio-safety levels, using negative pressure and laminar flow systems for ventilation, and using UV irradiation for sterilisation, among other things.<sup>15-18</sup> It is high time for India's mortuaries to be made safe and well-equipped. It is stipulated that a virtual autopsy be performed using sophisticated radiological equipment (like CT, MRI, Angiography, fluoroscopy etc).<sup>19</sup> However, none of India's mortuaries are equipped to conduct autopsies on such infectious bodies. However, some Indian institutions are attempting to establish such mortuary facilities, such as AIIMS in New Delhi, which has established a virtual autopsy, and AIIMS in Patna, which has established a highly sterilised and ventilated autopsy room by installing negative pressure ventilation and laminar flow with a VRV system.

#### Planning of Mortuary for infectious environment

Mortuary dealing with highly infectious bodies may be planned as under following headings:-

- 1. Area division and layout
- 2. Ventilation specifications for mortuary
- 3. Environmental disinfection
- 4. Individual protection
- 5. Autopsy sample extraction
- 6. Virtual autopsy facility
- 7. Effluent and waste disposal
- 8. Preservation of body
- 9. Transport of body
- 2. Area division and Layout : Areas of mortuary for the purpose of dealing with infectious bodies may be divided as: -
- i. Autopsy room (contaminated area): This is where post-

mortem examinations are carried out. Because health staffs come into direct contact with the dead corpse before and after dissection, this area is a possible source of infection.<sup>20,21</sup> Forensic pathologists, trainees, anatomical pathology technologists (APTs), and onsite managers in the morgue are the target health personnel for this polluted region.<sup>22,23</sup> In the mortuary, infections may be acquired via:

- Percutaneous inoculation
- Skin contamination without inoculation
- Inhalation
- Ingestion
- Contamination of mucosal surfaces (eye, mouth, nose).<sup>24</sup>

During an autopsy, there is a good chance of coming into direct touch with bodily fluids or spillage. Direct contact can also occur as a result of accidental cuts or needle piercing.<sup>24</sup>

When treatments for HIV and hepatitis viruses were not accessible, the relative risks of getting HG3 infections at a mortuary via the above-mentioned routes were examined decades ago, and infection loads of these HG3 infections were high in the deceased.<sup>25</sup>

List of the routes of infection that are linked to higher risks of acquiring a specific infection after exposure are given in table 1.26 SARS-CoV-2, which has been classified as an HG3 pathogen, poses a high risk to personnel who come into contact with infected or deceased patients.<sup>25-27</sup>

ii. Semi-contaminated area: It incorporates the autopsy room's entrance and exit. During the handling and transportation of deceased bodies, certain locations may get contaminated. This can be understood if you understand how different infectious agents persist on different surfaces and how to eliminate or lessen their infectivity. According to Kampf et al, Human corona viruses can survive on inanimate surfaces for up to 9 days.<sup>28</sup> Viruses can survive for up to 24 hours on cardboard surfaces, but can live up to 2-3 days on stainless steel and artificial materials.<sup>29</sup> SARS and MERS, which are closely linked to SARS-CoV-2, can survive for up to 2 days in tap water and sewage, up to 3 days in faeces, up to 14 days in saltwater, and up to 17 days in urine in humid and shaded conditions.<sup>30</sup> Up to 3 days after death, MERS-CoV could be found in nasal swabs.<sup>31</sup> SARS-CoV-2 can also be found in CSF fluid, although these findings are only available in ante-mortem research.<sup>32</sup> Corona virus infectivity is thought to be greatly reduced when surfaces are treated with 0.1 percent sodium hypochlorite or 62-71 percent ethanol. Copper has antiviral effects as well.<sup>33</sup> Increased temperatures, detergents, and routinely used disinfectants are all toxic to Corona viruses.<sup>2</sup>

**iii. Clean area :** Where the working personnel can stay and complete ordinary job should be defined. In the clean part of the morgue, there should be a designated downing place. Two distinct paths must exist in a polluted and clean location, one for entry ("contaminated") and one for exit ("clean").<sup>34</sup> Wipe down any clean spots first. Object surfaces that are not regularly touched should be cleansed first, followed by object surfaces that are frequently touched (When cleaning an object surface, replace the used wiper with a new one).<sup>35</sup>

iv. Cold chamber room: This is the location where the body of a

deceased person must be preserved. Cold cabinets with proper demarcation should be accessible for dead corpse preservation, and the area should be adequate. For maintaining and adjusting the temperature of the cold cabinet, a constant power source is required.<sup>36</sup> Infectious and non-infectious bodies should be separated in the current mortuary facility for body storage. To avoid spilling of bodily fluids or other material owing to lifting and tilting of the body, the infectious bodies should be maintained in lower chambers. Dead bodies should be kept in designated cold chambers that are kept at a temperature of 4-8°C.<sup>37</sup> It is necessary to keep the cold chamber clean. The cold chamber room's ventilation should be segregated from the ventilation of other units.<sup>38,39</sup> After handling each corpse, disinfect all surfaces, tools, door knobs, and transport trolleys with a1 percent sodium hypochlorite solution. The body should be transported in funeral vans with a portable cool chamber set to 4°C to 8°C.

v. Sample processing area: These are the locations where relevant samples for the detection of infectious agents are gathered. Depending on the suspected infectious agents, arrangements for sample collection and a quick detective technique should be developed. In the case of COVID-19 confirmation, three key tests are required: real-time polymerase chain reaction, immunochemistry, and electronic microscopy. Because SARS-CoV-2 can be transmitted in a variety of ways, both molecular and serological testing are required to confirm viral presence.<sup>40</sup> Not only in patients with confirmed COVID-19, but also in patients with suspected or probable COVID-19, postmortem examinations raise a number of problems. This is mostly owing to the restricted ability of even highly developed countries to conduct broad population screening tests that surpass logistical and budgetary capacities. Post-mortem investigations and tests for SARS-CoV-2 are critical because they allow for adequate precautions to be taken based on the current threat level, not only during the autopsy but also in the aftercare of the deceased.<sup>4</sup> Given the current epidemiological scenario, autopsy should be performed with extreme caution, even in patients with unknown or uncertain causes of death, in accordance with an appropriate preventive policy, as unconfirmed cases pose a risk of contamination.25

vi. Waste disposal area: There should be a separate trash disposal location because it is a high-risk infection source. Standard infection control rules should be followed while disposing of waste.<sup>42</sup>

vii. General area (for chambers and office work): This is where general official tasks such as dead body receiving and handover register entry, dead body tag preparation, file/certificate preservation for the deceased's details, and so on are completed. The consultant rooms, doctors on duty rooms, and report writing rooms are also included. The region should be marked and built in such a way that contamination is minimised.

# 2. Ventilation specification of different areas of mortuary Autopsy room should be equipped with facilities of: -

**I.** Sufficient and sustained negative pressure: According to the rules of the CDC, "Autopsies on decedents known or suspected to be COVID-19 cases should be conducted in



Figure 1 : View of inside of Autopsy Room at AIIMS, Patna.



Figure 2 : Vent for laminar flow air out with negative pressure.



Figure 3 : Internal unit of Laminar flow.



Figure 4 : External unit of Laminar flow.



Figure 5 : Sketch Figure of VRF project of AIIMS, Patna.

Airborne Infection Isolation Rooms (AIIRs)". These rooms must be "at a negative pressure to adjacent regions," have "a minimum of 6 air changes per hour (ACH) for existing structures and 12 ACH for renovated or new structures," and "exhaust air directly outside or via a high efficiency particulate aerosol (HEPA) filter."<sup>43</sup> The WHO recommends using Biosafety Level 3 (BSL 3) for autopsy on SARS-CoV-2 patients who have died.<sup>44,45</sup>

**ii. Filtration and disinfection devices in air discharge (HEPA filter):** To limit the potential of cross-contamination, deceased people on airborne precautions for probable aerosolizing illnesses should be placed in a mortuary with HEPA filters.<sup>46,47</sup> The American Institute of Architects (AIA) and the Centers for Disease Control and Prevention (CDC) recommend that in duct HEPA filters be used to filter exhaust air before it is recirculated in Airborne Infection Isolation Rooms.<sup>48,49</sup> At least 25 feet away from public areas, the exhaust should be. HEPA filters can be put in the discharge duct upstream of the exhaust fan to clean the air if a suitable location for exhaust cannot be found. It should be noted that adding a HEPA filter to an existing system is not suggested since it can induce airstream friction, resulting in less-thandesigned air delivery to the room (i.e., pressure drops).<sup>50</sup> If

 Table 1: lists the routes of infection that are linked to higher risks of acquiring a specific infection after exposure.<sup>23</sup>

Inhalation	Oral Mucosa
CJD (?)	CJD (?)
Anthrax ++	TB +
TB +++	HIV +
COVID-19 +++	Anthrax +
Skin Surface	Inoculation
TB ++	CJD (?)
COVID-19 (?)	Fungi +
	HIV++
	Anthrax ++
	TB +++
	HCV +++
	HBV +++

\*The increasing relative risks of acquisition are indicated by +, ++ or +++

Area designation	Air moveme nt in relation to adjacent area	Minimu m total air change per hour	All air exhauste directly to outdoor	Reti culated by means of room units	Relative humidity	Design Tempera ture
General area		6	-	-	-	Autopsy room
Autopsy room	In	12	Yes	No	As per comfort	As per comfort
Non refrigerated body holding room	In	Yes	Yes	-	As per comfort	210 C
Sterilization room	In	10	-	-	-	Forensic Histopath
ology room	6	6	Yes	No	-	240 C
In	In	10	Yes	-	-	240 C
Microbiolog y sampling area	In	6	Yes	-	-	240 C
Ante-room	In/Out	12	Yes	No	-	-
Soiled or decontamina tion room	In	6	Yes	No	-	200 C – 230 C
Bath room	In	10	-	-	-	240 C
Resident Room	-	2	-	-	-	210 C- 240 C
Resident gathering area	-	4	-	-	-	-
Linen and trash chute room	In	10	Yes	No	-	-
Clean linen storage	Out	2	Yes	No	-	-
Soiled linen shorting and storage	In	10	Yes	No	-	-
House Keeping	In	10	Yes	No	-	-

room

Table 2: Details of ventilation specification of different areas including
autopsy room (as per CDC Guidelines). <sup>23,25,57,58</sup>

1.Work Place	/ork Place During examination		
	spraying of 500 mg/L chlorine containing disinfectant on floors, walls etc	Spraying of 1000 mg/L chlorine containing disinfectant. If surface is contaminated by excreta and secretions then first it should be covered with hygroscopic materials then sprayed with 2000 mg/L chlorine containing disinfectant.	
2.Apparatus and instruments	Before examination	After examination	
	Instruments should be wiped with 500 mg/L chlorine containing disinfectant.	First it should be soaked 1000mg/L chlorine containing disinfectant for 30 minutes or it should be boiled for 30 minutes. Secondly it should be rinsed with clean water three times There after it should be wiped with clean dry cloth.	
3.Electronic apparatus (telephone, computer, camera etc.)	It should be wiped with disinfectant containing 5% ethanol solution.		
4.Air	<ul> <li>1.UV ray irradiation for 1 hours or</li> <li>2.Spray with</li> <li>•3% hydrogen peroxide</li> <li>•5000 mg/L peroxyacetic acid</li> <li>•500 mg/L chlorine dioxide disinfectant</li> <li>Should be sprayed in the quantity of 20 to 30 ml/m3 and left for 2 hours in closed doors and windows. Thereafter rooms should be thoroughly ventilated</li> </ul>		

installing in-duct HEPA filters is not possible, a re-circulating HEPA filter unit should be installed instead. They can be installed on the wall, the floor, or the ceiling. The airflow is less obstructed by the wall and ceiling units, and the floor units are easier to service.<sup>49</sup> HEPA filters remove particulate matter of 0.3 m or larger with a 99.97 percent or higher efficiency, and they are usually shielded by less expensive filters on the outside air intake and air return.<sup>51</sup>

iii. Directional air flow (Laminar flow): According to the Mortuary Design and Construction Guidelines, there should be no recirculation of air in the autopsy room, ante-room, cold cabinet room, or any other room with odour problems.<sup>52</sup> The air flow should be one-way.<sup>53</sup> Figure 1 to 5 shows the directional flow arrangement in mortuary of AIIMS, Patna. (Figure 1 View of inside of Autopsy Room at AIIMS, Patna, Figure 2 Vent for laminar flow air out with negative pressure, Figure 3 Internal unit of Laminar flow, Figure 4 External unit of Laminar flow, Figure 5 Sketch Figure of VRF project of AIIMS, Patna).

**iv. Odour control:** For odour management, a HEPA filter and laminar flow should be used. In autopsy rooms or rooms with an odour problem, no air recirculation is permitted.<sup>52</sup>

**v.** Asepsis: To reduce the risk of cross contamination, keep the area as clean as possible.  $^{54}$ 

#### Table -3 : Environmental disinfection.

vi. UV ray sterilization of air : For air, water, and nonporous surfaces, UV radiation is a well-known disinfectant. For decades, UV radiation has been used to effectively prevent the spread of microorganisms such as tuberculosis. UV lamps are often referred to as "germicidal" lamps because of this. The exterior protein coating of the Coronavirus has been demonstrated to be destroyed by UV light. The virus is inactivated as a result of the destruction. UV radiation is often used to cleanse the air inside air ducts. Air can be sterilised for at least 1 hour by exposing it to UV light.<sup>55</sup> It should not, however, be used to disinfect living tissues because it might irritate and injure the eyes.<sup>56</sup>

Table 2 summarizes the ventilation specifications for several areas, including the autopsy room.  $^{\rm 25,57-59}$ 

3. Environmental Disinfection (Table 3)<sup>59</sup>

**4. Individual protection** <sup>60</sup>: The autopsy team should be trained in the autopsy of the HG3 pathogen group as well as universal precaution. All classes of workers working in autopsy room/ contaminated areas should wear BSL-3 level protective cover (PPE kit) which includes: -

- i. Protective suit
- ii. Cap
- iii. Grade>/=N95 mask
- iv. Goggles
- v. Shoe cover
- vi. Double layer latex gloves
- vii. Respirator etc

Any harm or prick should be avoided by the worker. If this occurs by accident, the area should be disinfected immediately, and a component of the PPE package should be replaced. If clothing becomes soiled, it should be cleansed quickly with a chlorinebased disinfectant. Skin that has become soiled should be cleansed and disinfected as away with a 0.5 percent iodine solution. It should be rinsed with normal saline and disinfected with a 0.05 percent iodine solution if the mucus membrane is contaminated. Personnel involved in autopsy procedures should receive prophylactic therapy and vaccinations.<sup>61</sup>

**5.** Autopsy sample extraction: A sample extraction plan can be created by consulting clinical pathologists, laboratory staff, physicians, and virologists prior to anatomical inspection. Samples should be taken immediately after the body cavity is opened to prevent infection concerns, and organ and tissue cuts should be avoided.<sup>62</sup> Formalin-fixed specimens should be collected/processed in well-ventilated laboratories that are exposed to UV light. Following the work, the table is rinsed and cleaned with a disinfectant containing 1000mg/L chlorine. Following tissue dehydration, the dehydrator's surface should be cleansed with a 1000mg/L chorine-containing disinfectant for 30 minutes before being properly rinsed and wiped. For sterilising, paraffin blocks should be soaked in a 75 percent ethanol solution. Disinfect metallic equipment in an oven at 80°C.<sup>63</sup>

**6. Virtual Autopsy :** In the case of Covid-19 deaths, medical-legal autopsy is a high-risk technique that should be avoided

wherever possible.64 The 'Virtual Autopsy/ Virtopsy' process has been proposed as a viable alternative to the high-risk traditional autopsy procedure. In a post-mortem examination, it employs radiological imaging techniques such as computed tomography (CT) and magnetic resonance imaging (MRI) to determine the cause of death. Virtual autopsy's whole-body imaging is especially beneficial for finding tiny lesions and lesions in locations that are difficult to reach with traditional autopsy. The new methods of 3-D/CAD-supported photogrammetry and medical imaging techniques such as MSCT and MRI complement each other, and a high-tech wound documentation and visualisation can be achieved by combining these two methods of coloured photogrammetric surface scan and gray scale radiological images.<sup>65–67</sup> It is extremely valuable in the event of a suspected or proven covid-19 positive death since covid-19 lesions can be discovered without accessing the thoracic cavity, which exposes the autopsy surgeon to infection. Additionally, regions of the body that are not commonly examined in traditional autopsy, such as the spine, pelvis, and limbs, can be investigated in detail without mutilation. As further evidence is acquired during the inquiry, the photographs might be made available for re-evaluation and re-interpretation. They can also be utilised for future references and expert consultations for a second opinion on a variety of occasions.68

7. Waste Disposal:<sup>25,69-71</sup> Before being sent for disposal, all effluents and trash should be adequately disinfected and sterilised according to biodegradable waste management rules. Fecal waste and other sewage must be disinfected with a chlorine-containing disinfectant for at least 1.5 hours before being discharged into the drainage system (Active chlorine must be greater than 40 mg/L for the initial application). Used single-use goods must be disposed of properly by placing them in double-layered medical waste bags. To begin, place the woven objects in a disposable, water-soluble plastic bag that has been properly tied. This bag should then be placed in another plastic bag, and the second bag should be tied and placed in a yellow fabric bag before being sealed. Vehicles used to transport COVID-19 victims should be disinfected with a chlorine-based disinfectant (1000 mg/L active chlorine), which should be left on the surfaces for at least 30 minutes before being washed or wiped down.

#### **Conclusions:**

Following the covid-19 pandemic and other comparable pandemics in the past, society is concerned about the increased risk of infectious diseases in the form of pandemics, bioterrorism, and other forms in the future. Mortuaries routinely receive extremely infected bodies, putting the health and lives of mortuary staff in jeopardy. It has mandated the establishment of state-of-the-art, safe, well-planned, and equipped mortuaries all over the world, in accordance with WHO, CDC, IATA, and other international standards. Very rarely mortuaries in India are adequately equipped to deal with such scenarios, but it is possible with strong policymaker's willpower and greater funding and planning for mortuaries.In India, AIIMS New Delhi has pioneered the development of virtual autopsy, while AIIMS Patna has implemented negative pressure ventilation, laminar flow, and a VRV system for temperature and infection control in the autopsy chamber. However, much effort remains to be done in order to make the mortuary entirely secure.

List of abbreviations

HG 3: Hazard Group 3

BSL 3: Bio safety Level 3

SARS-CoV-2: Severe acute respiratory syndrome coronavirus 2

HSE: Health and Safety Executive

ACDP: Advisory Committee on Dangerous Pathogens

SARS: Severe acute respiratory syndrome

MERS: Middle East respiratory syndrome

UV: Ultraviolet

CT: Computed tomography

MRI: Magnetic resonance imaging

AIIMS: All India Institute of Medical Sciences

VRV: Variable refrigerant volume

MERS-CoV: Middle East respiratory syndrome-coronavirus

CDC: Centre for Disease Controland prevention

ACH: Air changes per hour

HEPA: High efficiency particulate aerosol

AIA: American Institute of architects

AIIRs: Airborne infection isolation rooms

PPE: Personal protective equipment

3-D/CAD: 3-Dimensional computer aided design

MSCT: Multi-slice computed tomography

IATA: International air transport association

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CASE REPORT

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# Murder Suicide with Offensive Corpse Mutilation: A case report

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#### Abstract :

Murder-suicide events involving child victims can have a pernicious aftermath on survivors of the violence, family members and friends of the decedents, and the community. We present an unusual case report where a middle aged man had killed five family members and then committed suicide by hanging. Financial stress, illicit relationship with the sister in law and morbid jealousy had probably triggered this disastrous event.

Keywords : Murder suicide; dyadic death; perpetrator; corpse mutilation; autopsy.

#### **Introduction:**

Murder-suicide is one of the more tragic forms of violence and although infrequent it causes family disintegration, psychological trauma amongst survivors and relatives, and public concern. It refers to a situation where the perpetrator of a homicide has taken his or her own life after the death of the victim(s) has occurred. It has been known by a variety of names, including homicide-suicide and dyadic death.<sup>1</sup> In spite of being rare, Murder suicide events have been reported from all over the world and in all strata of the society.<sup>2</sup>

Cases of Murder suicide not only are they of interest and importance in their own right but cases of murder suicide contribute significantly to the murder rate for both female and child victims.<sup>3,4</sup> Intimate partner homicide suicide (IPHS) constitutes the most violent domestic abuse outcome, devastating individuals, families, neighbourhoods and communities. Sometimes the number of people killed in an intimate partner homicide event reaches four or more, crossing the Federal Bureau of Investigation USA's threshold of four deaths for classifying it as a mass murder.<sup>5</sup>

We present an unusual case report where a middle aged man had killed his wife, son, daughter, sister in law and mother in law one after the other in span of couple of hours and then committed suicide by hanging. The murder of the sister in law was followed by offensive mutilation of her corpse by the perpetrator.

#### Case Report :

On the fateful day of June 22<sup>nd</sup> 2021 six dead bodies were brought to the mortuary of Department of Forensic Medicine and Toxicology, Indira Gandhi Government Medical College Nagpur for medicolegal autopsy with alleged history of homicide suicide of five family members by a middle aged man.

As per police history four dead bodies were found at an apartment, main door of which was locked from inside. The dead body of a middle aged woman and a girl were lying in a pool of blood on the ground while the dead body of a boy was present over the bed. The dead body of a middle aged man was hanging to the ceiling fan of the same room. About 200 meter from the crime scene was located the house of the in-laws of the aforesaid man. The door of this house was wide open and dead bodies of two women were lying in the pool of blood in the bedroom of this house. Police had recovered two kitchen knives, a meat chopper and a hammer from the crime scenes. Weapons were blood stained. No suicide note was found at the scene.

As per the police records the perpetrator who had killed himself after murdering his family was a tailor running his own tailoring shop. He had a love marriage and the couple had two children, a 12 year old son and a 15 year old daughter. The in-laws of the man lived close to his home. His sister in law used to assist the man in his business. However, illicit relationship had developed between the man and his sister in law from last couple of years. The man had become possessive about his sister in law and was torturing her for being friendly with other persons. His sister in law had lodged a police complaint for the same and a non-cognizable complaint had been registered by the police.

Medicolegal autopsies on the dead bodies was conducted at our institute (Table 1). Following findings were observed –

#### a. The wife (age 40 years) of the perpetrator -

On external examination the body was half naked with blood stains over clothes and body at places. Cut throat incised wound (Figure 1) was noted over the neck with underlying muscles, vessels including common carotids and jugulars, nerves, trachea, oesophagus, cervical spine and spinal cord had been cut. Defence cut wounds were noted over both palms. Cause of death was opined as Cut throat injury.

#### b. The son (age 12 years) of the perpetrator-

On external examination contusions and laceration were noted over inner aspect of the lips. Subconjunctival haemorrhages, Cyanosis over fingernails and lips and oozing of blood from mouth was noted (Figure 2). Blood stained froth was present in trachea and multiple submucosal haemorrhages were seen at the base of tongue. Cause of death was opined as Smothering.

#### c. The daughter (age 15 years) of the perpetrator -

On external examination both hands and legs were tied together

with a piece of cloth. Clothes were blood soaked. Blood stains were present over body at places. Cut throat incised wound was noted over the neck with underlying muscles, vessels including common carotids and right internal and external jugular veins, nerves, trachea, oesophagus, cervical spine and spinal cord had been cut (Figure 1). Cause of death was opined as Cut throat

#### injury.

#### d. The sister in law (age 21 years) of the perpetrator -

On external examination clothes were blood soaked. Tongue clenched between teeth, cyanosis over fingernails and lips, oozing of blood from nostrils and blood stains over body at places were noted. Whitish fluid was oozing out of genitalia with old healed hymenal tears noted over 6 and 7'O clock position.



Figure 1 : Victims killed by the perpetrator (A) Mother in law (B) Wife (C) Sister in law (D) Daughter



Figure 2 : Son of perpetrator with evidence of smothering.

Cut throat incised wound was noted over the neck with underlying muscles, vessels including common carotids and jugular veins, nerves, trachea, oesophagus, cervical spine and spinal cord had been cut. Multiple incised wounds and crescentic abrasions were also noted over the neck. Nine stab wounds were noted over the pubic region and external genitalia (Fig. 1, 3 and 4).

Mutilation of the dead body by the perpetrator was noted in the form of postmortem incised wounds over both breasts with complete separation of both nipples and part of surrounding areola from the breasts. Cause of death was opined as cut throat injury.

Table	1.	Details	of	the	family
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Sr. no.	Relation with the Perpetrator	Age (years)	Sex	Cause of death
1	Wife	40	Female	Cut throat injury
2	Son	12	Male	Smothering
3	Daughter	15	Female	Cut throat injury
4	Sister in law	21	Female	Cut throat injury
5	Mother in law	55	Female	Cut throat injury
6	Self	45	Male	Hanging



Figure 3 : Mutilated breasts of sister in law of perpetrator.



Figure 4 : Genital mutilation of sister in law of perpetrator.

#### e. The mother in law (age 55 years) of the perpetrator-

On external examination clothes were blood soaked. Cut throat incised wound was noted over the neck with underlying muscles, vessels including common carotids and jugulars, nerves, trachea, oesophagus, cervical spine and spinal cord had been cut (figure 1). Cause of death was opined as Cut throat injury.

#### f. The perpetrator himself (age 45 years)

On external examination ligature material was present around neck with an oblique completely encircling ligature mark. Underlying tissues were intact. No bruising was noted. Cause of death was opined as Hanging.

Samples for chemical analysis were preserved in all cases to rule out consumption of any poisonous or stupefying compound. Vaginal, anal and oral swabs were preserved in female victims for seminal analysis. To rule out paternity issues DNA samples were preserved in both children. Chemical analysis of the samples did not reveal any poison or inebriant substance in any of the victims. Seminal analysis of the samples was negative.

#### **Discussion:**

The term 'dyadic death' has often been used differently in the literature. While some authors propose that it is the course of events and relation of the events which are more important rather than the time interval, others consider that the term dyadic death should be used in relation to the time intervals between the fatalities. While some authors have proposed this time interval to be 24 hours,<sup>6</sup> a time period as long as 5 years has also been reported.<sup>7</sup>

Men commit the majority of intimate partner homicides,<sup>8</sup> intimate partner homicides with multiple victims, including children,<sup>9</sup> intimate partner homicides followed by suicide, with or without child victims.<sup>10,11</sup> Although homicides tend to occur more commonly within lower socioeconomic groups, murder-suicides have been found to be more a middle class phenomenon in several studies.<sup>12</sup> The perpetrator in our case was a tailor by profession of middle income group with a loan default.

The victims involved in dyadic deaths are usually females, children, mentally disabled individuals, or individuals incapacitated by drugs, disease, or alcohol. The perpetrator in these cases is usually male.<sup>13</sup> The majority of deaths associated with homicide/suicide incidents in the western countries involve a firearm. Other weapons include knives, blunt objects, and motor vehicles: other methods of homicide have included strangling/asphyxiation, poisoning, and physical assault.<sup>14</sup> However in India Guns are rarely used for homicide-suicide incidents<sup>15</sup>. The most common method of homicide was by sharp instrument, and hanging was the most frequently used method of suicide.<sup>16</sup> Findings are consistent with our case report. Predisposing factors for homicide suicide include breakdown in a relationship, mental illness, Physical ill health, financial stress and criminal behaviour.<sup>17,18</sup> Signs of premeditation, which included written or verbal threats or warnings, are quite common in familicides, with and without offender suicide.<sup>12</sup>

The perpetrator in our case had mutilated the body of his sister in law in fit of rage. It appears to be offensive mutilation which is necro-sadistic and passionate in nature. The main purpose here is to sherd the body.<sup>19</sup>

When familicide occurs, it exacts a heavy toll on communities. An integrative approach of the social, medical, enforcement and administrative entities is necessary for prevention of such deaths and mitigation of colossal damage it does to the family unit.

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#### **CASE REPORT**

### **Death due to Rupture of Tubal Pregnancy**

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#### **Abstract :**

Ectopic pregnancy (EP) is defined as a pregnancy in which the implantation of the embryo occurs outside the uterine cavity, most frequently in one of the two fallopian tubes or, more rarely, in the abdominal cavity. The result of an undiagnosed ectopic pregnancy is rupture of the fallopian tube with intra-abdominal bleeding, leading to hemorrhagic shock and death. Here, we present a case of 26-year-old recently married female who was brought for postmortem examination with history of sudden death following pain abdomen. Postmortem examination revealed findings suggestive of ectopic pregnancy. Histopathology revealed multiple vascularized branching villi lined trophoblasts and syncytiotrophoblasts along the lumen. The significance of ectopic pregnancy lies in the fact that it often goes undiagnosed with massive intraperitoneal bleeding. This case emphasizes the need for mandatory pregnancy screening in female patients of reproductive age groups who present with abdominal pain.

Keywords : Ectopic pregnancy; Fallopian tube; Maternal mortality; Pain abdomen.

#### **Introduction:**

Ectopic pregnancy is one in which the fertilized ovum is implanted outside the normal endometrial cavity.<sup>1</sup> It contributes significantly to the cause of maternal mortality. The maternal mortality rate in ectopic pregnancies is known to be as high as 20%.<sup>2</sup> Deaths due to rupture of ectopic pregnancy constitute 0.5 to 1% of sudden natural deaths sent for medico-legal autopsy.<sup>3</sup> The frequency of ectopic pregnancy has been rising over the past two decades. Early diagnosis and therapy have helped to reduce the maternal deaths due to ectopic pregnancy. The incidence varies from 1 in 300 to 1 in 150 deliveries.<sup>1</sup> The most common site of ectopic pregnancy is fallopian tubes (95%). The tubal rupture is common in isthmic and interstitial implantation. Isthmic rupture usually occurs at 6-8 weeks. An acute ectopic is fortunately less common (about 30%) and is associated with cases of tubal rupture with massive intraperitoneal hemorrhage. The classic triad of symptoms of tubal pregnancy are abdominal pain (100%), amenorrhea (75%) and vaginal bleeding (70%). Abdominal pain is acute, agonizing, or colicky.<sup>1,4,5</sup>

#### Case Report :

A 26 year old female who was married 4 months back was brought for autopsy with history of sudden death. Husband gave history that she had pain abdomen for one day for which she was taking treatment from a practitioner of alternate system of medicine. She had been prescribed pain killers and antacids. The body was subjected to postmortem examination to know the cause of death under Section 174 CrPC. There was no history of confirmed pregnancy.

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#### **Autopsy findings:**

The general examination of the deceased body revealed pale face, palms, and fingers with distention of abdomen. No external injuries were noticed on abdomen or in any part of the body. On internal examination, both lungs were pale with frothy fluid on cut section. Brain was edematous. Stomach contained 600 ml of partially digested rice particles and liver appeared pale. Upon opening the abdominal cavity 2.7 liters of blood tinged fluid was seen in lower abdomen and pelvic cavity Figure 1. 800g of thick blood clots were seen in pelvic cavity. Uterus weighed 60g with dimensions of 9cm x 6cm x 3cm and was empty on cut section. Cervix was unremarkable. The major vessels were intact. The uterus along with both adnexa were collected and sent for histopathological examination. Macroscopically, the right fallopian tube measured 6cm and showed no gross abnormality. Right ovary measured 3cm x 2.5cm x 0.8cm and was intact and unremarkable. Left fallopian tube measured 7cm in length and showed highly vascularized mass which was continuous with tube measuring 3cm x 2cm x 0.5cm with evidence of rupture. Figure 2 A grey, brown oval mass was seen in the course of fallopian tube, measuring 3cm x 2cm x 0.5cm. Cut section of mass in continuity of tube showed thin walled cyst filled with numerous friable excrescences. Microscopy showed thinned out muscular wall of fallopian tube with focal stromal hemorrhage and congested blood vessels, multiple vascularized branching villi lined trophoblasts and syncytiotrophoblasts seen along the lumen. Left ovary was intact and unremarkable. The findings were suggestive of ectopic pregnancy in left fallopian tube Figure 3.

Based on the postmortem examination findings and the histopathological report, the cause of death was opined as the deceased died as a result of hemorrhagic shock due to rupture of ectopic left fallopian tube pregnancy.

#### Discussion

Ampulla of the fallopian tube is the most common site of implantation in tubal pregnancies.<sup>6</sup> Increasing incidence of pelvic inflammatory diseases, use of intrauterine contraceptive devices and prevalent use of assisted reproductive technologies have contributed to the rise in cases of ectopic pregnancy. The rate of occurrence of ectopic pregnancy is 1:80 pregnancies or more.<sup>4</sup> Concurrently, 50% of all women who receive a diagnosis of an ectopic pregnancy do not have any known risk factors.<sup>7</sup> Ectopic pregnancy accounts for 3.5-7.1% of maternal deaths in India.<sup>8</sup>

Tubal pregnancy accounts for 90%-95% of all ectopic pregnancies. The most common causes of death in ectopic gestations in order of frequency are hemorrhage, embolism,



Figure 1. Intraperitoneal & Pelvic bleed in ruptured ectopic Pregnancy.



Figure 2 : Left fallopian tube with ectopic pregnancy & Point of rupture (shown in arrow). Cut section of the mass shows thin walled cyst filled with numerous friable excrescences.



Figure 3 : Microscopy of products of conception in left fallopian tube. Branching trophoblastic villi and edematous tubal muscular wall seen.

Pregnancy induced hypertension complications and infection.<sup>9</sup> Ruptured ectopic pregnancy is usually spontaneous and usually results in sudden natural death. The common clinical presentations are similar to that of appendicitis, obstructed inguinal hernia and acute abdomen.<sup>10</sup> Previous literature has shown that only 40-50% of patients who presented with ectopic pregnancy had presenting complains of vaginal bleeding, while 50% have a palpable adnexal mass and 75% may have abdominal tenderness.<sup>11</sup>

Early diagnosis of ectopic pregnancy helps to decrease the rate of female morbidity and mortality. As a routine examination in a female of reproductive age group, proper screening of such a patient who presents with history of amenorrhea, abdominal pain and vaginal bleeding should be done without any delay. The combination of sensitive urinary pregnancy tests, transvaginal ultrasound, and serum hCG estimations enables the early diagnosis of ectopic pregnancy.<sup>12</sup>

The autopsy conducted in this case confirms that the cause of death is ruptured tubal pregnancy. The significance of ectopic pregnancy lies in the fact that it often goes undiagnosed with massive intraperitoneal bleeding.<sup>4,5</sup> In the present case, the female was treated by a practitioner of alternate system of medicine who failed to diagnose the cause & missed the diagnosis. Similar cases have been reported in literature wherein ectopic pregnancy has been wrongly attributed to diseases of gastro-intestinal tract origin.<sup>13,14</sup> Eliciting menstrual history would have raised a suspicion of pregnancy and a subsequent possibility for ectopic pregnancy; thus, it might have saved the deceased's life.

#### **Conclusion :**

The incidence of ruptured ectopic pregnancy is more in developing countries which is attributed to late diagnosis or failed diagnosis. An undiagnosed ectopic pregnancy may rupture and prove to be fatal. Extracting complete history, including menstrual history, is vital to the diagnosis and thus preventing any fatalities. A simple urine pregnancy test using a pregnancy kit would have changed the outcome of this case. We would suggest that strip tests, which are inexpensive and non-invasive, should be mandatory for screening of pregnancy in female patients of reproductive age presenting with pain abdomen. There is a need for adopting 'two-pronged' approach of developing standard treatment protocols to avoid misdiagnosis of pain-abdomen and thus avoid life threatening complications, together with awareness building attempts among general population so as to not disregard pain-abdomen as something too trivial.

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#### **CASE REPORT**

# Rare Inward Compression Fracture of Hyoid Bone In Hanging: A Case Report and Review of Literature

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#### Abstract :

Fracture of hyoid and laryngohyoid complex may result from violence like strangulation, hanging, accidents, therapeutic interventions or postmortem processing. Inward compression fracture of hyoid bone usually indicates strangulation, and unexpected finding of hyoid fracture may cast suspicion of throttling or manual strangulation and may misguide the investigation. Here, we report a case of a rare, occurring inward compression fracture of hyoid bone identified in the autopsy examination of a 41-year-old decedent male who committed suicide by complete hanging.

A 41-year-old man decedent committed suicide by complete hanging with a thin, cord-like nylon rope. At autopsy, the authors observed a typical incomplete, obliquely placed grooved ligature mark on the neck. After achieving a bloodless field in the neck, layer by layer dissection was done. Internal examination revealed inward displaced greater cornu of the hyoid bone suggesting periosteal tear of the outer side at the junction of the body with right greater cornu. The displaced fragment was mobile in one direction, offering one degree of movement freedom. This finding of inward compression fracture of the hyoid is rare in hanging. Focal bleeding at the site confirmed the fracture and proved its intravital nature.

Fracture of hyoid following strangulation or hanging is well documented in the literature. In a suspected case of compression of the neck, fracture of the hyoid bone indicates throttling. However, the presence of unexpected fracture of the hyoid bone in a case of hanging may create confusion, raising the possibilities of direct trauma to the neck and possibly third-party involvement. It is, therefore, essential that the forensic pathologist adopt proper dissection techniques in interpreting injuries to the osseocartilaginous structures of the laryngohyoid complex.

Keywords : Trauma; Laryngohyoid complex; Hyoid bone fracture; Inward compression; Hanging; Forensic Medicine.

#### **Introduction:**

Assessment of trauma to the neck during forensic autopsy examination needs close observation of the laryngohyoid complex. Neck trauma to these structures may result from violence like strangulation or hanging, accidents, therapeutic interventions, or post-mortem processing. The nature of injuries may vary from haemorrhages in neck muscle, to fractures of the hyoid bone and laryngeal cartilages, which account for 10% of violent deaths.<sup>1,2</sup> Fractures of the larynx or hyoid bone are a classical sign of "pressure to the neck", caused manually or by the application of a ligature, i.e., strangulation or hanging.<sup>3,4</sup> Nevertheless, fracture of the laryngohyoid complex is less appreciated in other types of trauma applied directly or indirectly to the neck, e.g., motor vehicle accidents<sup>5</sup> or falls.<sup>6-7</sup>

Forensic pathologists are supposed to be aware of the complex anatomy of the human neck to understand the findings at autopsy. Understanding the anatomy and variations in the human laryngohyoid complex is valuable when assessing the cause and manner of death.<sup>8</sup> Forensic imaging with the help of X-ray, Computed Tomography (CT) and Magnetic Resonance imaging (MRI) techniques may help confirm findings at autopsy. The

Corresponding Author Himanshi Narang Email : himanshin07@gmail.com Mobile No. : +91-9053875296 unexpected result of such a fracture at autopsy should usually raise the possibilities of direct pressure to the neck and third-party involvement.<sup>9</sup> Hence, examining neck structures, especially the laryngohyoid complex, becomes the most integral and essential part at the autopsy table when any case of hanging, strangulation or throttling comes for forensic autopsy examination.

This article presents an unusual and rare autopsy finding of inward compression fracture of hyoid bone observed during neck dissection in a case of complete hanging. We also reviewed various research articles on fracture to hyoid or laryngohyoid complex to understand the cause, types and mechanism involved in the causation of these fractures concerning the anatomical characteristics of the laryngohyoid complex.

#### Anatomy of Laryngohyoid Complex :

The typical adult hyoid-larynx complex is described as a combination of hyoid apparatus (i.e., stylohyoid ligaments, stylohyoid ligaments) body and lesser and greater horns, uncalcified thyroid, cricoid, arytenoid cartilages and their ligaments proper. The thyroid cartilage includes superior and inferior horns. No other cartilaginous structures are present in the trajectories of stylohyoid ligaments, median and lateral thyrohyoid ligaments.

The hyoid bone is a horseshoe-shaped, single bone localized in the anterior neck at the third and fourth cervical vertebrae level between the thyroid cartilage and the mandible. It has a body and two greater and two lesser horns. It is located beneath the protruding part of the mandible, just above thyroid cartilage, as a hanging styloid protrusion that supports the movement of the tongue in front of the cervical spine.<sup>10</sup>

The hyoid is a sensitive sesamoid bone on which the cervical and tongue muscles are attached and is close to vital structures. It does not directly make a joint with any surrounding bone. The greater and lesser horns usually unite to the body of the hyoid via fibrous tissue or a proper joint. As age progresses, there is progressive ankylosis of the joints, which is physiologically connecting the greater and lesser horns with the body of the hyoid.<sup>11</sup>

Minor variations in the laryngohyoid complex consist of a fusion between the body with greater and or lesser horns by ankyloses of the joints, calcification of thyroid mostly age-related, and a triticeal cartilage in the lateral thyrohyoid ligament. Variations in the morphology of the hyoid are closely related to sex, race, body proportions and age.<sup>12</sup> Male hyoids are generally larger and typical with inward curving and flattening of the greater horns and are more susceptible to age modifications.<sup>13,14</sup> Besides that, male shows a high degree of thyroid ossification, ultimately leading to the completely ossified thyroideum.<sup>15,16</sup>

The hyoid bone is unique as it does not articulate with any other bones and is suspended in the neck by the muscles and ligaments that attach to it. Figure:1 In fact, it acts as an attachment site for many muscles in the neck. The three main ligaments attached to the hyoid bone works to support the position of the hyoid in the neck.<sup>17</sup>

#### Types of Hyoid bone fracture :

As per reviewed literature, fracture of the hyoid bone is classified into three different types and best described by Weintraub C:<sup>18-20</sup>

1. Inward Compression fractures with outside periosteal tears mostly commonly seen in throttling or manual strangulation. As the finger of the grasping hand squeezes the throat, the more excellent horn of the hyoid bone is compressed inwards, causing fracture of the bone with a tear of its periosteum on the outer side, the inner side, thus displacing the fragment inwards. If the small portion is grasped between the forefinger and thumb and the body of the bone held in the other hand, it will be noticed that the small fragment can be bent freely in an inward direction. When it is moved outwards, it will be found that the piece moves to the corrected position but no further. This type of fracture can occur on both sides. Inward compression may produce a similar fracture at the joint between the greater horn and body of the hyoid bone.

2. Antero-posterior compression fractures with inside periosteal tears most seen in hanging, ligature strangulations, run over motor vehicle accidents, blow on front of neck etc. In hanging cases, the cord encircling the neck lies at the level of or in the region of the hyoid bone. The bone is forced backwards against the vertebrae and soft tissue around the vertebral column. In anteroposterior compression, the hyoid bone is driven directly back, the divergence of the greater horn is increased, causing fracture with outward displacement of the posterior fragment. As

a result, the periosteum on the inner side of the fracture is torn when the fragment can be easily moved outwards, but the internal movement is limited to normal position only.

3. Avulsion or Traction, or Tug fractures occur due to hyperextension of the neck or muscular over activity because of traction on thyrohyoid ligament either by downward or lateral compression or when direct pressure is exerted between hyoid and thyroid by pressing fingers. The hyoid is drawn upwards and held rigidly. These fractures are the result of muscular overactivity in the absence of direct injury to the hyoid bone.

#### Case report :

The decedent was a 41-year averagely built male labourer by occupation. Autopsy surgeons of the Forensic Medicine and Toxicology Department, AIIMS Patna, performed forensic autopsy examination on the deceased body. As per the police inquest, the dead allegedly committed suicide by hanging and with his body found in the position of complete suspension with a nylon rope tied around his neck.

At autopsy, external examination revealed rigor mortis in the body with fixed gloves and stocking type of post-mortem lividity. We noticed dried salivary stains over the middle part of the lower lip, chin, and elongated neck, which was bent more on the right side. Facial congestion was present, and the protruded tongue was seen clenched between the teeth.

Neck examination showed obliquely place single dark brown parchmentized grooved non-continuous ligature mark with a reddish colour margin over the upper part of the neck, above the thyroid cartilage measuring 31cm x 0.5 cm -1.5 cm, minimum width of 0.5 cm at the right lateral part of the neck and maximum width of 1.5 cm at the anterior part of the neck. The ligature mark was deeply grooved in the neck tissue and was directed upward & backwards from either side of the neck. The ligature mark was situated 4.5 cm below the chin in the midline and 9.5 cm above the sternal notch, 4 cm below the right ear base on the right side of the neck, 3.5 cm below the left ear base on the left side of the neck, incomplete and deficient by 2.5 cm with the formation of a suspension peak at the occipital region of the scalp, more towards the left side at the back of the neck Figure 2. The ligature mark was more prominent and grooved on the right side of the neck, thereby suggesting the application of maximum pressure compared to the left side.

To minimize the post-mortem artefact and to achieve a bloodless field in the neck, the cranial cavity was opened first, followed by the thoracic and abdominal cavity, so that all the neck vessels were drained out of the blood, and thus a clear bloodless field was obtained for the neck dissection. Consequently, using a V-shaped skin incision commencing from mastoid regions to the sternal notch, the neck dissection was done at the end. The tissue underneath the ligature mark was white, dry, firm and glistening, a typical presentation seen in hanging. There was no bleeding into the strap muscles, but extravasation of blood was seen at the junction of the hyoid body with the right greater cornu Figure 3 and 4. The greater cornu of the hyoid bone was inwardly displaced, suggesting the periosteum was torn from outside, thereby offering mobility only in one direction, i.e., with one



Figure 1 : Laryngohyoid Complex with muscle and ligament attachments.



Figure 2 : Obliquely placed ligature mark on the neck.

degree of movement freedom. The rest of the hyoid bone, thyroid and cricoid cartilages were regular. Internal examination of organs revealed generalized congestion and signs of asphyxial changes.

#### **Discussion :**

Identification and morphological characteristics of injuries to the hyoid and thyroid cartilage are poorly presented in the literature due to lack of detailed information in retrospective approach and difficulties of such assessment in the visual and palpatory examination of unprepared neck complexes.<sup>21</sup>

Authors can find many reports on the frequency of solid neck structure fractures in the literature: Betz and Eisenmenger<sup>22</sup> established it in 67% of cases; Feigin<sup>23</sup> found at least a single fracture of the throat skeleton in 9.5% of the examined cases; Uzun et al.<sup>24</sup> established 59.9% fracture determined cases in hanging; Suarez-Penaranda et al.<sup>25</sup> did in 75.3% cases of the observed sample; Azmak<sup>26</sup> did in 76.7% of all investigated cases; Luke<sup>27</sup> did in 25%, and James and Silcocks<sup>28</sup> did in 36% of the observed sample. Though fracture of the laryngo-hyoid complex is seen in other traumatic conditions, more than half, i.e., 54.6% of them, were attributed to the pressure to the neck (either hanging or strangulation). Other studies have noted this



Figure 3 : Focal bleeding around the fracture site.



Figure 4 : Hyoid bone dissected and separated from neck structures showing inward fracture at the junction of the body and right cornu of the hyoid bone.

association, the frequency of laryngo-hyoid fractures in hanging ranging from 8.8% to 44.8% of the cases.<sup>1,3,23,28</sup> While the frequency of this association is more common in manual strangulation, about 68 to 70%.<sup>29</sup>

The hyoid bone is encircled by bones mainly by mandible anteriorly and laterally and by the cervical spine posteriorly. The surrounding neck musculature and ligamentous attachments also offer some protection. However, when the neck is extended or is compressed by direct application of force, this protection is diminished, allowing direct or indirect trauma to cause an isolated fracture of the hyoid bone. Each element of the neck complex can partially resist an external impact due to the reversible deformation. When the strength limits are exceeded, destruction of the supporting tissue begins, usually in the surface layers on the side of maximum stretching tensions. Firstly, a linear fissure appears without disconnection of the broken parts of bone or cartilage. If violence continues, the fissure instantly turns into infraction (mobility of broken part only in one direction, i.e., with one degree of movement freedom), and further – into fracture with two or three degrees of freedom.<sup>3</sup>

In the case of hanging, the damage to the hyoid commonly affects the greater horns or the region between the body of the hyoid and the horns, and these injuries are mainly in the form of vertical or oblique fractures.<sup>11</sup> As proposed by Weintraub C,<sup>19</sup> inward fractures were produced by forces approximating the grater horns and outward fractures by compression of the bone against the vertebral column with resultant diversion of the greater horns from each other. He also observed that manual strangulation produces inward fractures and hanging outward fractures, with exceptions.

With exceptions mentioned by Weintraub C, this case reports the unusual finding of inward fracture of the hyoid bone in hanging with outside periosteal tear at the junction of the body and greater cornu, thereby producing classical inward compression fracture. The position of the ligature cord encircling the neck was at the level of the hyoid bone. The thin and hard ligature material inflicted highest compression on the right side of the neck, as evident from the deep grooved ligature mark on the neck. The pressure is highest at the site opposite the knot position. In this case, the ligature material used is a hard and thin nylon rope thereby producing a "cheese cutter-like effect", applying firm pressure without lacerating the skin or underlying deeper tissues. The thinner the ligature, the higher the applied ligature pressure (per square unit of skin area).<sup>1</sup> Since the victim's age was above 40 years, ankylosis of hyoid joints or age-dependent ossification would have contributed to the fracture as hyoid-laryngeal fractures appear significantly more often in persons older than 30 years.<sup>31, 32</sup> The focal bleeding around the injured site was proof of its intravital nature as the finding of fracture-associated haemorrhage at autopsy provides strong evidence that the fracture occurred before the cessation of the cardiac output.<sup>2</sup> As the bleeding was evident to the naked eye, histological examination confirmed the surgeons did not do it.

The hyoid bone gets broken involving the greater horns, most likely at the junction of their outer one-third and inner two-third which is due to direct compression of ligature to the neck.<sup>33</sup> Reddy et al. mention that inward fracture occurs when the greater horns of hyoid bone get squeezed towards each other, due to which the bone may get fractured within one cm of the tip and the posterior fragment gets displaced inwards. The periosteum gets torn on the outer side but not on the inner side.<sup>18</sup> According to D. Miao et al,<sup>1</sup> fracture neck is rare in hanging and is usually seen only in individuals with advanced degenerative disease of the cervical spine, such as osteoarthritis, in combination with a complete suspension of the body, a sudden drop, and, frequently, obesity. D'Souza et al. say that, clinicians and forensic experts can expect a fractured hyoid, even after pressure on the neck when a victim is over 38 years.<sup>34</sup>

As explained in Knights et al., calcification of hyoid occurs at variable times where the body is calcified but the horns may calcify irregularly, both in space and time. In teenagers and young adults, they are usually cartilaginous and the joints mobile. In middle and later life, the hyoid and thyroid horns calcify and become more brittle. The cricoid cartilage is a modified upper tracheal ring but can also become partly calcified as age increases; no meaningful ages can be placed on any calcification, but traumatic fractures can occur at any time except in children and most teenagers, in whom fractures are rare.<sup>2</sup> Further, lateral pressure on the neck can displace any of the four horns inwards, either by direct force or by pressure on the thyrohyoid membrane, which then drags the horns medially. In young persons, the horns are so pliable that they return to their normal position on the release of the pressure, but, variably beyond the third decade, they may be sufficiently calcified to fracture.<sup>2</sup>

Fractures in the hyoid-larynx complex are one of the best indicators of strangulation. Still, they can also be caused by hanging, traffic accidents, osteoporosis senilis, sporting accidents, and intubation.<sup>29,21,35</sup>

#### **Conclusion :**

Fracture of hyoid following strangulation or hanging is well documented in the literature. In a suspected case of murder, fracture of the hyoid bone is indicative of throttling. The typical autopsy findings observed in deaths due to compression of the neck will confirm the manner and cause of death. However, the presence of unexpected fracture of the hyoid bone in such cases may create confusion, raising the possibilities of direct trauma to the neck and third-party involvement. It is, therefore, essential that the forensic pathologist adopt proper dissection techniques in interpreting injuries to the osseocartilaginous structures of the laryngohyoid complex.

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#### **CASE REPORT**

# **Unplanned Complex Suicide - Poisoning Followed by Hanging**

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#### Abstract :

Complex suicide is when more than one method is used to commit suicide. Sometimes the first method chosen fails to end one's life making the person to adopt another method which was not thought of earlier. Such cases are termed as unplanned complex suicides. A 33 year old woman was found dead hanging in her bedroom. There was also a bottle of insecticide and a bowl containing a mixture of crushed glass particles and insecticide in the same room. Autopsy revealed features of ante mortem hanging and stomach perforation caused by crushed glass particles. Dichlorvos an organophosphorus insecticide was detected in stomach during chemical analysis. Perforation of stomach caused acute pain abdomen and victim survived for some time. Intolerable pain during the survival period made the person chose another method. Chain of events could be ingestion of organophosphorus compound mixed with crushed glass pieces and then hanging.

Keywords : Complex suicide, Unplanned, Poisoning, Hanging.

#### **Introduction:**

The term "complex suicide" refers to suicides in which more than one suicide method is applied. This refers to those cases in which the simultaneous combination of several methods of suicide is employed to guarantee one will at least succeed. The purpose of the second suicide method employed and any further method that may be employed too is to serve as a safeguard in case that the first method fails. However, the term "complex suicide" is also used for those cases in which the methods of suicide are not applied simultaneously, but one after the other. This may be the case if the first method chosen did not cause death, if death occurs too slowly, or this method causes too much pain.<sup>1</sup>

Pollak called those suicides in which "the success is to be guaranteed by a planned coincidence or mutual acceleration of two or more methods of suicide" primary combined suicides. In contrast to the aforementioned group, secondary combined suicides are those in which the suicidal individual uses one or several other forms of inflicting damage to him or herself directly after the unintentional failure of a first attempt in one and the same course of action.<sup>2</sup> The terms primary combined suicide and secondary combined suicide can also be used for planned complex suicide and unplanned complex suicide respectively. Planned complex suicides have been further divided into "typical" i.e. associations of two common methods, and "atypical" ones that present rare combinations or a coincident use of more than two suicide means.<sup>3</sup>

Any combination of suicide methods both rare and common ones is adopted. More commonly one of the methods used is ingestion of poison. Frequently sedatives are used to avoid suffering and pain caused by the second method. Harder methods of suicide like fall from height, hanging, use of firearms or sharp weapons are employed as a second method. Sometimes the victims would or would not have thought of a second method while using the first method.

#### **Case Report :**

**History :** A 33 year old woman, married for 5 years had history of domestic violence and constant mental harassment by husband and parents-in-law as she was unable to bear a child. On one night her husband had compelled her to leave the house and threatened her father as well. Later next day at around 08:30 am she was found hanging from the ceiling by her husband. Door was locked from inside and a bottle of Doom (Dichlorvos) Insecticide was found at the scene and a bowl containing the insecticide and crushed glass particles. (Figure No. 1, 2 & 3) Magistrate inquest was conducted and body was subjected for post mortem examination on the same day.

Autopsy findings : Moderately built and moderately nourished dead body of an adult female measuring 152 cm in length. Nail beds showed cyanosis and greenish blue coloured stain was present over the right angle of mouth. Ligature material (veil) was present in-situ on the body measuring 335 cm in length. Oblique incomplete ligature mark measuring 22 cm x 2 cm was present over front and sides of neck characteristic of hanging. Peritoneal cavity and omentum was greenish discoloured (Figure No. 4). Stomach was perforated at various places and contained greenish blue discoloured fluid with crushed glass particles (Figure No. 5). There was also a smell of kerosene emanating. Mucosa was intensely congested and haemorrgahic. Other organs were intact and congested. Blood and viscera were sent for chemical analysis to the Forensic Science Laboratory and was tested positive for the presence of dichlorvos insecticide in stomach. It was not detected in blood, liver and kidneys. Cause of death was attributed to combined effect of asphyxia due to hanging and shock resulting from perforation of stomach.

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#### **Discussion :**

Suicide is intentional taking of one's own life. Many factors like firmness to end one's life, chosen method and the preparedness influence the fatality of suicidal attempt. It is termed as complex suicide when more than one method is applied. Both methods are applied simultaneously or a second method is employed when the first one fails. Methods are chosen and planned based on previous knowledge. People who are rigid and are definite to end life choose multiple methods and apply them simultaneously. They want to be certain that they would die even if one method fails. Such cases are termed as planned complex or primary combined suicides. Rarely a method may fail or may cause intractable pain which makes a person to resort to another method. Such cases are called unplanned complex or secondary combined suicides. Methods like poisoning or self-inflicted cut injuries which are less lethal are combined with a second method which is usually more lethal like hanging, burning, falling from a height. Complicated suicide is another entity different than complex suicide which is characterized by unintentional secondary injuries following the initial suicide method. Suicide by hanging may get complicated when the ligature material accidentally gets



Figure 1 : Bottle of Doom (Dichlorvos) Insecticide found at the scene and bowl containing the insecticide and crushed glass particles



Figure 2 : Bottle of Doom (Dichlorvos) Insecticide (close up view)

cut making the person fall causing injuries.

In the present case, the deceased was found hanging and insecticide with crushed glass particles was seen in the death scene and also in the stomach. Stomach perforation caused



Figure 3 : Bowl containing the insecticide and crushed glass particles (close up view)



Figure 4 : Peritoneal cavity and omentum was greenish discoloured.



Figure 5 : Stomach showing perforation and greenish blue discolouration.

intense pain, shock and did not lead to immediate death. Considering these facts it was deduced that the victim had first consumed insecticide mixed with crushed glass particles and later hung herself using a readily available cloth material (veil) as ligature as a second method to end her life.

In a similar case reported, incised injury was inflicted over wrist and was later combined with consumption of sulphuric acid. Incised wound over wrist was deep severing the radial artery. Here cause of death was attributed to both perforation of stomach caused by sulphuric acid and the hemorrhage and shock caused by incised wound over wrist.<sup>4</sup> Two fatal cases of planned complex suicide were reported involving two males, 86 and 51 years old, who had resorted to ingestion of petroleum distillates and hanging. There were no signs of lesions in both the stomach and the intestine which could have been caused by petroleum distillates because there was no time to provoke more severe damage. The medical examiners in both cases reported the cause of death as hanging, and based upon examination of the scenes and the anatomopathological and toxicological data, the manners of death were determined to be planned complex suicide.<sup>5</sup>

Present case had several risk factors for suicide including harassment by husband and parents-in-law, societal and domestic pressure of not being able to bear a child. Suicide note was not found at the scene of death. There was no evidence of a struggle or drag marks suggestive of homicide.

Possible sequence of events is ingestion of organophosphorus compound mixed with crushed glass pieces (planned) which lead to intractable pain caused by the perforation of stomach. This made her use a second method i.e. hanging (unplanned). The ligature material used was a readily available one and was not procured newly to commit hanging. Based on brief facts of case, autopsy findings and crime scene examination, manner of death was opined as unplanned complex suicide or secondary combined suicide.

#### **Conclusion :**

Unplanned complex suicide where the combination is ingestion of pesticide and crushed glass particles and hanging is a rare incident. Often simpler soft method is used and when it fails a more lethal violent method is used. In such cases, careful analysis of crime scene, autopsy findings and reconstruction of sequence of events is required to ascertain manner and cause of death.

#### Abbreviations - Not applicable

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#### **CASE REPORT**

## Strychnine Poisoning: A rare occurrence

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#### Abstract :

Strychnine poisoning, though rare, the incidences are reported around the world. Intentional poisoning due to Strychnine ingestion is uncommon. In the most severe cases of strychnine poisoning, whether deliberate or unintentional, the Patient dies before reaching a hospital due to respiratory failure. The management of strychnine poisoning is well-documented and practiced across the world. Hence, if any poisoned patient is brought to the hospital in time, rapidly diagnosed and the appropriate aggressive management is started immediately, the patient's survival chances are higher.

Here, we present one case of intentional consumption of strychnine that survived after early intervention and recovered completely. The rationale behind the drugs used in the management of this case is discussed here.

Keywords : Intentional poisoning; Strychnine; Respiratory failure; Survival; drugs used.

#### Introduction:

Strychnine is a toxin derived from the seeds of the plant Strychnous nux vomica, which contains two alkaloids: strychnine and brucine. Apart from the seeds, they can also be isolated from other plant parts like the bark, roots, and leaves.<sup>1</sup> It was earlier used as an antiseptic, stomach tonic, a stimulant for circulatory and central nervous system, and recently used as a rodenticide.<sup>2</sup> Certain drugs like amphetamines, heroin and cocaine also contain strychnine.<sup>3</sup> Once ingested strychnine antagonizes glycine resulting in powerful muscle contractions which can be fatal if not managed.<sup>1</sup>

We present a case wherein the relatives brought a 48-year-old male who exhibited various symptoms after consuming Nux vomica seeds (strychnine). After appropriate treatment, he survived.

#### Case report:

A 48-year-old male construction worker was brought by his relatives to the hospital due to consumption of Nux Vomica seeds for reasons unknown. He presented with abdominal pain, drowsiness, involuntary tonic and clonic activity of all the limbs, jerks and spasticity of the neck and limbs, and urinary incontinence.

When examined, the Patient was conscious and oriented, and his vitals were stable. He had a history of Bronchial asthma, which was well-controlled. Investigation revealed that the stomach contents tested were positive for strychnine. The test was determined by employing TLC (Thin Layer Chromatography) method using the methanolic extract of Nux Vomica seeds. The Patient was treated by administering Lorazepam – an anti-

Corresponding Author Shankar M Bakkannavar Email: shankar.mb@manipal.edu Mobile No. : 9110240992 convulsant for spasticity, and Fentanyl – an opioid analgesic for pain reduction. Due to proper treatment, the Patient's condition improved, and we discharged him.

#### Discussion:

Strychnine is an alkaloid found in seeds of Strychnous nux vomica. It is currently used as a rodenticide. Upon ingestion, strychnine is rapidly absorbed by the gastrointestinal tract and metabolized in the liver. Other routes include via the respiratory tract and intact skin.<sup>4</sup> Strychnine acts as a competitive antagonist of the inhibitory neurotransmitter glycine, exerting an excitatory effect on the central nervous system by preventing glycine uptake mainly in ventral horns of the spinal cord, brainstem, and higher centers.<sup>5</sup> This produces typical muscular spasms known as spinal seizures with the Patient being alert and can be caused even by a minor stimulation.<sup>1</sup> Excitatory action is also seen in the medulla and enhances touch, smell, hearing, and sight sensation.<sup>5</sup> First symptoms start appearing within 5 minutes to 1 hour of exposure, including restlessness, heightened senses, risus sardonic - cus, trismus, extreme muscle stiffness, and spasm followed by convulsions. These symptoms can be accompanied by severe complications like rhabdomyolysis, hyperthermia, metabolic and respiratory acidosis, and myoglobinuric kidney failure.<sup>4</sup> If not treated, the clinical manifestations culminate in respiratory arrest due to contraction of the diaphragm, thoracic and abdominal muscles, and death ensues within hours after ingestion.<sup>4</sup>

Conditions like tetanus, epilepsy, meningitis, and rabies can cause similar seizures. But the differentiating features between these conditions and strychnine poisoning are the Patient's consciousness which is not seen in the case of epilepsy, sudden onset of convulsions, and absence of fever, ruling out meningitis and absence of trauma and fever before the start of symptoms distinguishing it from tetanus. Survival after increased dosage is possible with a proper diagnosis.<sup>4,6</sup>
In our case, the Patient developed severe spasticity and muscle spasms to which a symptomatic treatment with Lorazepam (anticonvulsant) and Fentanyl for pain reduction was provided. Though many studies<sup>3,7,8</sup> done in the past suggest Diazepam as the drug used in the management of strychnine poisoning, we used Lorazepam as it stays less time (half-life is 18 hours) in the body compared to Diazepam, which stays up to 48 hours.9 It is suggested by various studies that the half-life of strychnine is around 10 - 16 hours.<sup>3,10</sup> Hence we used Lorazepam instead of Diazepam. It is Also helpful in cases where the Patient's condition appears to be under control, and the amount of poison consumed is less so that the person can become normal after a short time. Since there is no antidote for strychnine poisoning, supportive and systematic management can only improve the condition.<sup>4</sup> In a case reported by Shadnia S et al.,<sup>10</sup> the Patient's clinical course included agitation, generalized tonic-clonic convulsions, and hyperactivity which were present in our case too. They used midazolam and sodium thiopental as continuous intravenous administration in their Patient.

In contrast, we used Lorazepam and Fentanyl as midazolam has the same memory impairment, but Fentanyl has no memory effects in the patients.<sup>11</sup> Following the treatment, the Patient's condition improved, and he was discharged. Strychnine poisoning is rare and can be fatal if left unrecognized.

#### **Conclusion:**

Early and effective intervention in strychnine poisoning is helpful in successfully managing patients. In this case, the rationale behind the appropriate use of drugs highlights the management strategy in such cases.

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#### Letter to Editor

# **Obstacles in the Pathway of Creating an Empathetic Indian Medical Graduate -An AETCOM Perspective**

#### Sunil M. Doshi

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### Sir,

with this letter I would like to highlight concerns regarding effective implementation of the AETCOM programme for the Indian Medical graduate.

To achieve the goal of making an Indian Medical graduate competent enough to practice the medicine appropriately and effectively in the community while being globally relevant, a newly structured longitudinal programme on attitude, ethics and communication, popularly cited as "AETCOM", has been introduced in addition to the new set of competency based curriculum. To incorporate the AETCOM programme within medical graduation, certain guidelines have been prescribed. However, effective implementation of this concept still needs attention as there are some discrepancies and grey areas in the recommended strategies.

The council has made a noticeable effort in terms of serving an AETCOM booklet "AETCOM competencies for the Indian medical graduate" for ready reference.<sup>1</sup> Furthermore, there is also enough clarity regarding how this program needs to run in every professional year by classifying it into different modules as well as allocation of specific hours dedicated to each module. However, a lesser amount of attention has been given to the areas of assessment and availability of the resource material pertaining to the AETCOM concept.

Teachers in medical colleges are largely dependent on AETCOM booklet as far as teaching sessions are concerned. The AETCOM modules are made in a way to define boundaries in context to when to teach, what to teach and how to teach. But, it lacks the fundamental material elaborating this novel idea. Teachers need to go through the references cited at the end of each module for further reading. Many of the referenced articles are not supportive enough to cover the concept for undergraduates as they are too ambiguous to address the competency in question. From the learner's perspective, students need to depend upon the presentations of teachers or internet based sources. Being more or less philosophical aspects, it's challenging for them to revise the subject in absence of any particular book to refer.

The AETCOM booklet has suggested exact number of hours for different modules to teach the AETCOM in a specified professional year. But, in absence of subject wise allocation of the modules, the liberty lies with the individual institute. Because of lack of homogeneity and unwarranted ambiguity in outlining the syllabus of AETCOM for a particular subject, the students may be subjected to go through all the modules of AETCOM for each

Corresponding Author Sunil M. Doshi Email : drsunil2347@gmail.com Mobile No. : +91-9558224327 examination especially, when the summative examination involves assessment by external examiners from different institutes across the nation.

Almost all the formative assessment methods under different modules mention that the students should be assessed based on their active participation in the sessions which is contrary to the document "Assessment module for undergraduate medical education, 2019" which clearly states that one question from AETCOM should be asked in internal exams of each subject.<sup>2</sup> More elaboration is needed from the commission on this discrepancy in context to whether the students should be assessed in a formal way or an informal way as far as AETCOM program is concerned. Moreover, apart from inherent subjectivity, how practical is this approach of assessing them during the sessions especially when the students-teachers ratio is also not favorable to justify it.

The recent reforms in medical education are set to produce a "competent graduate" who is not only required to obtain enough knowledge but also to possess certain skills and attitude to practice medicine in an empathetic way. Although it is clearly mentioned in the booklet that the given document is a conceptual framework only and the Institutions are at liberty to modify this in accordance with their settings. Nevertheless, the phrase "at liberty" is directly proportional to the level of importance that can only be guaranteed by the individual institute in implementing AETCOM. The chances are not negligible when the goal of making "revised IMG (Indian Medical Graduate)" remains only partially achieved in absence of qualitative assessment of medical institutions themselves.

#### Author's suggestions-

- AETCOM modules should be further classified and the related competencies need to be amalgamated within the curriculum of each subject so as to make it uniform across the country.
- A reference book should be developed to accommodate every aspect of AETCOM as well as to address the competencies related to different modules in a detailed manner.
- Methods of assessment should be prescribed systematically to incorporate AETCOM within the pattern of examination in a way to make it formal and identical.
- A comprehensive training of faculties is desirable to uplift the present attitude and orientation towards this concept.

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