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Case Study

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An Autopsy of Unrecognized Aftofin Herbal Solution Poisoning: A Case Report

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Abstract

Background: Aftofin is a pure natural herbal remedy which is commonly used herbal solution therapy in ruminant animals. Livestock herders widely use herbal medicines for treatment of farm animals. Thus, animal herders or their family members are prone to a potential health risk from herbal drugs due to improper handling, irresponsibleness and haphazard usage with careless protection and storage of these remedies. Up to date poisonings due to Aftofin herbal solution has not been previously outlined. The aim is to discuss mismanaged and description of the case follow-up.

Case presentation: A case reported on a 2-year-old girl who mistakenly ingested unknown volume of the drug. Consequently, she initially developed nausea; vomiting; abdominal pain; and elevated body temperature. Inphysical examination abdomen was distended with no bowel sound. Nasogastric tube immediately inserted and treated with supportive measurements. Laboratory results showed the patient in septic condition.

Conclusions: She passed away on fourth-day post ingestion. The cause of death was assigned due to septic shock resulting from intestinal perforation as outcome effects of the herbal solution ingredients. Public education and awareness among people and health professionals are necessary to be widened to protect from this type of poisonings and dramatic outcomes.

Keywords: Aftofin, Herbal, Poisoning, Autopsy, Case report

Background

Aftofin is a pure natural herbal remedy made of Peppermint Myrtle. It is commonly used herbal solution in treatment of all kinds of rashes, erosions, and dermal/mucosal blisters in ruminants (Cattle, Sheep and Goat). This herbal solution contains variety of chemicals to achieve its application aim of production including tannins, phenolic acids and flavonoids[1]. Nowadays, herbal medicines are widely utilized globally although they have a potential risk for health states of their users. The harmful effects of these sorts of drugs are usually due to irresponsible, improper handling and haphazard storage and

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protection [2]. Chemical ingredients of the Aftofin solution includes Anthocyanins Caffeic acid, Gallic acid, Catechin, Myricetin and Quercetin, they are powerful tannin antioxidants with anti-inflammatory activities[3]. The most significant active component of this herbal solution is Menthol, which has anti-inflammatory and pain relief effects. Furthermore, this active ingredient has a strong minty odour and taste. In one study,it was reported that Menthol is fatal in dose of 50-500mg/kg, however recovery was recorded after single dose of 8 to 9 g[4]. Unfortunately, information on Aftofin toxicity was not announced by manufacture maker. To the best of our knowledge, a fatal poisoning case involving Aftofin herbal use has not been described before in the literature review. Thus, the main purpose of this case report on incautious drinking herbal solution is to increase awareness among farmers, public and healthcare professionals in order to prevent mysterious risks due to the misuse of herbal products.

Case presentation

Two years old female baby accidentally swallowed few amount of Aftofin herbal solution in barn; where the herbal solution was used for washing and disinfection of domestic cows by family members. Then 3 hours later, one family member observed discharged fluids coming out from her mouth. Therefore, they brought the child to a local health provider in their countryside. On next day, the patient was vigorously vomiting and there was noticeable rise of her body temperature. For that reason, she was immediately referred to pediatric hospital. On admission, she was crying, tired, and distended abdomen with repeated projectile vomiting. Clinical examination (Seen in table 1) manifests a mild elevation of temperature (38°C), with generalized abdominal tenderness and no bowel sounds (no bowel motion for 2days). In addition, the signs of vitality were normal and She looked very unwell, drowsy, pale, and yellowish discoloration of sclera with poor hydration. Her chest was clear by auscultation. the senior pediatric doctor referred the patient to intensive care unit.

Table 1: Clinical examination on admission

Clinical examination	Signs and symptoms
Consciousness	Lethargy and drowsy
Eye	Slightly yellowish color of sclera
Skin	Signs of dehydration
Abdomen	Distended, tender, no bowel sound detected, no organomegaly or mass detected
Signs of Vitality	No significant change apart from raised temperature
Chest	Bilaterally clear

At ICU, they were immediately inserted nasogastric tube to prevent further vomiting and risk of aspiration. Moreover, the patient was treated with supportive measurements. Sadly, the patient passed away on 4th day early morning. The deceased was sent to a medicolegal institute as it was a case of suspecting herbal poisoning without a professional diagnosis. On autopsy, the external examination was marked cyanosis of lips and nail of both hands with color of sclera turned to yellow. What's more, a tense unpleasant odor from mouth and bloating of abdomen were noticed.

On internal examination, after exploration of chest and abdomen, a tense foul and minty smell was sensed suggesting sever infection and peritonitis. All abdominal cavity was full of pus and internal organs adhered to each other i.e. frozen abdomen. Additionally, stomach was empty with signs of congestion and erosion and light hemorrhage of the gastric mucosa at places [Figure 1A and 1B]. Routinely, all internal organs were removed and examined looking for details. In proximal part small intestine, one point of greenish color leakage was found. Then a water pressure test applied to find the exact point of discharge and finally a tiny longitudinal tear (perforation) was discovered as shown in figure 2A and 2B. No clinically significant pathology was seen inrest of organs and tissues. The deceased had a survival period of 4 days, and there was no urine at the time of autopsy. Hence; viscera and blood were preserved and sent for chemical analysis to the concerned regional forensic laboratory. However, the chemical analysis report came negative for toxins.

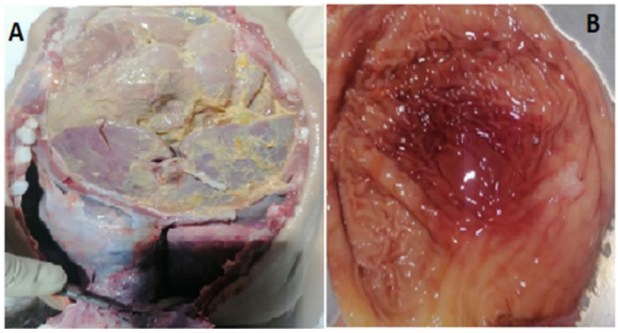

Figure 1: A- Chest and abdominal organs. B- Interior view of stomach

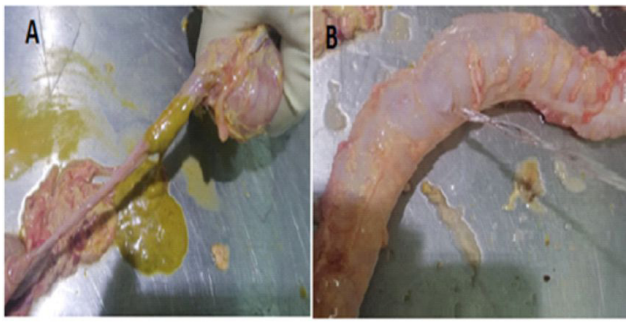

Figure 2: A- Leakage in intestine. B- Perforation site with water pressure test.

Discussion

Generally, herbal poisoning may frequently occur because of inadequate labeling and preservation, handling, overdose, and misidentification[5]. In the current report, the victim drank unknown amount of herbal solution that is used for domestic cow treatment and then her clinical features were quickly progressed in ways that she only survived 4 days after swallowing the mentioned herbal solution. Knowingly, undesirable outcomes of herbal medicines depend on the ingredients and the amount of used dose but a life threatening and rapid death consequence are clearly related to poisonous effects of the herbals[6]. In addition, Studies revealed that more than half of intensive care unit mortality is due to septic shock. Moreover, sepsis-related mortality has been estimated to raise by 7–10% in case each hour of septic treatment delay. Therefore, early detection of sepsis is quite imperative to reduce mortality and prevent unfavorable consequences[7]. For that reason, when the patient was admitted to hospital, they were immediately treated with supportive measurement and were prepared forward for laboratory investigations. The bowel injury found during conducted autopsy was related to the patient's status that she didn't have bowel motion for 3 days along with that developed colic and abdominal bloating. These conditions can lead to erosion and event perforations of stomach and intestine due to continuous exposure to acid secretion of gastric origin. Moreover, it is known that bowel perforation can be secondary inflammation, infection, obstruction and usually the patient suffers abdominal pain and distention [8]. Moving to ingredients of Aftofin, Anthocyanins reviewed to have low toxicity on ingestion and causing abdominal pain, constipation, nausea and vomiting in case of high dose exposure [9]. Nevertheless, other components such as Quercetin, Catechins, Caffeic acid, Gallic acid and Myricetin are mentioned in literature review showing no adverse side effects or toxicity properties and even they are a normal element of a wide range of daily using fruits and vegetable[3,10].Although, details in a brochure of Aftofin maker are mentioned with no any toxic components in the solution, Menthol was considered main active ingredient in the solution and on other side, it countered as toxic substance with lethal dose of 50-500mg/kg (1,10). Additionally, strong minty odor that has been sensed during autopsy is also supporting possibility of toxicity by Menthol. Furthermore, clinical feature of nausea and vomiting, abdominal pain, drowsiness, vertigo and constipation that were manifested by the patient, are observed in cases of Menthol overdose[4]. However, the results from toxicological screening were negative for toxins. But, a negative result from chemical analysis report does not rule out the toxicity. In addition, a postmortem toxicological screen result for a dead case of menthol inhalation poisoning was negative [11]. If so, the diagnosis can primarily be determined by history taking and physical examination. In particular, the only clue for diagnosis of herbal toxicity may be based on a variety of clinical signs and symptoms [12]. Finally, the author has reached a conclusion that a possible explanation for child death is due to the complications of the active constitutes of the ingested herbal solution particularly Menthol.

Conclusions

Herbal products should usually consider containing an active ingredient with highly toxic property. Therefore, their use for therapeutic

purposes, handling and preservation must be done with caution in order to avoid cases of poisoning which can sometimes have serious effect. In this case report, the 2 years old baby developed aggressive clinical course of severe gastrointestinal manifestation followed by death after the ingestion of ruminant herbal medicine. The autopsy findings revealed that delayed patient referral to emergency hospital played cruciate role in early diagnosis and intervention, which are vital for a successful treatment. Thus, it is quite significant to create awareness and educate people and health professional about this kind of poisoning.

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Conflict of interest: There are no conflicts of interest.

Ethical clearance: Since this is a case report no ethical clearance needed.

Consent for publication: taken from parents.

Funding: Not applicable

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Case Study

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Paraquat Poisoning Presenting as Sinus Bradycardia; A Rare Clinical Manifestation

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Abstract

Paraquat poisoning is a common yet fatal consequence in rural India. Usually it presents with local corrosive effects and early multi organ dysfunction involving lungs, liver and kidney. Here we present a case of a 25 years old man who presented with paraquat poisoning and developed asymptomatic bradycardia after admission. He was treated conservatively with isoprenaline drip, N-acetyl cysteine, steroids and other supportive therapy. The bradycardia recovered spontaneously and patient was discharged.

Keywords: paraquat, bradycardia, isoprenaline

Background

Paraquat is a chemical herbicide which is used quite extensively in India. But it is a highly toxic compound to human subjects and accidental exposure or suicidal attempts are often fatal even in low doses and there are delayed detrimental effects too. The mortality rate of acute paraquat poisoning has a wide variation ranging from 33% to 91% from different studies. [1]the in hospital mortality ranges from 46-55% from different studies.[2] The severity of paraquat poisoning is classified into three categories: mild, moderate-to-severe, and fulminant according to organ system involved and prognosis. Mild poisoning is characterized by local corrosive effects and minor gastrointestinal tract effects like vomiting and pain abdomen. Moderate-to-severe poisoning often leads to acute renal failure, acute hepatitis, acute lung injury, and progressive pulmonary fibrosis. Fulminant poisoning results in multiple organ failure and death within a few days.[3] Still there are gaps in medical literature regarding clinical and pathological features and under reporting of poisoning cases particularly from rural areas is a problem. We report a rare cardiac manifestation following paraquat poisoning in a medical college in north Bengal, India.

Case Report

A 25 year old male presented to the emergency department of our hospital with history of ingestion of about 30 ml of herbicide containing paraquat in

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30% concentration in a suicidal bid about 6 hours ago. He presented with shortness of breath and pain over throat, chest and abdomen. There was no history of any co-morbidity, any serious illness requiring prolonged treatment or hospitalization, psychiatric illness or recurrent self harm. On examination he was in obvious physical discomfort with oral ulcers. Vital parameters were regular pulse with rate 90/min, blood pressure 110/70 mm of Hg in both upper limbs in supine posture, temperature was normal with oxygen saturation 93% in room air. On systemic examination significantly there was epigastric tenderness, rest of the examination was within normal limits. Diagnosis was based on history and patient relatives also had a snapshot of the bottle from which the poison was consumed. Although confirmation can be done by toxicological analysis of gastric lavage it was not done in this case because of risk of further injury and perforation of the visible oral ulcers. Routine blood examination showed haemoglobin 14.1 g/dL, WBC 5700, platelet 1.2 lakh/cc, urea 10 mg/dL, creatinine 0.7 mg/dl, Na 141 mmol/l, k 4.3 mmol/l, total bilirubin 0.6 mg/dl, AST 12U/L, ALT 10 U/L. Chest x ray and ECG done during admission was normal. The following day patient developed bradycardia and hypotension. ECG showed sinus bradycardia. He was put on inotropes and 2 mg atropine was given intravenously but there was no alteration in pulse rate. The hypotension responded adequately to medication and he was put off inotropes after 24 hours. He was put on isoprenaline drip and transvenous temporary pacing was planned if patient becomes symptomatic. On further investigations echocardiography showed good biventricular systolic function and normal diastolic filling. Thyroid profile and coagulation profile was normal, NT-proBNP 163 pg/mL, CPK-MB 2.50 ng/ml. Patient was put on pulse dose of methy prednisolone 1 gram intravenously for 3 days followed by oral methyl prednisolone 16 mg for 7 days. Other supportive therapy included N-acetyl Cysteine 400 mg intravenously thrice daily, proton pump inhibitors, sucralfate, antibiotic ceftriaxone and local chlorhexidine and triamcilone application. Holter monitor was done which showed infrequent supra ventricular ectopics without any sinus pause or arrhythmia. Patient was followed up for 3 more days and gradually his pulse rate normalized and clinical and biochemical parameters were stable. So he was discharged after 5 days of hospital stay in a haemodynamically stable condition.

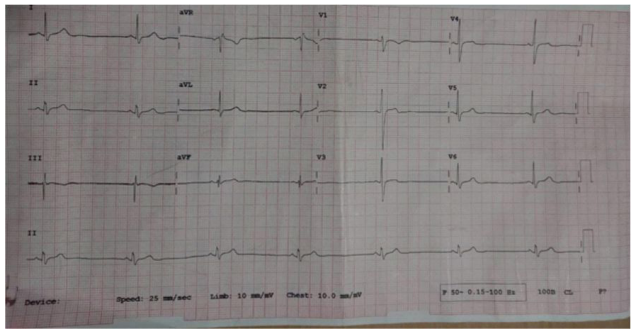

Figure 1: ECG showing sinus bradycardia

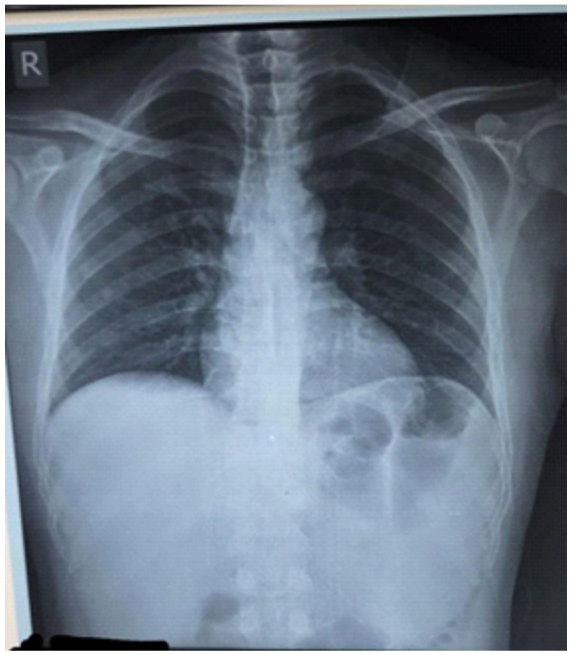

Figure 2: chest x ray on day 1 of admission

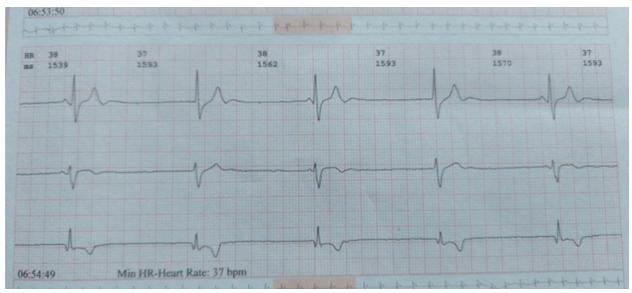

Figure 3: Holter strip showing bradycadia

Discussion

Paraquat $C_{12}H_{14}N_2C_{12}$ is a potent herbicide belonging to the dipyridyl family which is very

much in vogue in the rural agricultural set up. The pure inorganic salt is crystalline, white and odorless and commonly procured aqueous solutions which the patient ingested is red in color. It has a caustic action on biological tissues and harmful in all forms of exposure as contact poison to skin and mucous membranes, droplet inhalation along with the common mode of ingestion. [4]Ingestion is the commonest and most fatal mode with a minimum lethal dose of 35 mg/Kg. [5] Absorption occurs in the small intestine with a facilitated, saturable diffusion. In a study done on isolated stripped rat intestinal mucosa three phases of paraquat absorption were identified:- (i) a rate which was faster than diffusion (2-20 mg/ml paraquat); (ii) a rate which was slower than diffusion and obeyed saturation kinetics, with an apparent Km = 116 mM and Vmax = 11.3 mumol/g/hr, at paraquat concentrations up to 150 mg/ml: and (iii) a rate similar to that of diffusion at 200 mg/ml paraquat. Paraquat absorption at 200 mg/ml was also associated with an increase in mucosal permeability and reduction in potential difference. [6]Different hospitals have protocols to administer adsorbents like Fuller's earth, activated charcoal, bentonite to prevent this absorption. The effects are deterministic :-(1) up to 2 g of paraquat ingestion has a bimodal effect, with initial local oro-labial mucosal effects which regress after 2-3 days & simultaneous pulmonary edema or ARDS. (2) about 2-6 g of paraquat ingestion lead to mucosal lesions and within 24 hours there is ulceration and involvement of gastrointestinal tract further complicated by perforation, mediastinitis, peritonitis. Death may occur within 3-5 days due to renal dysfunction or ARDS. (3) Ingestion of >6g of paraquat leads to early multi organ dysfunction with cardiovascular collapse and a grave outcome. [7] Mechanism of cell death is due to generation of superoxide radical induced oxidative stress, depletion of protective NADPH radicals leading to lipid peroxidation, mitochondrial dysfunction and membrane degeneration.[8] Cell death may also occur through necrosis or apoptosis. Generally organs with high metabolic activity, high oxygen tension and energy requirement like lung, heart, kidney and liver are affected first with minimal cerebral involvement as paraquat doesn't cross the blood brain barrier. The deleterious effects in the lungs range from an early destructive phase i followed by a proliferative phase characterized by edema, infiltration by inflammatory cells, fibroblast deposition leading to early fibrosis. Histological evidence of multi organ dysfunction is found from acute tubular necrosis, hemorrhagic cystitis, hepatocyte, esophagogastric necrosis and frank cardiac hemorrhage. [9, 10, 11] The clinical manifestations depend on the organ system involved and mode of entry. In the commonest mode of ingestion there is local pain and swelling of the mouth. There may be serious gastrointestinal effects like nausea, vomiting, pain abdomen, diarrhea often bloody, haematemesis and melena. Respiratory manifestations are shortness of breath and cough which may progress to respiratory failure in form of ARDS and pulmonary fibrosis. Renal involvement leads to acute kidney injury in form of oliguria, haematuria and heavy proteinuria. There may be acute liver failure in form of coagulopathy, jaundice and hepatic encephalopathy. Central nervous system involvement in form of headache, encephalopathy in form of seizures and mental confusion is common. In addition, autopsy studies of patients who died of acute paraquat poisoning showed diffuse cerebral edema and deep white matter lesions, which are mainly located around the lateral ventricles and the third ventricle; and electron microscopy showed obvious brain edema, myelin damaging, microglia or astrocytes proliferation and meningitis. It is uncertain, however, whether these lesions are secondary changes of multiple organ failure or simply reflect the process of brain death. [12] So almost all systems may be involved in paraquat poisoning.

In our patient there was some local gastrointestinal tract involvement which responded to conservative measures but quite strikingly asymptomatic bradycardia which didn't respond adequately to cholinergic medications. Mechanism may be due to toxic myocarditis or sinus node dysfunction. Incidences of Paraquat poisoning presenting with sinus bradycardia are rare as per literature. The first reported case was by Song et al but the patient was later found to have hypothyroidism which was excluded in our patient [13] Myocarditis was ruled out by normal echo and normal levels of NTproBNP. Another two cases were reported in Southern India but there also patients had retroviral and hepatitis B virus infection respectively which could be a confounding factor. [14 and 15] The exact mechanism of transient sinus bradycardia in our patient couldn't be determined but as he didn't respond adequately to anticholinergic drug atropine so probably there was no shortening of atrial refractory periods which

heralds sinus node dysfunction. Now he is kept under follow up in OPD basis to see whether there is any cardiac long term effect.

The prognosis following poisoning is dismal. A previous study had determined the following factors: young age, percutaneous or inhalational route, exposure to less paraquat, and lesser degrees of leukocytosis, acidosis, and renal, hepatic, and pancreatic failures on admission as good prognostic factors of survival after acute paraquat poisoning. [16] Further studies are needed to comprehensively detect the effects and prognosis following paraquat poisoning.

Conclusion

Paraquat poisoning has a myriad of clinical presentations although the initial presentation is similar to any corrosive ingestion. Bradycardia is a rare phenomenon for this poison as tachycardia is the norm. The exact mechanism could not be understood but the conclusions were it was transient and self-limiting so caution to be exercised before proceeding with dual chamber transvenous pacing. An electrophysiology study could have been helpful to detect sinus cycle length, sinus node recovery time and atrial refractoriness but the facility is not available in our cath lab. If the patient presents with bradycardia again or similar cases are encountered EPS can be done.

Source of funding: All investigations and treatment was done with available resources in our government medical college and hospital.

Conflict of interest: There was no conflict of interest.

Consent: Patient and relatives had given consent for publication of the case.

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Case Study

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Autopsy of an Unknown Dead Person to find out Cause of Death: A Massive Cerebrovascular Accident (CVA)

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Abstract

Introduction: Intracerebral haemorrhage (ICH) is one of the lethal and most debilitating type of stroke affecting more than 1 million people globally every year. Most common cause of ICH is hypertension and responsible for about 70% of all ICH.

Case report: Sealed dead body of 45 years old unknown male brought for autopsy to find out the cause of death. Patient was admitted to district hospital with unconscious state. Status of vital at time of admission was 210/110.

Autopsy finding: No external injury was present on the body. No internal injury or abnormality seen on opening neck, chest and abdomen. Facial bone intact. No abnormality detected at scalp, cranial bone and meninges. Externals urface of brain was normal and intact. Brain was soft and congested. On sectioning of cerebral hemisphere huge hematoma of size 6.0×4.5 cm was present in deep left cerebral hemisphere.

Conclusion: Hypertension is one of the most important risk factors for ICH. ICH is a medical emergency with high chances of morbidity as well as mortality. Advancement in early diagnosis and neurocritical care have improved and increased the survival.

Introduction

Intracerebral haemorrhage (ICH) is one of the lethal and most debilitate type of stroke affecting more than 1 million people globally every year[1]. Most common cause of ICH is hypertension which is responsible for about 70% of all ICH. High blood pressure (BP) may lead to spontaneous ICH which is also known as hypertensive intracerebral haemorrhage (HICH)[2]. Incidence of ICH is more common in Asian due to poor primary care for hypertension and non-compliance[1].Hypertensive brain damage represents in various ways- associated with malignant hypertensive encephalopathy, large vessel atheroma, eclampsia, expansion and ruptured of berry aneurysm and with leukoariosis

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(diffuse white matter change)[3]. Lacunar infract and primary(non-traumatic)intracerebral haemorrhage (PICH) are 2 distinct entities of hypertensive small vessels stroke[4].Beside advancing age, high blood pressure is another important, more prevalent and treatable cause for both haemorrhagic and ischemic type of stroke. For every rise of 7.5 mm Hg increase in diastolic pressure, the chances of stroke double. Antihypertensive drug reduces the risk of stroke upto 38 %[3].

Case report

Sealed dead body of 45 years old unknown male was brought by police from district hospital to mortuary, Hind Institute of Medical Sciences, Barabanki for autopsy to find out the cause of death.Patient was admitted to district hospital with unconscious state. Status of vital at time of admission was 210/110. Patient expired within 3 hours after admission to the hospital.

Autopsy finding: Autopsy was performed at mortuary, Hind Institute of Medical Sciences, Barabanki. The body was that of an average build male, of age 45 years having weight 43 Kg and height 168 cm. Rigor mortis was passed off. Post-mortem lividity was present on the back and dependant parts of the body in supine position. Greenish discoloration over right iliac fossa. Since body was placed in freezer so no other decomposition seen. Both eyes were open with shrunken eyeball.Mouth was closed. No abnormality detected at natural orifices.

External finding: No external injury was present on the body.

Internal finding: No internal injury or abnormality seen on opening neck, chest cavity (right chamber of heart was filled with blood whereas, left chamber was empty. No abnormality seen in heart) and abdominal cavity.

Head: Facial bone intact. No abnormality detected at scalp; cranial bone was intact. On opening cranial cavity no abnormality or haemorrhage detected in meninges. No abnormality or haemorrhage detected in meningeal space. External surface of brain was normal and intact. Brain was soft and congested (Figure 1).On sectioning of cerebral hemisphere huge hematoma of size 6.0 cm ×4.5 cm (Figure 2) was present indeep left cerebral hemisphere at basal ganglion extending to involve putamen and internal capsule. Since there were no external and internal injuries except deep intracerebral bleed, it makes the diagnosis of intracerebral haemorrhage most probably due to hypertension. So, cause of death in this autopsy was coma due to antemortem intracerebral haemorrhage.

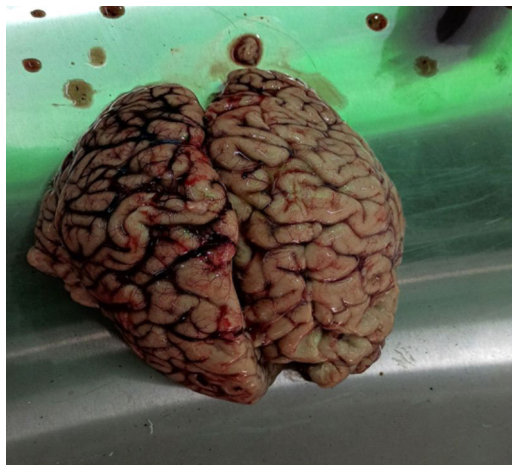

Figure 1. Intact and congested brain

Figure 2. Massive Intracerebral Hematoma visible on deep left cerebral hemisphere on sectioning brain

Discussion

Most common etiology for intracerebral haemorrhages is hypertension. Most common anatomic sites for hypertensive ICH are basal ganglion, putamen, lobar white matter, thalamus, pons and cerebellum. Other non-hypertensive cause of ICH is neoplasm, arteriovenous malformation, familial cerebral amyloid angiopathy, DIC, drugs, haemophilia and thrombocytopenia[5]. In our case report location of intracerebral haemorrhage was present in deep left cerebral hemisphere at

basal ganglion. In various studies it was observed that incidence of ICH was twice higher in Asian population than other ethnicities such as Indian, Black, Hispanic, White, Maori. Incidence of ICH was 15 % higher in males than females. Incidence of ICH increased strongly as age advances. Risk of ICH was ten-fold higher in person having age 85 years and above than person having aged 45 to 54 years[6]. One study reported that males were affected more than twice than female with greatest occurrencein male is seen in age group 41-50 years. This was similar with age of the subject in our study. Suspicion of ICH in a patient may arise when there is severe headache, vomiting, high blood pressure especially systolic blood pressure or reduced level of consciousness. Rapid and early diagnosis is key step for appropriate and good functional outcome. Due to expansion of hematoma early deterioration is common in first few hours after onset of ICH. Non contrast CT (NCCT) scan head is very sensitive and specific for early diagnosis of ICH. NCCT scan of head will also reveal mass effect, intraventricular expansion and early sign of herniation. CT angiogram is highly sensitive for any vascular abnormalities. Repeat imaging study is recommended for the evaluation of any neurological deterioration or follow-up of vascular abnormality or underlying lesion[1,7,8,9]. Intracranial haemorrhage is a medical emergency which requires urgent and rapid therapy. Urgent medical treatment during first few hours decreases Glassgow Coma Scale (GCS) of 2 or more point in more than 20% of patients and restrict haematoma expansion and neurological decline among 15-23% of patient. Maintenance of airways, breathing and circulation is crucial steps for complications from hypertension, hypoxaemia and haematoma expansion. Airways protection by intubation is indication in patient with significant respiratory distress or GCS <8[1].

Most of the patient of ICH have significantly high blood pressure. High systolic blood pressure contributes to expansion of haematoma, neurological deficit and poor outcome following ICH. Intensive lowering down systolic blood pressure below 140 mm Hg is protective and without any associated side effect. Early intensive lowering of blood pressure is associated with improved functional outcome in patient of ICH[1]. Coagulopathy is associated with expansion of haematoma and poor neurological outcome and even death. Rapid correction of coagulopathy is recommended in every potentially curable patient[10].ICH increases 16% risk of clinical seizures among the patient within first week and with greater part occurring at or near onset of ICH. Most important risk factor for seizure is lobar ICH with cortical involvement. Antiepileptic medication should be used for clinical seizures[1].

ICH is one of most lethal type of stroke and its outcome is depending on several factors such as location and size of haematoma, expansion of haematoma, GCS score, age, ventricular involvement and anticoagulant use. Many studies demonstrate that support withdrawal and do not resuscitate orders during first day of admission are independent predictor of poor outcome. American Heart Association recommended early and aggressive patient care after ICH[1,11,12,13].

Conclusion

Intracerebral haemorrhage (ICH) is caused by several predisposing risk factors and etiologies. Hypertension is one of the most important risk factors for ICH. Other important risk factor for ICH isfamilial cerebral amyloid angiopathy. ICH is a medical emergency with high chances of morbidity as well as mortality. Advancement in early diagnosis and neurocritical care have improved and increased the survival. New imaging technique in future may be assessed for their ability to identify the person at greater risk of ICH. Progressive research into prevention and adequate treatment may act as key role in reducing burden of ICH and ameliorating functional recovery.

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Informed consent: Not required since the deceased was unknown. Permission was taken from the department for publishing.

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Case Study

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A Death too Fast - Suxamethonium Chloride Poisoning: A Case Report

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Abstract

Introduction: Suxamethonium chloride (SUX) is a short acting depolarizing muscle relaxant commonly used for medical procedures to induce respiratory paralysis. The case report aims to highlight the important postmortem findings associated with SUX poisoning.

Case report: A female adult health-care worker in her thirties was found dead in her bedroom at home. There were two empty ampoules of IV/IM Suxamethonium Chloride 100 mg/2 ml found next to the body.

Results: The autopsy revealed an adult female with multiple needle injection marks. Gross examination of the lungs showed markedly congested lungs and froth in the airways. The liver showed foci of petechial haemorrhages and confluent haemorrhages. Other internal organs showed diffuse vascular congestion. Microscopically, significant pathological changes were seen in the lungs and kidneys with areas of pulmonary infarction and acute tubular necrosis. SUX was not detected from the toxicological analysis. Correlating the circumstantial evidence at the scene of death, autopsy and microscopic findings, the cause of death was certified as SUX poisoning.

Conclusions: We wished to demonstrate the autopsy and histopathological findings associated with acute SUX poisoning culminating in death due to respiratory paralysis.

Keywords: Suxamethonium chloride; Muscle relaxant; Poisoning; Autopsy

Introduction

Suxamethonium chloride (SUX) is a short-acting anticholinergic neuromuscular blocking agent commonly used as an anaesthetic agent in medical setting. As a muscle relaxant, its use will result in respiratory paralysis which will in turn be compensated by mechanical ventilation.[1,2] A

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therapeutic dose of SUX may result in apnea and death in the absence of mechanical respiratory support.[1,2]

In forensic casework, anaesthetic agent misuse by the manner of homicide or suicide is rarely encountered. As such, SUX poisoning as a result of intentional self-harm purposes usually involved health-care workers (HCW).[1,3] While death was usually fast, data regarding pathological findings and SUX analysis from the postmortem samples were insufficiently published.[1] In this case report, we wish to highlight the important postmortem findings associated with SUX poisoning. Unfortunately, this case also involved a HCW who had access to the medication and based on the police investigation, the circumstance surrounding the death was intentional self-harm.

Case presentation

A female adult in her thirties was found unconscious and unresponsive in her bedroom. She was single and staying with family members. In the fateful night, her elder brother noticed that she was quiet when she got home from work and immediately went to her bedroom. Later, when she did not join the family for dinner, he knocked on her bedroom door. As there was no response, he forced open the door and found her lying in bed with needles and syringes strewn next to the body. There were two empty ampoules of IV/IM Suxamethonium Chloride 100 mg/2 ml found next to the body (Fig. 1A). Death was pronounced at the scene by a paramedic team responded to the distress call. The body was brought to the Forensic Department for a medico-legal autopsy. At the mortuary, preliminary history obtained from the next-of-kin showed that she had no underlying medical illness.

Results

Autopsy findings

Autopsy showed an obese adult female, measuring 156 cm in length and 99 kg in weight, with body mass index of 40.7 kg/m^2. The face was markedly congested. The pupils were fixed and dilated. The conjunctiva was also distinctly congested. Blood-stained fluid was noted emanating from the nostril. The nail beds of both the fingernails and toenails showed prominent bluish discolouration. Multiple needle injection marks were present at the upper limbs; two at the dorsum of the right hand, two at the right wrist, nine at the dorsum of the left hand, three at the left wrist and one at the left antecubital fossa. All the injection marks were accompanied by large surrounding bruises, ranging from 2 x 3 to 3 x 4.5 cm (Fig. 1B). Multiple linear, horizontal scars at the anterior aspect of both forearms were observed. Urinary and fecal incontinence were present.

Internal examination showed an intact skull with normal brain anatomy. The cerebral blood vessels were congested. The internal thoracic organs showed normal heart weight of 290 gm. The left anterior descending coronary artery showed an intramyocardial bridging of 3 mm depth. There was no evidence of past or recent ischaemic change of the myocardium. The major tributary of the coronary arteries showed patent lumens. The right and left lungs weighed 455 gm and 355 gm respectively. Both lungs were markedly congested (Fig. 1C). Serial cut sections of the lungs showed vascular congestion and oedema bilaterally (Fig. 1D). The tracheal showed blood-stained froth, in keeping with pulmonary oedema. There was no apparent area of infarction or haemorrhage noted on gross inspection. Examination of the other internal organs such as the spleen, kidneys, and intestines generally showed vascular congestion. The liver showed scattered petechial haemorrhages of the surface, with large area of prominent yellowish discoloration and confluent petechial haemorrhages at the inferior surface of the left lobe (Fig. 1E).

Postmortem blood specimen was obtained for laboratory investigations, however, there was no urine sample available for collection during autopsy. Forensic toxicology analysis from the blood sample showed presence of ethyl alcohol 212 mg/100 ml. Common drugs were not detected.

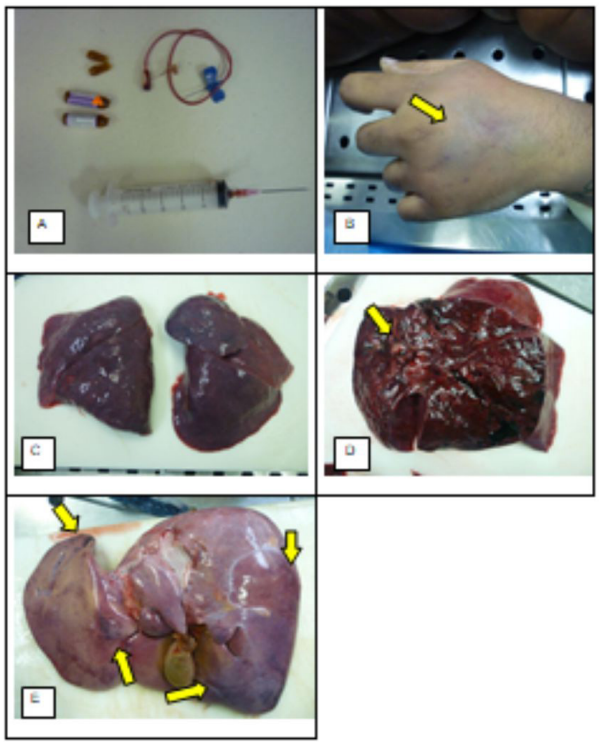

Fig. 1A Medical apparatus found at the scene; a syringe with needle, a butterfly needle and two empty ampoules of Suxamethonium Chloride 100 mg/2 ml. B Needle puncture marks with swollen haematoma at the back of the left hand (yellow arrow). C Markedly congested lungs. D Cut sections of the left lung shows diffuse vascular congestion with froth within the airways (yellow arrow). EInferior surface of the liver shows prominent yellowish discolouration at the left lobe with scattered areas of confluent petechial haemorrhages (yellow arrows).

Microscopic findings

Representative tissue samples from the brain, heart, lungs, liver, kidneys, and spleen were obtained for microscopic examination. Routine hematoxylin and eosin (H&E) staining showed non-specific changes such as marked vascular congestion,liver steatosis and acute tubular necrosis (Fig. 2). Significant pathological changes were discovered in the lungs, as it showed areas of pulmonary infarction, in the background of prominent congestion and oedema (Fig. 3).

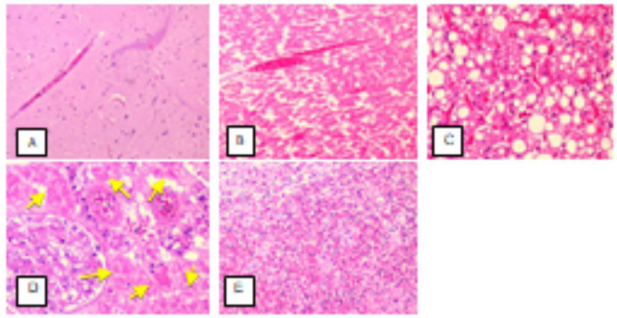

Fig. 2 Histological findings in the brain (A), heart (B), liver (C), kidney (D) and spleen (E) showing congestion. Other findings seen in the liver and kidney include fatty changes and acute tubular necrosis (yellow arrows).

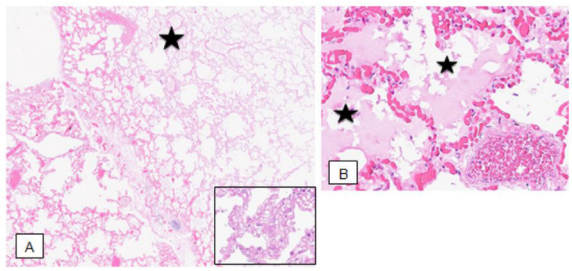

Fig. 3A Histology findings of the lungs showing features of infarction (black star) with pneumocyte ghost cells (inset). B Pulmonary oedema (black stars) with marked vascular congestion of the alveolar capillaries and blood vessels.

Correlating the circumstantial evidence at the scene of death, autopsy findings and the microscopic examination result, the cause of death was certified as suxamethonium chloride poisoning. In our opinion, SUX had been introduced into the body at more than commonly prescribed dosage, therefore causing respiratory paralysis and death.

Discussion

SUX is a nicotinic acetylcholine (ACh) receptor agonist which resembles the endogenous neurotransmitter ACh. Its function at the postsynaptic ACh receptors in the skeletal muscle will cause depolarization of the endplate membrane, causing paralysis.[1,4] As a short-acting muscle relaxant, it has rapid onset, short duration of action and also fast recovery. Therefore, it is usually used

in medical procedures requiring rapid muscle relaxation such as endotracheal intubation and as an adjunct to general anesthesia during surgery.[1,5,6] SUX is usually presented in 20 mg/mL or 100 mg/mL injectable solutions. The usual dosage for intravenous loading dose is between 0.3-1.1 mg/kg and for intramuscular loading dose is 3-4 mg/kg.[4,5] There was no documented lethal level of SUX or its metabolites from blood or urine samples. However, a fatal intoxication case reported that 8.1 μg/ml SUX present in the urine.[7] After absorption into the body, SUX cannot be metabolized effectively and results in continuous muscle fibre depolarization, causing paralysis.[6] Therefore, its side effects include apnea, bradycardia, tachycardia, hypotension, hypertension, hyperkalemia and hyperthermia.[5]In this case report, two empty ampoules of SUX 100mg/2mL were found with the deceased in which an estimated 200 mg of SUX had been introduced into the body. The recommended dosage for her body weight was between 29.7 mg to 108.9 mg. The injection of 200 mg was more than doubling the recommended dose and unsupported by mechanical ventilation, fatal outcome was inevitable.

Upon administration of SUX, paralysis occurs about 1 minute after the injection and lasts for approximately 7 to 12 minutes. The paralysis which persists, may inhibit respiratory function, leading to ischaemia and hypoxia of the brain.[1,6] Acute SUX poisoning may cause death in less than 30 minutes after the injection.[1] In general, acute SUX poisoning have non-specific features at autopsy. The main pathological changes include haematoma at the injection site, visceral congestion, severe pulmonary oedema and petechial haemorrhages at the heart and lungs.[1] Cerebral oedema with features of ischaemic neurons may also be present. The internal organs such as the liver, spleen, kidneys and intestines usually show varying degrees on congestion.These features are in keeping with apneaas a result of prolonged respiratory paralysis.[1]

In this case, most of the autopsyfindings were in keeping with the previous reports. The external examination showed large bruises at the injection sites. The internal organs showed marked vascular congestion. The lungs showed pulmonary oedema and congested blood vessels. Microscopically, acute pulmonary infarction was seen, most likely contributed by the respiratory paralysis. Prolonged ischaemia of the kidneys resulted in acute tubular necrosis. These features were not reported in the literature.

Suxamethonium chloride toxicity is difficult to establish due to its quarternary structure and high hydrolytic susceptibility. The detection window in blood is within 10 minutes after injection, while its metabolite, succinylmonocholine (SMC) can still be observed within 6 hours. In freshly excreted urine, it is still detectable within 2 to 6 hours.[8]Therefore, SMC analysis from urine sample has the best chance to confirm a diagnosis of SUX poisoning. In this case, only postmortem blood sample was available for analysis and SUX or its metabolite was not detected. The negative result was not unexpected as the body was received at the mortuary approximately 7 hours after her demise and the blood sample was collected during postmortem examination, approximately 37 hours of postmortem interval. According to the detection window, SUX and its metabolites would have been fully degraded by then.

Conclusions

On hindsight, the cause of death in this case was elusive. Vital evidence was obtained from the scene of death and autopsy findings. In this case report, we wished to demonstrate the autopsy and histopathological findings associated with acute SUX poisoning. Respiratory paralysis was unmistakably the causative factor leading to acute pulmonary infarction and death.

Ethical Considerations

Compliance with ethical guidelines

We seek for waiver of ethical review and approval since the data was observatory in nature and the research involved no risk to the deceased subject. Consent for publication could not be obtained because the next-of-kin was uncontactable.

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Data collection and analysis: All authors; Original draft writing: All authors; Review and editing: Razuin.

Conflict of interest: The authors declared no conflict of interest.

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Case Study

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Acyclovir Induced Stevens-Johnson Syndrome and Toxic Epidermal Necrolysis: A Rare Case Report

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Abstract

Stevens-Johnson Syndrome and Toxic Epidermal Necrolysis are serious, life-threatening conditions often triggered by drug reactions, characterized by widespread skin detachment and mucosal involvement. This case report describes a 29-year-old woman who developed Stevens-Johnson Syndrome and Toxic Epidermal Necrolysis after receiving prophylactic acyclovir for suspected herpes. The patient initially presented with oral ulcers that rapidly progressed to widespread blisters, ulcers, and severe skin peeling. A thorough diagnostic evaluation, including skin biopsy and the Naranjo algorithm, identified acyclovir as the causative agent. The patient was managed in intensive care with intravenous methylprednisolone 500mg per day for 3 consecutive days as pulse therapy, antibiotics, and other supportive treatments. This case underscores the importance of early recognition, prompt discontinuation of the offending drug, and a multidisciplinary treatment approach. It also highlights the critical need for heightened awareness among healthcare professionals regarding the potential for severe adverse reactions with commonly used medications like acyclovir, to improve patient safety and outcomes.

Keywords: Stevens-Johnson Syndrome, Toxic Epidermal Necrolysis, Acyclovir, Adverse Drug Reaction.

Introduction

Stevens-Johnson Syndrome (SJS) and Toxic Epidermal Necrolysis (TEN) are severe, life-threatening conditions primarily caused by drugs, characterized by extensive skin detachment and mucosal involvement. SJS and TEN occurs at a rate of 1 to 6 and 1 to 2 cases per million annually.[1]The epidemiology of SJS/TEN highlights regional differences in drug associations and genetic risk factors. In Southeast Asia, aromatic anticonvulsants cause over 50% of cases, with carbamazepine alone responsible for 25-33%, compared to only 5-6% in Europe. The HLA-B*15:02 allele, a genetic variant of the Human Leukocyte Antigen (HLA) system commonly found in Southeast Asians but rare in Europeans and Africans, explains this higher risk. Strontium ranelate, associated with HLA-A*33:03 and HLA-B*58:01, also shows regional variation in drug-induced SJS/TEN.[2] In India, the incidence of SJS/TEN is unknown, but it accounts for 6.84% of severe Cutaneous Adverse Drug Reactions (CADR).

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Mortality rates are 12.94% overall, with drugs causing 97.14% of cases. The leading causes are antibiotics, anti-epileptics, and NSAIDs. Ocular complications occur in 40.29% of acute cases, with 60% of chronic cases leading to low vision or blindness.[3] Although antiviral agents like acyclovir are generally well-tolerated with a low incidence of adverse effects, such as mild nausea and headache, rare but serious complications like encephalopathy and seizures can occur, especially with high doses.[4] Despite its overall safety profile, there have been rare reports of fatal cases of SJS/TEN induced by acyclovir.

SJS/TEN often begins with nonspecific symptoms such as fever, sore throat, and general malaise, followed by the rapid development of painful mucocutaneous lesions that can affect the eyes, mouth, and genitals.[5]Diagnosis primarily depends on clinical assessment rather than histopathology. Effective management involves promptly identifying and discontinuing the causative agent, using tools such as the ALDEN (Algorithm of Drug Causality for Epidermal Necrolysis) algorithm for drug causality and the SCORTEN (Severity-of-Illness Score for Toxic Epidermal Necrolysis) scale for prognosis.[6] ALDEN is a specific tool developed to improve the individual assessment of drug causality in SJS/TEN. It categorizes drug involvement as "very probable", "probable", "possible" or "very unlikely" based on multiple criteria, including drug notoriety, pharmacokinetics, and temporal relationship.[7] The SCORTEN tool is used to predict mortality and severity in SJS/TEN patients. It should be calculated within 24 hours of admission and on the 3rd day, with some suggesting a reassessment on day 5. SCORTEN identifies seven risk factors, each scored as one, with mortality rates increasing with higher scores. SJS/TEN has high mortality rates: 1–5% for Stevens-Johnson syndrome, 10–15% for transitional forms, and 25–30% for toxic epidermal necrolysis. Death is most commonly due to sepsis, pulmonary failure, and multiple organ failure.[8]In addition to these diagnostic methods, the Naranjo's Adverse Drug Reaction causality assessment scale[9] and the causality assessment scale provided by the WHO-Uppsala Monitoring Centre also play a crucial role in evaluating drug-related adverse events, offering standardized approaches to determine the likelihood of a causal relationship between a drug and the observed adverse effects.

The initial management of SJS and TEN centers on promptly discontinuing the causative drug, ensuring hospital admission, and addressing any co-morbidities. For severe cases, intensive care or burn unit admission is recommended. Wound care focuses on preventing infection and preserving skin, with varying approaches across centers. Fluid and electrolyte management is crucial due to risks similar to burn victims. While the use of corticosteroids remains debated, cyclosporine shows promise, and other treatments like IVIg and TNF-α inhibitors are under investigation for severe cases.[10]

This case report presents information about a rare and severe case of acyclovir induced Stevens-Johnson Syndrome and Toxic Epidermal Necrolysis.

Case Presentation

A 29-year-old married female presented with chief complaints of blisters and ulcers all over the body for the past 6 days, which initially started as an oral ulcer. The vesicular lesions first appeared on the right upper limb and then spread across the body after the intake of drug therapy for suspected chicken pox. She was immediately admitted to the emergency department and was administered intravenous dexamethasone at a dosage of 8 mg. In addition, she received a combination of 2 units of Ringer's Lactate and 1 unit of Normal Saline, infused at a rate of 75 mL/hr. For immediate relief of symptoms, a single dose of 10 mg cetirizine tablet was also given. Following this initial treatment, she was transferred to the Intensive Care Unit for further management and was subsequently evaluated by a dermatologist. She had a past medical history of a small vesicle on her neck, for which she consulted a doctor who prescribed tablet Acyclovir 500 mg twice daily as a prophylactic treatment for suspected herpes. After administration offirst dose, she developed blisters and ulcers around her mouth and other areas of her body. Despite the worsening condition, she continued the drug, which led to a significant increase in symptoms. By the sixth day, she experienced severe skin peeling throughout her body.

On examination, the patient was conscious, oriented, and febrile. Local examination showed a widespread skin rash, blisters, sores over the face and hands, and swelling and crusting of the mouth and

mucosal membranes. Systemic examination and vitals were found to be normal. Laboratory investigations revealed a normal WBC, RBC, hemoglobin, hematocrit, MCV, MCHC and platelet count. Differential counts show an increased neutrophils of 75.1% and a decreased lymphocyte of 17.8%. All others are found to be normal. Other findings such as RBS, electrolytes, LFT and RFT were found to be normal. Peripheral smear showed mild neutrophilic leukocytosis with massive thrombocytosis. CRP was positive at 96 mg/dL, indicating inflammation. Urine routine showed no albumin or sugar, with 1-2 pus cells suggesting infection or inflammation. HIV test was negative. Lipid profile revealed elevated triglycerides (376 mg/dL) and VLDL of 75 mg/dL, with a lowered HDL of 36 mg/dL. ECG, ECHO and USG was found to be normal.

Dermatological examination revealed generalized hyperpigmentation with islands of sparing, multiple bullae, and vesicles of varying sizes ranging from 2x2 cm to 5x4 cm distributed across the body. Multiple erosions were noted on the genital area and upper limbs, along with oral and lip erosions. The palms and soles showed pigmentation, and similar pigmentation was observed in the genital area. The histopathological examination of the skin biopsy revealed extensive epidermal necrosis, accompanied by basal vacuolar degeneration and a prominent lymphohistiocytic infiltrate within the dermis, reflecting a significant inflammatory response. (Fig.2) Following all examinations and investigations, an ADR causality assessment was conducted to establish a precise diagnosis. The Naranjo algorithm was utilized, resulting in a score of 11, which classified the case as a "definite" drug-induced reaction. This strongly suggested acyclovir as the causative agent for SJS/TEN.Based on the prognostic factors, a SCORTEN score of 1 was found which indicates a 3.2% mortality risk for SJS/TEN. Furthermore, the WHO-Uppsala Monitoring Centre criteria indicated a 'probable/likely' causality, supporting the diagnosis of acyclovir-induced SJS. The clinical presentation and timing of symptom onset relative to drug administration, combined with the absence of any prior history of drug allergies or hypersensitivity, confirmed this as a first-time hypersensitivity event.

After being transferred to the ICU, the patient's treatment was revised, discontinuing dexamethasone 8 mg IV and initiating piperacillin-tazobactam 4.5 g IV three times daily, methylprednisolone 500 mg IV in 1 unit of 5% dextrose over 2 hours only for 3 consecutive days as pulse therapy, and ranitidine 50 mg IV twice daily.[8] Additional medications includedtablet paracetamol 500 mg three times daily, tablet chlorpheniramine maleate 4 mg at bedtime, povidone-iodine ointment, saline-soaked dressings, and B-complex, vitamin C, and calcium tablets for 7 days. On the third day, 0.1% betamethasone ointment was added; on the fourth day, an injection of Astymin Forte was given, and liquid paraffin was started. On the same day an ophthalmologist's examination was done which revealed both eye lagophthalmos, leading to the prescription of Lacryl-PF gel for twice daily and lid taping at bedtime. On the sixth day, the patient had a seizure with fever, chills, and rigor, prompting the initiation of levetiracetam 500 mg IV twice daily and the resumption of dexamethasone 8 mg IV once daily. On the seventh day, the patient was transferred to the Female Medicine Ward.

Fig. 1: Clinical presentation of SJS/TEN during admission showing (A) Extensive lesions on the face, (B) erythematous patches on the forearm, (C) pigmentation on the palm, and (D) widespread epidermal detachment on the dorsal portion of the body.

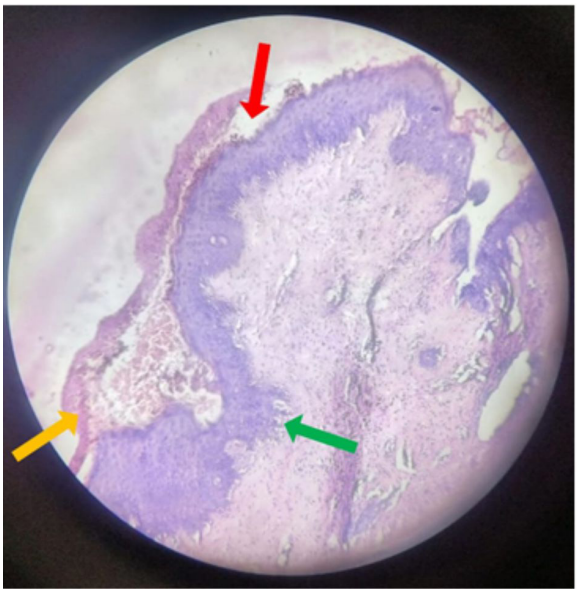

Fig. 2: Skin biopsy showing extensiveepidermal necrosis (⇑) with basal cell vacuolar degeneration (⇑) and a prominent intraepidermal bulla (⇑), indicating a significant inflammatory response.

Fig. 3: One week after pulse therapy showing (A) healing lesions on the face with reduced erythema and (B) significant recovery on the forearm with fading pigmentation and re-epithelialization.

Discussion

The intricate pathophysiology of Stevens-Johnson syndrome (SJS) and toxic epidermal necrolysis (TEN) underscores the complexity of immune-mediated skin disorders. These conditions are characterized by widespread keratinocyte apoptosis, primarily driven by cytotoxic T cells through mechanisms such as perforin-granzyme and Fas-FasL pathways, alongside the role of granulysin, a potent cytolytic protein. Additionally, metabolic factors like slow acetylation contribute to the disease by generating reactive metabolites that can provoke severe immune responses. The impact of genetic susceptibility is evident, with specific HLA alleles being strongly linked to drug-induced SJS-TEN, particularly within certain ethnic groups. Furthermore, variations in drug metabolism genes, such as CYP2C9, can influence disease severity by impairing drug clearance and exacerbating toxicity.[11]

Clinical presentation in this case included widespread erythematous lesions, blistering, and mucosal involvement after intake of acyclovir, which are hallmark features of SJS. The dermatological findings, combined with systemic involvement, highlight the severity of the condition and the importance of early diagnosis and intervention. The rapid onset of these symptoms following drug intake strongly implicates tablet acyclovir as the causative agent. To assess the likelihood of this adverse drug reaction, the Naranjo algorithm was employed, which is a systematic tool used to determine the probability of drug-induced adverse effects. The patient's case was classified as a "definite" drug-induced Stevens-Johnson Syndrome (SJS) with a Naranjo score of 11, signifying a high likelihood that acyclovir was responsible for the reaction. Also, causality assessment indicated a 'probable/likely' relationship based on the WHO-Uppsala Monitoring Centre criteria. Given the clinical presentation and the timing relative to drug administration, a diagnosis of acyclovir-induced SJS was confirmed. Notably, the patient had no prior history of drug allergies or hypersensitivity reactions, suggesting this was a first-time hypersensitivity event. The clinical presentation and rapid onset of symptoms in this case align with findings by *Sen et al.*,[12] and *Gungam P et al.*,[13] who reported with similar features of SJS and TEN associated with acyclovir diagnosed by using Naranjo's and WHO's causality assessments.

Acyclovir, a synthetic analogue of guanosine, is commonly used to treat infections from herpes simplex and varicella zoster viruses. While it is usually well-tolerated, some individuals may experience adverse drug reactions. These rare side effects can include mild issues like inflammation at the injection site and phlebitis, as well as more serious conditions such as bullous reactions, acute renal failure, neurotoxicity, and, in exceptional cases,

Stevens-Johnson syndrome.[12] This underscores the importance of careful monitoring during acyclovir therapy to promptly identify and manage any unexpected reactions.

The management of SJS and TEN centers on the immediate discontinuation of the suspected drug, though identifying it can be challenging. Key aspects of care include supportive measures such as skin barrier restoration, fluid management, and infection control. While systemic treatments like cyclosporine show potential outcome, they lack conclusive evidence. Treatment varies with skin involvement, and long-term complications may include pigmentation changes and scarring.[8] The pulse therapy of SJS/TEN involves administering 500 mg/day of intravenous methylprednisolone for 3 consecutive days. If no new mucocutaneous lesions develop, oral prednisolone is initiated and gradually tapered.[14] Likewise, in this case the patient received pulse therapy with 500 mg of intravenous methylprednisolone for 3 consecutive days which is an important aspect in reversing this condition. This tailored regimen balanced effective treatment with minimizing side effects, considering the patient's clinical condition.

Comprehensive care involves addressing ocular, gynecologic, oral, respiratory, renal, gastrointestinal, and hepatic complications through a multidisciplinary approach. Nutritional support is critical, with nasogastric or parenteral nutrition often needed. Physical and occupational therapy are crucial for long-term recovery, while pain management and social work support are essential for addressing acute and chronic needs. Effective risk communication and coordinated care planning are vital for patient education and follow-up.[15]

Therefore, this case highlights the critical need for vigilant monitoring of patients receiving acyclovir due to its potential to induce severe adverse reactions such as SJS. Healthcare professionals must exercise heightened awareness when prescribing acyclovir, particularly in individuals with a history of hypersensitivity or those at higher risk. It is essential to monitor for early symptoms of SJS and to educate patients on recognizing these signs promptly. Effective patient education, coupled with early detection and intervention, is crucial for managing and mitigating the impact of such severe reactions, thereby improving overall patient safety and outcomes.

Conclusion

In conclusion, this case underscores the importance of careful monitoring when prescribing acyclovir, despite its general safety. The potential for severe adverse reactions like Stevens-Johnson syndrome (SJS) highlights the need for prompt recognition and swift discontinuation of the offending drug. Healthcare professionals must remain vigilant, educate patients on early symptoms, and ensure a coordinated care approach to manage and reduce the risks of such serious complications, ultimately enhancing patient safety and outcomes.

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Ethical Clearance: A written informed consent was taken from the patient and is available on request.

Conflicts of interest statement: Authors declare no conflict of interest.

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Case Study

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Fatal Paraquat Poisoning: A Case Report

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Abstract

Paraquat, a widely used herbicide, is notorious for its high toxicity and limited antidotal options. This case report details the clinical presentation, management strategies, and outcomes of a patient with paraquat poisoning. A 32-year-old male presented to the emergency department with a history of intentional ingestion of paraquat. The patient exhibited signs of acute toxicity, including gastrointestinal distress, respiratory distress, and multi-organ failure. Prompt recognition and initiation of treatment were crucial in navigating the complex clinical course. The treatment protocol involved aggressive decontamination, administration of activated charcoal, and utilization of specific antidotes such as cyclophosphamide and methylprednisolone. The patient received supportive care, including mechanical ventilation and hemodynamic support. Continuous monitoring of renal and hepatic functions was implemented to detect and manage complications promptly. Despite the aggressive therapeutic approach, the patient faced significant challenges, with progressive deterioration of respiratory and renal functions. The case highlights the limited efficacy of current treatment modalities in severe paraquat poisoning. The patient eventually succumbed to multi-organ failure, underscoring the need for further research to explore alternative interventions. Paraquat poisoning remains a significant clinical challenge with high mortality rates. This case report emphasizes the importance of early recognition, aggressive decontamination, and advanced supportive care in managing paraquat toxicity. Further research is imperative to explore novel treatment strategies and improve outcomes in cases of severe paraquat poisoning.

Keywords: Paraquat, herbicide poisoning, toxicology, antidote, multi-organ failure.

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Introduction

Paraquat (1,1-dimethyl-4, 4'-bipyridylium dichloride) is a broad-spectrum, contact herbicide extensively utilized in agricultural sectors globally [1]. In humans, paraquat is extremely toxic, with an estimated lethal dose ranging from approximately 3 to 6 grams of paraquat ion for adults [2]. The primary route of poisoning typically occurs through ingestion, whether intentional or accidental, of the concentrated solution [2,3].Dermal exposure, particularly in individuals with pre-existing skin lesions, has been documented to lead to severe paraquat poisoning. Inhalation of sprayed paraquat solution typically causes local irritation with minimal systemic absorption [3]. Upon ingestion, approximately 20% of paraquat is absorbed by the gastrointestinal tract, with higher absorption rates noted in the presence of ulcerated mucosa or an empty stomach [4]. Paraquat undergoes minimal metabolic processing in the body, with over 90% excreted unchanged by the kidneys. [4] At the tissue level, paraquat undergoes reduction to paraquat radicals in the presence of reduced nicotinamide adenine dinucleotide phosphate (NADPH) [5]. Subsequently, these paraquat radicals interact with oxygen molecules, leading to the production of superoxide anion (O2 –) [6]. Excessive levels of superoxide anion facilitate the formation of hydroxyl free radicals (OH–), which have the potential to induce cellular damage through processes such as lipid peroxidation and inhibition of crucial cellular enzymes [6]. This mechanism elucidates why the lungs are particularly vulnerable to paraquat poisoning, as they exhibit high tissue concentrations resulting from active uptake mechanisms and abundant oxygen availability, facilitating the formation of reactive oxygen radicals [6,7]. Between 1985 and 1990, approximately 340,000 cases of agricultural and horticultural poisoning were reported in the United States, resulting in 97 deaths. Although paraquat poisoning comprised only 0.34% of these cases, it had the highest mortality rate, responsible for 13% of all fatal cases [8,9]. In Indian scenario, at a tertiary care institute, Household and agricultural poisons together make up the majority (approximately52%) of the substances found in suspected poisoning cases [10].

Case Summary

The patient presented with worsening epigastric discomfort, severe dysphagia, and progressing shortness of breath in the Department of Emergency Medicine at a tertiary care hospital, in North India. The attendant gave history of ingestion of approximately 20 ml of paraquet which had 250gram of paraquet dichloride in one liter. A chest radiograph at the outset of symptoms showed bilateral infiltration (Figure-1). Blood chemistry indicated elevated levels of blood urea nitrogen, creatinine, and liver enzymes. Arterial blood gas values demonstrated respiratory acidosis. Oxygen supplementation at 10 liters per minute by non-rebreathing mask was required to maintain saturation levels above 88%. By the second day, the chest radiograph depicted bilateral infiltrate showing ARDS and lung ultrasound showed Shred sign (lung consolidation) and B-line (pulmonary edema) (Figure-2). The patient's condition deteriorated, necessitating intubation and mechanical ventilation. Renal function declined, prompting the initiation of hemodialysis. Despite intervention, multiple-organ failure ensued, culminating in death on the fourth day post-admission.

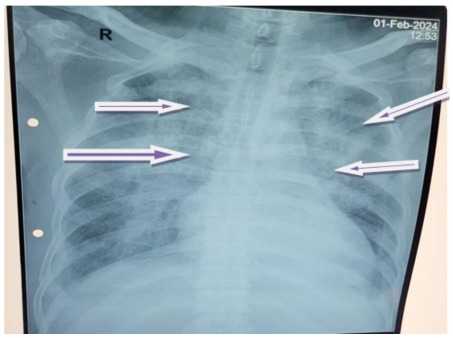

Figure-1: Chest radiograph at the outset of symptoms showed bilateral infiltration (arrow).

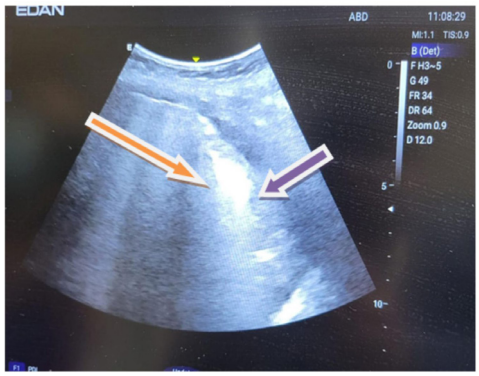

Figure-2: Shred sign (lung consolidation- yellow arrow) and B-line (pulmonary edema- green arrow) in lung ultrasound

Diagnosis: Based on the information provided by the patients' attendants and the observed clinical features, a tentative diagnosis of paraquat poisoning was established.

Treatment: The 32 year male patient arrived at the emergency department, after 4 hour of paraquat ingestion; with chief complain of epigastric discomfort, severe dysphagia, and progressing shortness of breath. Patient had no history of DM/ HTN. There is no similar past history. No significant drug history was reported. Patient was not reported to take any drug for any psychiatric illness or other chronic illness. After clinical suspicion of paraquat poisoning patient was admitted in emergency intensive care unit for further management. On day one, immediately after admission, gastrointestinal decontamination was initiated by the administration of activated charcoal according to body weight followed by intravenous fluids, antiemetic therapy, steroids, N-Acetyl cysteine, and broad spectrum antibiotics to cover secondary infections with a SpO2 reading of 90% on 10 liters of oxygen therapy. Blood, urine and gastric lavage samples collected and sent for analysis. On day two, the patient required tracheal intubation and mechanical ventilation due to tachypnea, cyanosis, GCS E2V2M3, and PaO2 levels around 40 mmHg in arterial blood gas analysis, with other supportive treatments continuing. By day three, the patient developed decreased urine output and low GCS (E1V1M1), complete renal shutdown, metabolic acidosis, and hypokalemia, necessitating hemodialysis. On day four, deranged liver functions and hypotension were observed, and an E-FAST ultrasound examination revealed the shred sign and B lines in the lungs (indicative of lung consolidation and pulmonary edema) and a dilated inferior vena cava, leading to fluid restriction, escalation of antibiotics, and initiation of inotropic support. On day five, the patient developed coagulopathy and rectal bleeding, for which plasma therapy was administered. By day six, Continuous Renal Replacement Therapy (CRRT) was started. Despite all efforts, the patient collapsed and could not be revived on day seven.

Discussion

Ingesting a substantial quantity of concentrated paraquat resulted in the onset of multiple-organ failure within a 24-hour timeframe.[11,12] Individuals experiencing severe paraquat poisoning may initially show no symptoms shortly after ingestion but may deteriorate.[13] Initial management of paraquat poisoning prioritizes the prevention of further absorption and gastrointestinal decontamination. [14] Administering adsorbents promptly is essential. Commonly utilized adsorbents include activated charcoal (1–2 g/kg) and Fuller's earth (1–2 g/kg), often administered alongside a cathartic like 70% sorbitol[12]. While hemoperfusion has demonstrated efficacy in reducing paraquat levels and improving survival in animals, its benefits in humans remain inconclusive. [16] Hemodialysis should be reserved for patients presenting with acute renal failure. Supportive care involves fluid and electrolyte management, pain control, and cautious avoidance of oxygen supplementation due to its potential to exacerbate paraquat-induced lung injury.[14] No specific antidote for paraquat poisoning exists. Various treatments, such as antioxidants (high-dose vitamin C or E), N-acetylcysteine, nitric oxide supplementation, corticosteroids, cytotoxic agents, or paraquat antibodies, have been explored in sporadic case reports, yielding diverse outcomes.[17] The combination of cyclophosphamide and corticosteroids may offer some benefits in moderate-to-severe cases by mitigating ongoing inflammation and pulmonary fibrosis.[7] Additionally, a limited number of cases have reported lung transplantation following paraquat poisoning[18] Extracorporeal membrane oxygenation may be beneficial; more research is necessary [19]. Despite initial management efforts and supportive care, the severity of parquet poisoning led to multiple-organ failure and eventual death. Limitations of this case include the absence of a specific antidote for paraquat poisoning and excessive free radical formation with oxygen therapy. Free radicals induce cellular death and irreversible organ failure. Despite the excessive free radical formation from oxygen therapy, reducing oxygen concentration significantly is challenging, especially in cases of respiratory failure. Additionally, the lack of timely access to advanced medical interventions, such as extracorporeal membrane oxygenation, hemoperfusion or lung transplantation, may have further restricted the potential for successful outcomes [19].

Conclusion

In conclusion, the case report of fatal paraquat poisoning underscores the urgent need for heightened awareness, prompt recognition, and effective management strategies for this highly toxic herbicide. The presented case highlights the devastating

consequences of paraquat ingestion, including rapid progression to multiple-organ failure and ultimately death. Despite advancements in medical care, the lack of a specific antidote for paraquat poisoning continues to pose significant challenges in clinical management. Furthermore, the limited therapeutic options available underscore the importance of preventive measures and public health interventions to mitigate the risk of paraquat exposure.

Recommendations:

Consider advocating for the enforcement of stringent regulations governing paraquat sale and distribution, alongside targeted public awareness campaigns. It might be beneficial to focus on strengthening healthcare infrastructure in agricultural regions to effectively manage poisoning cases. Allocating resources for research into antidote development can be prolific idea.

Consent: Written informed consent was taken from the relative after explaining the purpose of the research.

Source of funding: There is no source of funding.

Conflict of interest: There is no conflict of interest to declare.

Ethical clearance: Not required since it is a case report.

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Review Article

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The Role of the Metaverse in Emergency Medicine and its Legal Implications: A Systematic Review

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Abstract

Introduction: The Metaverse, a virtual reality space fostering real-time interaction, captivates diverse sectors, including healthcare. This paper explores the Metaverse's role in emergency medicine, probing its implications on patient care and training. Amidst the fusion of virtual and physical realities, we also scrutinize the legal landscape, unraveling promises and challenges in this transformative domain.

Aim-To review metaverse applications in emergency medicine, analyze legal and ethical implications, and provide insights for future integration from a legal perspective.

Methods: A comprehensive review of the literature was conducted to examine the current applications of the metaverse in emergency medicine. Legal frameworks, regulations, and ethical considerations relevant to utilizing the metaverse in healthcare were also analyzed.

Results: The metaverse in emergency medicine presents opportunities and challenges. Real-time communication enhances response times, while simulated training refines skills. Telemedicine integration boosts accessibility, but data security and privacy concerns require legal adaptations. The evolving metaverse demands comprehensive regulatory structures to govern emergency medical services. Addressing liability and accountability issues, especially in emergencies, necessitates a nuanced legal approach. Balancing transformative potential with legal and ethical considerations is crucial for responsible implementation.

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Conclusion: In conclusion, integrating metaverse technologies in emergency medicine holds great potential for improving workflows, enhancing patient care, and expanding healthcare accessibility. However, addressing legal and ethical challenges is crucial for responsible and ethical application. Collaboration among policymakers, healthcare providers, and legal authorities is essential to establish robust frameworks protecting patient rights, securing sensitive health information, and ensuring accountability in virtual healthcare. Standardizing regulations and guidelines is crucial for clarity in metaverse technology utilization.

Keywords: Metaverse, Emergency Medicine, Virtual Reality, Legal Implications, Healthcare Technology.

Introduction

In the realm of healthcare, the continuous evolution of technology has ushered in transformative changes that extend beyond the physical boundaries of traditional medical practices[1]. One such paradigm-shifting innovation is the Metaverse, a virtual universe where users can interact with computer-generated environments and other users in real-time.[2] While the metaverse is commonly associated with entertainment and gaming, its potential reaches far beyond the confines of leisure, extending its tendrils into the realm of emergency medicine.[3]This intersection of the metaverse and emergency medicine not only promises groundbreaking advancements in patient care but also presents a complex web of legal implications that necessitate careful consideration.[4] The metaverse, with its immersive and interactive capabilities, has the potential to redefine the landscape of emergency medicine by overcoming geographical barriers and enhancing the speed and efficiency of medical interventions.[5,6] Emergencies often demand rapid decision-making and prompt medical attention, and the metaverse can offer a platform where healthcare professionals can collaborate seamlessly in a virtual environment.[7,8] Through virtual reality (VR) and augmented reality (AR) technologies, medical practitioners can simulate emergency scenarios, conduct training exercises, and refine their skills in a risk-free digital space.[9,10] This virtual training ground can elevate the preparedness of emergency responders, ensuring they are equipped to handle diverse and challenging situations.[11,12] In addition to training, the metaverse holds promise in facilitating real-time collaboration among medical professionals across the globe during critical situations.[13] Imagine a scenario where a specialist from a different continent can provide immediate consultation and guidance to an emergency medical team dealing with a complex case.[14] The metaverse, by breaking down geographical barriers, has the potential to create a global network of expertise, enabling a swift exchange of information and resources.[15] This interconnectedness could prove instrumental in improving patient outcomes, particularly in cases where timely intervention is crucial.[16] However, as the metaverse integrates itself into the fabric of emergency medicine, it brings with it a myriad of legal considerations that demand a thorough examination.[17,18] The virtual nature of the metaverse blurs the lines between the physical and digital realms, raising questions about jurisdiction, liability, and patient confidentiality.[19] In the event of a medical error or malpractice within the metaverse, determining the responsible party and applying legal remedies becomes a complex task.[18,20] Traditional legal frameworks may struggle to keep pace with the rapid advancements in technology, necessitating the development of novel legal frameworks specifically tailored to the metaverse in the context of emergency medicine.[21] Patient confidentiality is another area where the metaverse introduces novel challenges. In the digital realm, the transmission and storage of sensitive medical information must adhere to stringent privacy standards to protect patient rights.[22] The metaverse's capacity to create realistic simulations and scenarios for training purposes requires careful consideration of how patient data is handled within these virtual environments.[23] Striking a balance between the educational benefits of immersive simulations and the imperative to safeguard patient privacy demands a nuanced legal approach that addresses the unique challenges posed by the metaverse in the medical domain.[24] Furthermore, the metaverse's potential to revolutionize telemedicine and remote patient monitoring raises questions about licensure, accreditation, and the legality of providing medical services across virtual platforms.[25] As medical professionals engage with patients through immersive technologies, ensuring compliance with existing healthcare regulations becomes imperative. The legal landscape must adapt to accommodate

these novel modes of medical practice, providing a framework that ensures the quality, safety, and ethical standards of care are maintained in the metaverse.[26,18]

Aim and objectives

The aim of our study is to systematically review and synthesize existing literature on the integration of metaverse technologies in emergency medical care, with a particular focus on the associated legal implications. The specific objectives are:

1. To identify and evaluate the current applications of metaverse technologies in emergency medicine.
2. To explore the legal considerations and challenges associated with these technologies.
3. To assess the quality of existing research and identify gaps in the literature.

Methodology

The research methodology adopted for this systematic review followed a meticulous process. Initially, an exhaustive literature search was conducted across the electronic database GoogleScholarutilizing relevant keywords such as "metaverse," "virtual reality," "emergency medicine," "legal implications," and "healthcare technology." In the subsequent stage of study selection, articles underwent screening based on predefined inclusion and exclusion criteria, with a specific focus on the metaverse's role in emergency medicine and its legal implications. Data extraction involved retrieving pertinent information from the selected studies, encompassing various aspects such as study characteristics, design, metaverse applications, and legal considerations. To evaluate methodological quality and assess bias risk, appropriate tools were employed. Thematic synthesis of data was then conducted to provide a comprehensive overview, identifying common themes, patterns, and literature gaps. The final stages of the research involved a detailed analysis and interpretation of the data, to conclude the integration of metaverse technologies in emergency medical care from a legal perspective. The findings were reported following the PRISMA guidelines to ensure transparency and rigor throughout the process. In the literature review phase, a digital database was utilized to search through a diverse range of publications and databases. Bullion Words yielded a total of 2,540 hits, from which 1,636 articles were selected after careful consideration to form a representative sample. Further analysis resulted in the selection of 904 samples for examination. However, 530 study samples were disregarded due to technical issues, primarily related to the unavailability or inaccessibility of full-text articles (e.g., paywall restrictions, broken links, or database errors). After eliminating 374 articles with quality problems, the reasons included methodological quality issues such as small sample sizes, lack of relevant outcomes, inadequate study design, or high risk of bias as determined by our quality assessment tools, a full-text analysis was performed on 341 articles, ultimately leading to the final selection of 33 papers (n=33).

Table No 1 Research question and findings

SN	Study Name	Research Question	Key Findings
1	Marx EW, Padmanabhan P. (2020)	How is healthcare digital transformation accelerated by consumerism, technology, and the pandemic?	The pandemic,combined with consumerism and technology, significantly accelerated healthcare digital transformation.
2	Truman BE. (2020)	How do embodied avatars in virtual environments facilitate transdisciplinary collaboration?	Embodied avatars enhance collaboration across disciplines by providing immersive, interactive experiences in virtual spaces.

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3	Dyer-Witheford N, De Peuter G. (2009)	How do video games reflect and reinforce global capitalism?	Video games serve as cultural artifacts that reflect and reinforce the dynamics of global capitalism.
4	Anurogo D, Hidayat NA. (2023)	What is the role of televisculobiomedicine in the future of healthcare?	Televisculobiomedicine 5.0 presents a paradigm shift in healthcare, integrating advanced technologies for improved care delivery.
5	Ullah H et al. (2023)	What are the applications, challenges, and future directions of metaverse technology in healthcare?	Metaverse technology offers significant potential in healthcare, though challenges such as privacy and implementation persist.
6	Singh RR et al. (2023)	What is the impact of overload on emergency medicine departments during festive seasons?	Festive season overload significantly strains emergency departments, affecting patient outcomes and departmental efficiency.
7	Bashir AK et al. (2023)	How can federated learning enhance the healthcare metaverse?	Federated learning provides a secure, collaborative framework for improving healthcare outcomes in the metaverse.
8	Ullah H et al. (2023) (Duplicate entry)	What are the applications, challenges, and future directions of metaverse technology in healthcare?	Same as above—emphasizes the potential and challenges of metaverse technology in healthcare.
9	Gasteiger N et al. (2022)	How effective is AR/VR training in upskilling healthcare workers?	AR/VR training is effective in certain contexts, especially for complex procedural skills, but requires careful implementation.
10	Li X et al. (2018)	How are VR/AR technologies applied in construction safety?	VR/AR technologies significantly enhance safety training and hazard recognition in construction.
11	JHA S et al. (2023)	How should krait bites be clinically evaluated in emergency settings?	Provides case studies highlighting the importance of timely and accurate diagnosis for effective treatment of krait bites.
12	Perry RW, Lindell MK. (2003)	What are the guidelines for effective emergency planning processes?	Effective emergency response planning requires comprehensive, multidisciplinary collaboration and community engagement.
13	Jagatheesaperumal SK et al. (2024)	How can extended reality and IoT-enabled metaverses advance education?	Extended reality and IoT-enabled metaverses hold the potential to revolutionize educational methods, though challenges remain.

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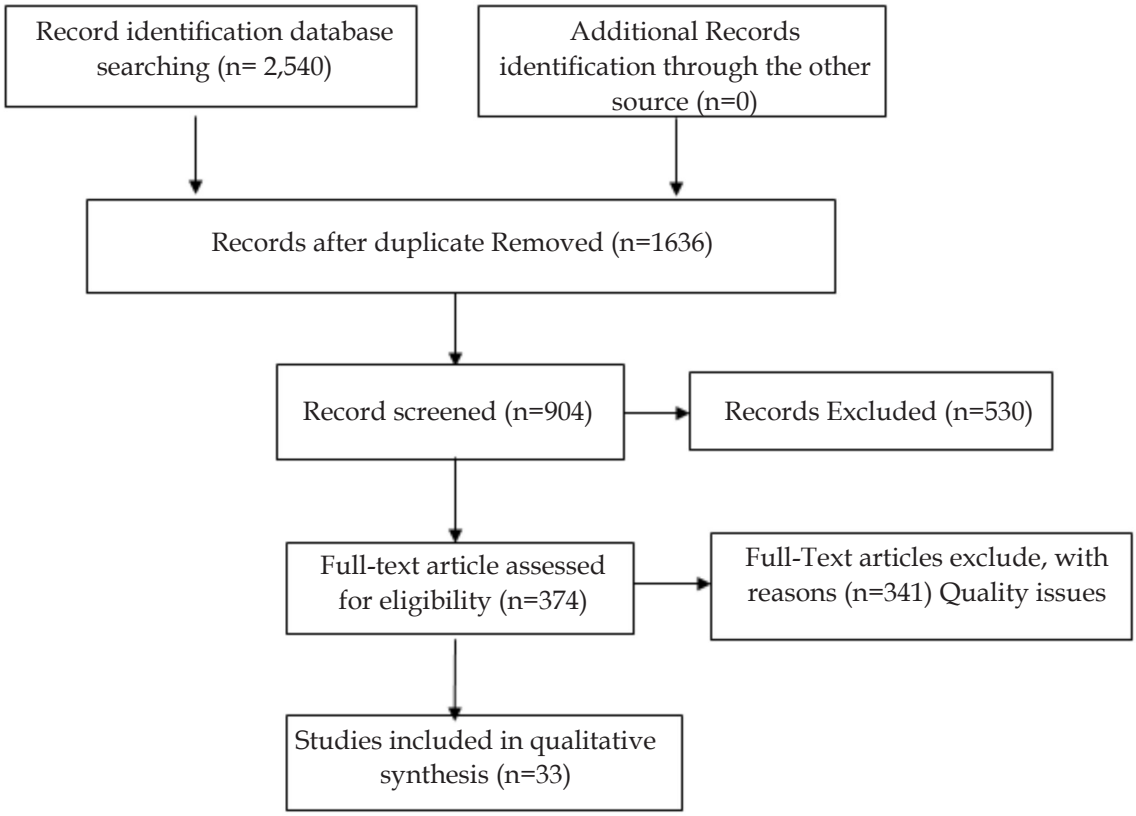
14	Haleem A et al. (2021)	What are the capabilities, features, barriers, and applications of telemedicine in healthcare?	Telemedicine enhances healthcare access and efficiency but faces barriers like technology access and patient acceptance.
15	Ali M et al. (2023)	What are the research issues and future directions for metaverse communications, networking, and security?	Identifies key research areas in metaverse technology, emphasizing the need for improved security and networking solutions.
16	Singh RR et al. (2023)	What are the best practices for emergency management of poisoning cases?	Highlights key strategies for managing poisoning cases, stressing the importance of quick response and accurate diagnosis.
17	Bashir AK et al. (2023) (Duplicate entry)	How can federated learning enhance the healthcare metaverse?	Same as above—focuses on the secure application of federated learning in the healthcare metaverse.
18	Singh RR et al. (2023)	What are the ethical dilemmas in emergency anesthesia?	Discusses ethical challenges in emergency anesthesia, including patient consent and decision-making under pressure.
19	Dolan L. (Year not provided)	What are the legal ramifications of virtual harms?	Virtual harms present new legal challenges, requiring updates to current laws to address issues in virtual environments.
20	Garon JM. (2022)	What are the legal implications of a ubiquitous metaverse and Web3 future?	Explores the need for legal frameworks to address emerging issues in the metaverse and Web3 environments.
21	Dwivedi YK et al. (2022)	What are the multidisciplinary perspectives on the challenges and opportunities of the metaverse?	Presents a broad overview of challenges and opportunities in the metaverse, calling for multidisciplinary research and policy.
22	Wylde V et al. (2023)	What are the cybersecurity and data privacy challenges in the post-COVID-19 metaverse?	Identifies significant cybersecurity and privacy challenges in the metaverse, exacerbated by the pandemic's digital shift.
23	Al-Ghaili AM et al. (2022)	What are the definitions, architecture, applications, and challenges of the metaverse?	Provides a comprehensive overview of metaverse concepts, highlighting its potential and current challenges.

24	Fredriksson A. (Year not provided)	How do privacy challenges manifest in virtual worlds within the metaverse?	Discusses the complex privacy issues in virtual worlds, advocating for more robust privacy protections.
25	Al Kuwaiti A et al. (2023)	What role does AI play in the healthcare industry?	AI is increasingly integral to healthcare, offering improvements in diagnostics, patient care, and operational efficiency.
26	Guze PA. (2015)	How can technology address challenges in medical education?	Technology offers solutions to educational challenges, enhancing access, interactivity, and engagement in medical training.
27	Rejeb A et al. (2023)	What future research areas are identified in metaverse studies?	Bibliometric and topic modeling highlight emerging research areas in the metaverse, guiding future investigations.
28	Mueller KJ et al. (2014)	How can tele-emergency improve care quality and health outcomes in rural care systems?	Tele-emergency services improve care quality and outcomes in rural areas by providing critical support and resources remotely.
29	Mehraeen E et al. (2023)	How has telemedicine been utilized during the COVID-19 pandemic?	Telemedicine played a crucial role during COVID-19, overcoming barriers to care delivery but requiring further integration.
30	Tretter M et al. (2023)	What ethical considerations arise in the healthcare metaverse?	Ethical challenges in the healthcare metaverse include patient privacy, consent, and the integrity of virtual health interactions.
31	Arafa A et al. (2023)	What are the cybersecurity challenges in emerging digital healthcare technologies?	Highlights the growing cybersecurity threats in digital healthcare, calling for enhanced protective measures and regulatory policies.
32	Howell AM et al. (2016)	What are the international recommendations for patient safety incident reporting?	Provides expert consensus on best practices for patient safety incident reporting systems globally.
33	Nittari G et al. (2020)	What are the current ethical and legal challenges in telemedicine practice?	Discusses the ethical and legal complexities of telemedicine, including issues of patient consent, data security, and jurisdiction.

Prisma Flow chart:



Result

The integration of the metaverse in emergency medicine holds promising advancements and challenges across various dimensions. Enhanced communication and collaboration among emergency medical personnel in real-time within the metaverse significantly contribute to faster response times and improved coordination during critical situations. Simulated training environments offer valuable tools for training emergency responders, allowing them to hone their skills without real-world consequences. Additionally, the seamless integration of telemedicine within the metaverse enhances accessibility and reduces response times for remote medical consultations and treatment planning. However, these advancements bring forth concerns regarding data security and patient privacy, urging the adaptation of legal frameworks to safeguard individuals' confidential health information. The evolving nature of the metaverse presents regulatory challenges, necessitating the development of comprehensive legal structures to govern emergency medical services within virtual environments. Determining liability and accountability, especially in the context of emergency medical interventions, requires a nuanced legal approach to address issues related to malpractice, negligence, and technology failures. Balancing the transformative potential of the metaverse in emergency medicine with these legal and ethical considerations is imperative for responsible implementation and realization of its benefits.

Discussion

In 2023, Rejeb A et al. conducted a study that highlighted the diverse impact of the metaverse in emergency medicine. The systematic review emphasized the need to address legal and ethical concerns. The discussion will delve into key themes, exploring metaverse benefits, legal aspects, and avenues for future research and policy development. [27] In 2014, Mueller KJ and colleagues conducted a study highlighting the potential benefits of integrating metaverse technologies in emergency medicine. This integration shows promise in improving clinical workflows, enhancing patient care, and broadening

access to healthcare services.[28] In a 2023 study led by Mehraeen E et al., Telemedicine stood out as a promising application, facilitating remote consultations, triage, and follow-up care, particularly benefiting emergency patients in underserved areas. Virtual reality (VR) simulations emerged as a valuable tool for medical training, enabling healthcare providers to practice emergency procedures in realistic virtual environments, enhancing their preparedness. Additionally, virtual triage systems, fueled by artificial intelligence (AI) algorithms, hold the potential to optimize resource allocation, minimize waiting times, and enhance patient outcomes in emergency departments.[29] In 2023, Tretter M et al. conducted a study revealing that the increasing use of metaverse technologies in emergency medicine poses notable legal and ethical challenges. Chief concerns include patient confidentiality and data security, highlighting potential risks like data breaches and unauthorized access in virtual healthcare settings. [30] In 2023, Arafa A. et al. emphasized the vital need for protecting sensitive health data and enforcing strong cybersecurity measures in virtual healthcare. Clear communication on risks and benefits in metaverse-based interventions is essential, especially in addressing challenges in informed consent during virtual consultations and medical simulations. [31] A 2016 study by Howell AM et al. highlights the challenges in integrating the metaverse into emergency medical care. The unclear allocation of responsibility for adverse events or errors in virtual environments underscores the need for precise legal frameworks and accountability mechanisms.[32] In 2018, Nittari G. et al. conducted a study revealing a lack of standardized regulations for virtual healthcare. This emphasizes the crucial collaboration needed among healthcare providers, policymakers, and legal authorities to develop comprehensive frameworks ensuring the responsible and ethical use of metaverse technologies in emergency medicine.[33]

Conclusion

In conclusion, the integration of metaverse technologies in emergency medicine holds immense potential for improving clinical workflows, enhancing patient care, and broadening healthcare accessibility. Telemedicine, virtual reality simulations, and virtual triage systems have demonstrated their capacity to optimize emergency medical care, particularly in remote or underserved regions. However, the widespread adoption of metaverse technologies introduces inherent legal and ethical challenges, encompassing issues such as patient confidentiality, data security, informed consent, liability, and regulatory compliance. Addressing these challenges is imperative to ensure the responsible and ethical application of metaverse technologies in emergency medicine. Collaboration among policymakers, healthcare providers, and legal authorities is essential to formulate robust frameworks that protect patient rights, secure sensitive health information, and establish clear accountability mechanisms for adverse events within virtual healthcare environments. Additionally, standardizing regulations and guidelines governing virtual healthcare practices is crucial to provide clarity and coherence in the utilization of metaverse technologies.

Recommendations:

Comprehensive legislative frameworks that address patient privacy, data security, and the ever-changing metaverse landscape are necessary for the responsible incorporation of the metaverse in emergency medicine. Realistic and moral standards are guaranteed by ethical rules for virtual training environments. For enterprises providing metaverse-based emergency services, strong data security and privacy policies are essential. Regulators should encourage flexibility by modifying frameworks to accept virtual emergency medical services. To create norms for liability and accountability, cooperation between legal experts, medical specialists, and technology developers is crucial. Campaigns to raise awareness and educate stakeholders about the advantages and moral implications of metaverse technology in emergency treatment are essential.

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Ethical clearance: Not Applicable as it is a systematic review without the involvement of human or animal subjects.

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Review Article

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The Role of Soil as Trace Evidence in Forensic Science: Methodologies and Applications

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Abstract

In forensic science soil as trace evidence can play a vital role of establishing connection between the suspect, victims, any object with a particular area based on the characteristics of soil. Forensic soil investigation is the analysis of soil evidence in the service of crime solving, environmental monitoring, and geologic exploration. Analysts use a combination of geological, ecological, biological, or chemical to identify soil origin, link evidence to crime scenes, or reconstruct events. This study aims to conduct a comprehensive review of existing literature on soil as trace evidence, with a focus on its forensic applications. This covers various aspects of forensic soil investigation, including Physical methods (grain size analysis, density gradient measurement), chemical processes (organic matter analysis; loss on ignition (LOI), pH), biological methods (DNA analysis, microbial community analysis), mineralogical analysis (SEM-EDX, XRD), for soil analysis are evaluated for their applicability and limitations. It concludes by arguing the importance of assembling multiple disciplines for effective forensic soil investigation. It provides a helpful resource for forensic scientists and researchers, as well as for investigators and practitioners in forensic science.

Keywords: Forensic soil analyses, Trace evidence, Physical methods, Chemical methods Interdisciplinary collaboration

Introduction

Soil is unprocessed mineral and organic material on the Earth's surface, featuring complex physical, chemical, and biological properties from interactions between organisms and non-organisms. In forensics, it serves as crucial background evidence, as its geographical source can be identified and applied in various forensic contexts [1]we hypothesized that soils can be forensically distinguished through the analysis of their clay fraction alone, and that samples of the same soil type can be consistently distinguished according to the distance they were collected from each other. To test these hypotheses 16 Oxisol samples were collected at distances of between 2 m and 1.000 m, and 16 Inceptisol samples were collected

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at distances of between 2 m and 300 m from each other. Clay fractions were extracted from soil samples and analyzed for hyperspectral color reflectance (HSI. Soil contains plant debris, microorganisms, and minerals that can link individuals or objects to crimes. Therefore, soil analysis is crucial for environmental forensics, applied investigations, and criminal and counter-terrorism efforts[2].

Soil, rocks, minerals, and man-made particles like bricks are crucial in linking suspects to crime scenes. In Corryn Rayney's 2007 Perth murder, synchrotron XRD matched red brick particles from her body to her home, suggesting she was attacked in her front yard, providing crucial evidence[3]. The case study involves a hit-and-run where two suspects fled. Control and alibi soil samples were analyzed using morphological, microscopic, XRD, and DRIFT methods to determine if the suspects crossed the crime trail.[4]

This review covers methodologies in forensic soil investigation, including physical, chemical, biological, and mineralogical analyses. Physical methods like grain particle size analysis and density gradient measurements help define soil texture and structure. Chemical methods, such as organic matter analysis, loss on ignition (LOI), and pH, determine soil elemental content. Biological techniques, including DNA and microbial analysis, add complexity by focusing on living microbes in soil. Therefore, the purpose of this current review is to perform a comprehensive review of existing literature on soil as trace evidence with consideration to forensic aspects. Consequently, forensic soil analysis is a complex discipline involving different methods for better analysis of soil and its evidence. When integrated, these methods allow a direct linking of soil samples to a crime scene as well as resources for solving a case and acquiring useful forensic conclusions.

Physical Methods

In forensic soil investigations, the physical properties of soil like grain size distribution and density measurements are important of identification of a specific soil sample [5]. Grain size analysis is a key method in forensic soil investigation, allowing forensic geologists to sort and compare soil samples based on particle size distribution[6]. Grain size analysis uses sieving and sedimentation. Sieving involves sorting soil particles using mesh-sized sieves, expressing coarse material in size fractions for easier assessment [7]. However, Sieving effectively quantifies soil composition, with grain size analysis being more useful for descriptions and exclusion rather than diagnostic purposes[8].

Table 1: Grain size distribution USDA(United States Department of Agriculture) and ISSS (International Society of Soil Science) classifications:

Classification	USDA Grain Size (mm)	ISSS Grain Size (mm)	Difference
Sand	0.05 - 2.0	0.02 - 2.0	The key difference lies in the sand-silt boundary: 0.05 mm (USDA) and 0.02 mm (ISSS)
Silt	0.002 - 0.05	0.002 - 0.02	
Clay	<0.002	<0.002	Both classifications define clay similarly

Despite its drawbacks, sieving remains crucial in forensic soil analysis, aiding in understanding soil gradation and comparing crime scene samples to suspects[9]. Forensic science also employs geological methods to differentiate soil samples by texture and composition [10]. Thus, while time-consuming, sieving is still a fundamental tool in forensic soil analysis [9].

Goin and Kirk introduced the density gradient method into forensics for the first time in 1947 as a way to distinguish between various soils densities. since been used as a common forensic test standard in determining the origins of soils [11]. Linear density gradients could be established in 30 cm glass tubes employing bromoform/bromobenzene solutions. The grades varied between 1.5 and 2.9 g/mL and could be relied on in the separation of soil samples that were difficult to differentiate based on their physical appearance [12].In a study, 241 soil samples from 133 Southeast England locations were analyzed using density gradient tubes containing bromoform

and bromobenzene. While density gradient analysis is efficient, it is time-consuming and may require fine-tuning [11].The density gradient tube technique examined soil samples from the same area at different depths using bromoform (2.9 g/mL) and bromobenzene (1.5 g/mL). Seven layers formed overnight, revealing significant differences in color, density, texture, and consistency [13].

A density gradient tube is a glass tube filled with liquids of varying densities, increasing towards the base. Heavy liquids like bromoform (2.89 g/mL) or tetrabromoethane (2.96 g/mL) are combined with lighter liquids such as bromobenzene (1.50 g/mL) or ethanol (0.789 g/mL). Soil samples are crushed and placed in the tube [14]. The density gradient range has been expanded from 2.89-1.50 g/mL to 4.24-1.00 g/mL using Clerici's solution and distilled water, allowing analysis of a broader range of soil mineral particle densities [15].

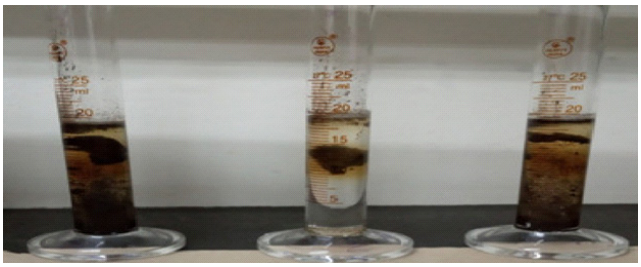

Figure 1: A density gradient tube for soil sample

analysis[16]

Chemical Methods

Organic matter is crucial in forensic soil analysis, providing provenance details. Variations indicate environmental differences and human activity, aiding criminal justice and environmental studies [17,18]. Loss on Ignition (LOI) method is a cheap and easy technique for assessing organic matter, but may take time if used only at specific temperatures[19] but is time-consuming and provides information only for specific, pre-determined temperatures. It also requires relatively large sample sizes and is destructive. Thermogravimetric analysis (TGA. The LOI method measures soil sample loss when heated in a muffle furnace. In a study in Manchester Township, NJ, a 2.0 g soil sample lost 4.319% of organic content, while samples from Connecticut fell between 13.747% and 13.309%[20].

The study found that temperature and heating time significantly impact soil mass loss. Sandy soil exhibited greater mass loss at temperatures between 350°C and 550°C, while silt loam soils showed gradual increases in LOI values across all temperatures. Higher heating times resulted in LOI values ranging from 2.22 at 350°C to 6.60 at 650°C.[21] It is essential to control parameters such as furnace type, sample mass, integration time, temperature, and soil clay composition during loss on ignition analysis [21]

Table 2. Temperatures and heating times for different types of soil [21,22]

Soil type	Temperature (°C)	Heating Time (hours)	Purpose
Sandy Soil	105	1	Drying
Loamy Soil	105	1.5	
Silty Soil			
Organic Soil			
Clay Soil	110	2	
Peaty Soil	105		
Sandy Soil	450		
Loamy Soil	500	2-3	Ashing/Organic Matter Removal
Silty Soil			
Clay Soil	550	3	
Peaty Soil	600	4	
Organic Soil	650	2-4	

Soil pH measurement is crucial in forensic analysis for distinguishing soil samples based on chemical traits. Using small samples (2.5g to 50mg), researchers noted significant pH variations across different soil colors, with a specificity of about 0.4[23].

Table 3. Soil pH values, and types of soil reactions[24].

PH Range	Soil Reaction Rating
<4.6	Extremely acid
4.6-5.5	strongly acid
5.6-6.5	moderately acid
6.6-6.9	slightly acid
7.0	neutral
7.1-8.5	moderately alkaline
>8.5	strongly alkaline

Soil pH is typically measured using a calibrated pH meter, which is reliable for forensic context analysis and field research in soil samples[25]. The study found that measuring soil pH in suspensions with deionized water and 1M calcium chloride provided useful differentiation between samples, particularly in the fall, despite some inconsistencies[26]. Four colorimetric methods were evaluated for forensic use, with the 2.5:1 water-to-soil ratio and centrifuge separation method being the most satisfactory, improving pH measurement reliability and accuracy [23].

Biological methods

DNA sequencing and microbial population's analysis adding forensic scientists obtain data when traditional soil analysis fail to differentiate between comparable samples.[27] Metabarcoding accurately identifies microflora, plants, metazoans, and protozoans, enhancing forensic investigations by distinguishing similar samples from different geographical locations. This DNA-based method involves extracting DNA, amplifying genetic regions, and sequencing to quickly and accurately identify species in environmental samples like soil.[28]

High-throughput sequencing and DNA extraction methods have shown promising findings in forensic science, revealing clear distinctions even in mixed soil samples, making it highly useful[29] Amplified Ribosomal DNA Restriction Analysis (ARDRA) is a forensic soil analysis technique that uses ribosomal DNA amplification and restriction enzyme digestion to identify microbial communities. This method helps correlate soil with crime scenes, increasing the accuracy of soils as forensic evidence.[30] Despite potential for forensic investigations, microbial profiling methods face challenges due to environmental factors affecting including, pH, land management, climate, soil texture, nutrient levels, bacteria and archaea, making accurate interpretation challenging[31]

Microbial profiling, a method used in forensic science, has shown efficiency and reproducibility in identifying soil types, as demonstrated in study was conducted in Miami-Dade[32]

Mineralogical analysis

SEM-EDX is a non-invasive method that retains the sample's admissibility for legal purposes as well as offering definitive qualitative and quantitative information[33]. The technique utilized in forensic examinations for high definition imaging and chemical compositional analysis as well as providing detailed information on surface topography[34]. SEM-EDX is a reliable and reproducible forensic examination method for criminal and environmental cases, enabling comparison of soil samples and analysis of rocks, sediments, dust, and soils [35] continues supporting its forensic applicability by using the clay and soil sources to solve the double murder case[36].

In a study developed a new semi-automated SEM-EDX that indicates how well it can distinguish samples from different parent populations in forensic soil analysis[37]. additionally the importance of automated mineralogical profiling undertaken with SEM-EDX to identify a bedrock lithology that may help in Geolocation and comparison of forensic samples[38].

SEM-EDX used in geographical investigations such as comparing Canterbury (UK), Dubai (UAE), and Kerala (India) with their samples of soil texture, color, and composition [39]. Another study comparing the effect of homogenizations at elemental composition level on the 17 sample collected in Istanbul using SEM-EDX[40]and have some characteristics because of the natural effects and transfers made by human and other living beings in time. So that forensic examination of soil is not only concerned with the analysis of naturally occurring rocks, minerals, vegetation, and animal matter. It also includes the detection of such manufactured materials such as ions from synthetic fertilizers and from different environments (e.g., nitrate, phosphate, and sulfate.

XRD, to determine crystalline phases of soil sample, XRD is shown capable of analyzing soil's mineralogy to resolve a real-world murder investigation[36]. XRD can classify samples based on the composition of minerals, whereas in the Swan Coastal Plain study quartz sand coatings were incorporated in order to identify sandy soils [41]. The review discusses the effectiveness of XRD in distinguishing minerals and confirms its importance in forensic soil examination[42].

Application of Forensic Soil Analysis

Forensic soil analysis is essential for crime investigation, geological exploration, border security, and disaster management. It identifies suspects; maps pollution sources, detects smuggling, and locates mineral deposits. Additionally, it supports disaster management, archaeological surveys, and climate change studies by linking evidence to crime scenes and employing advanced analytical techniques[4,43,44]

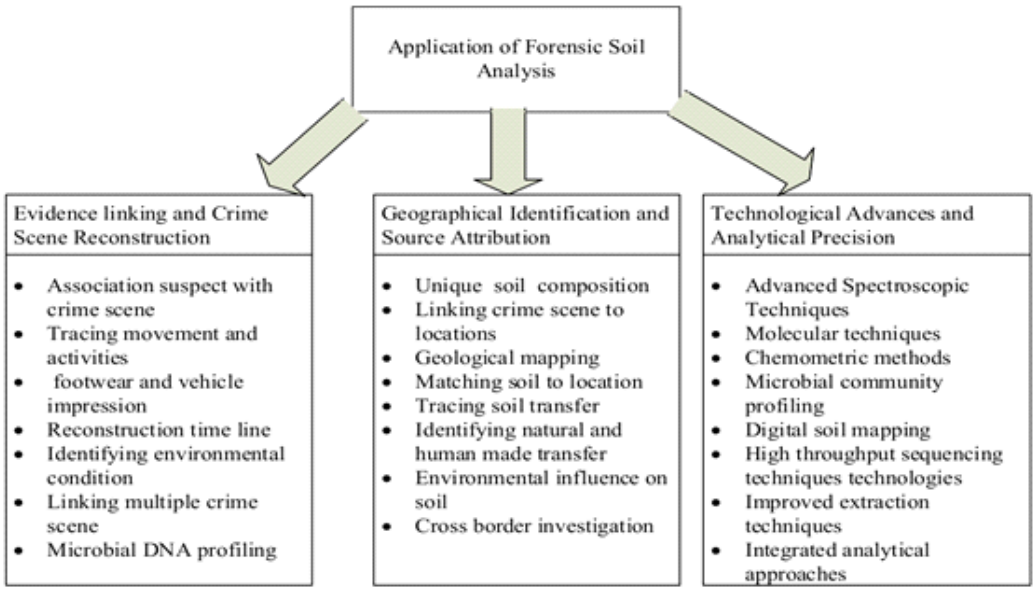

Figure.2 Application of forensic soil analysis[4,45,46]

Challenges and Future Directions

The chemical method of soil analysis has limitations, especially when used in isolation, due to sample-related factors and expert intervention, resulting in errors in conclusions [47]. Influence of microbial populations in soil samples and database created quite a challenge in relating collected soil samples to the very specific position [30] Mishandling by introducing contaminants, personal protective equipment (PPE), cleaning, and decontamination of working surfaces are critical prevention activities within forensic settings [48]

Soil is heterogeneous in nature, and there are no uniform process controls for comparison, which makes forensic soil analysis challenging[17].

However, several practical issues, including small sample sizes, time constraints, and funding issues, also limit comprehensive research and the capacity to deliver clearly forensic results[49]. Combining analytical techniques with improved statistical tools and reference databases can boost the confidence and probative value of soil analysis in forensic investigations[50]

Conclusion

Soil is vital in forensic science as trace evidence, linking suspects, victims, and crime scenes. Its composition of minerals, organic materials, and pollutants can be analyzed to connect samples to specific locations or objects. Forensic soil analysis aids in crime investigations, geological surveys, border security, contamination assessment, and disaster victim identification. This review discusses various methodologies, including physical, chemical, biological, and mineralogical analyses, emphasizing the need for interdisciplinary collaboration. However, challenges like contamination, sample heterogeneity, and standardization persist.

The review encourages continued research on novel DNA analysis techniques that complement traditional physical and chemical approaches. Technological advancements are improving methodologies and expanding the capabilities of forensic soil analysis, ultimately serving as valuable resources for forensic scientists and practitioners.

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Original Article

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Autopsy-Based Cross-Sectional Observational Study on Carotid Artery Injury in Non-Penetrative Neck Trauma

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Abstract

Background: Non-penetrative neck trauma poses a significant risk of carotid artery injury, which can lead to severe consequences. Diagnosis of carotid artery injury in non-penetrative trauma remains challenging due to delayed clinical presentation. Research on non-penetrative mechanisms of injury is relatively less common compared to penetrating trauma. This study aims to analyse patterns of vascular injuries in compression injuries to the neck, focusing on non-penetrative trauma.

Materials and Methods: A cross-sectional study was conducted in a Forensic Medicine Department of Government Stanley medical college, Chennai, over a one-year period, analysing 150 cases of non-penetrative neck trauma. Post-mortem data, including gross and histopathological findings, were collected and analysed.

Results & Discussion: Among the 150 cases studied, hanging was the most prevalent cause of blunt cervical trauma. The majority of cases affected individuals were between the age group 21 and 40 years, with male preponderance. Gross examination revealed intimal tears in a proportion of cases, with histopathological examination identifying a higher prevalence of injuries. Posterior knot ligatures were predominant in both complete and partial hanging cases, correlating with a higher incidence of carotid body haemorrhage. The association between posterior knot position and carotid body haemorrhage emphasizes specific vulnerabilities in hanging cases.

Conclusion: The findings of the study emphasize the importance of forensic investigations in identifying vascular injuries, guiding injury prevention strategies, and informing medicolegal proceedings. Further research is needed to enhance diagnostic and management approaches in clinical and forensic practice.

Keywords: Non penetrative trauma, Carotid artery injury, Carotid body haemorrhage, Autopsy-based study

Introduction

Non-penetrative neck trauma, although less frequent than penetrating trauma, poses a significant risk of carotid artery injury (CAI), which can lead to devastating consequences such as stroke, vascular compromise, and even death. Diagnosing carotid artery injury (CAI) in non-penetrative trauma can

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be difficult due to its potential for delayed clinical presentation and subtle or nonspecific symptoms.

Non-penetrative neck trauma encompasses a diverse array of incidents, such as motor vehicle accidents, sports-related injuries, fall from heights, strangulation, and blunt assaults. These events can lead to various forms of trauma to the neck structures through blunt force impact, compression, and hyperextension. The carotid arteries, vital conduits supplying blood to the brain, are susceptible to stretching, compression, or tearing during traumatic events, especially those involving rapid deceleration or blunt force impact.

Existing literature suggests that certain demographic factors such as age, gender, and underlying medical conditions may influence the susceptibility to carotid artery injury following non-penetrative neck trauma. Moreover, the mechanism and severity of trauma, including the direction and magnitude of force, may impact the probability and extent of carotid artery injury. Furthermore, anatomical variations, such as tortuosity or aberrant branching patterns of the carotid arteries, may predispose individuals to injury. Despite advancements in diagnostic imaging and clinical evaluation, carotid artery injury in non-penetrative neck trauma remains underexplored, particularly from a post-mortem perspective.

Autopsy-based studies present a distinctive opportunity to systematically evaluate carotid artery injury in non-penetrative neck traumaenabling the detection of subtle injuries, characterization of injury patterns, and correlation with clinical findings. An autopsy-based cross-sectional observational study was conducted with the aim to advance understanding of carotid artery injury in non-penetrative neck trauma, elucidating the epidemiology and associated factors underlying this condition. The incidence of carotid artery injury was assessed by both gross and histopathological examination.

Materials and Methods

The present study was conducted as an autopsy based cross sectional study to analyse the pattern of vascular injuries in compression injuries to the neck in the Department of Forensic Medicine & Toxicology, Government Stanley Medical College between May 2021 and April 2022. Ethical clearance was obtained from the Institutional Ethical Committee [Certificate No. FM201420101002 dated 24/03/2021] before commencement of the study150 cases of deaths due to non-penetrative injury to the neck such as hanging, strangulation, road traffic accidents, railway accidents, workplace accidents and fall from height subjected to postmortem examination in Government Stanley Medical College Mortuary on receiving requisition from the concerned investigating officer was included for the study. Data was collected from the post mortem records, inquest reports and histopathological examination. In case of death due to hanging, details like position of knot, completeness of hanging (partial or complete) were also obtained. Based on the position of knot, deaths due to hanging were divided into anterior, posterior, left and right represented as I, II, III and IV respectively. Also, cases of hanging were further categorised based on completeness of hanging as complete hanging (A) and incomplete hanging (B). The possibility of association between the position of knot in hanging, the completeness of the victim's body suspension and vascular injury was explored.

In all the cases of non-penetrative trauma to neck, layer by layer bloodless dissection of neck was done. After removing the neck organs, gross examination of the both right and left carotid arteries was done by making longitudinal cuts with the blunt arm of scissors to visualize its intimal layer. Both right and left carotid arteries were subjected to histopathological examination.

Observations:

(a) Among 150 cases of blunt cervical trauma, hanging cases were 91, strangulation 8 cases, fall from height 13 cases, road traffic accidents 28 cases, railway accidents 5 and workplace accident were 5. Out of the 150 cases, 113 were male and 37 were female.

(b) The primary age group affected in both genders fell within the range of 21– 40 years, comprising 52.67% (n = 79) of cases. The least affected age group consisted of individuals over 80 years old, with only 2 cases (n = 02).

(c) Out of 91 instances of hanging, gross examination revealed an intimal tear in 22 cases, with 21 cases exhibiting unilateral tear, 1 case demonstrating bilateral tear in the carotid artery and artery dissection was observed in 2 cases (Fig. No.1,2). Among the 8 cases of strangulation and 5 railway accident cases, no vessel wall injury was detected upon gross examination. In road traffic accidents, 2 cases displayed unilateral intimal tear. For falls from height and workplace accidents, one case each showed unilateral intimal tear upon gross examination, while the rest appeared normal.

(d) Out of 91 hanging cases, histopathological examination revealed intimal tear in 32 cases, with 30 cases showing unilateral tear, 2 cases with bilateral tears,3 cases with artery dissection (Fig.No.3,4,5). In cases of strangulation and road traffic accidents, histopathological examination revealed unilateral intimal tear in 2 out of 8 cases and 3 out of 28 cases, respectively (Fig.No.6). Unilateral intimal tear was noted in one case each of railway accidents and workplace accidents, and in 2 cases of falls from height.

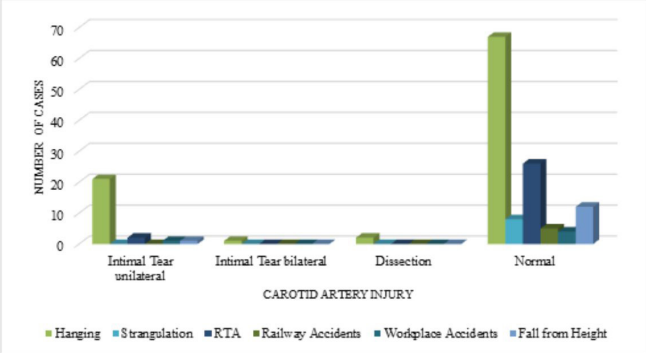

Fig. No. 1: Carotid Artery Injury in Gross Examination and Type of Trauma Associated

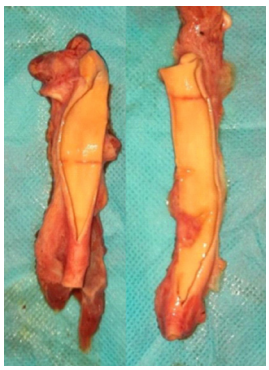

Fig.No.: 2 Bilateral Carotid Artery Intimal Tear in a Case of Hanging - Gross

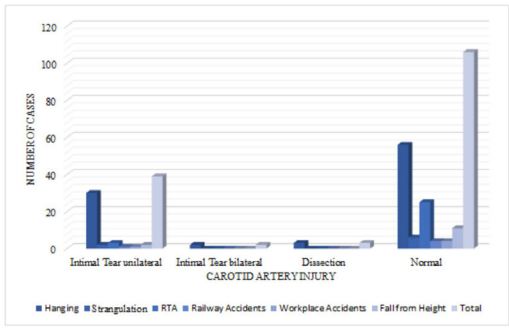

Fig No. 3: Carotid Artery Injury in Histopathological Examination and Type of Trauma Associated

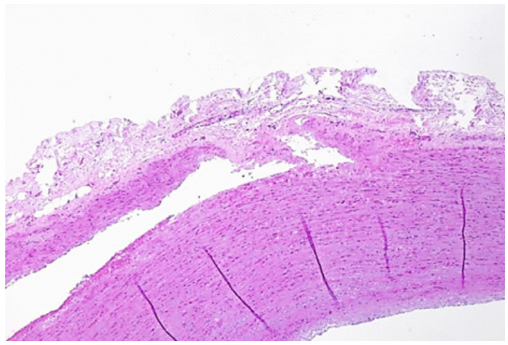

Fig. No. 4: Carotid Artery Intimal Tear – Histopathology

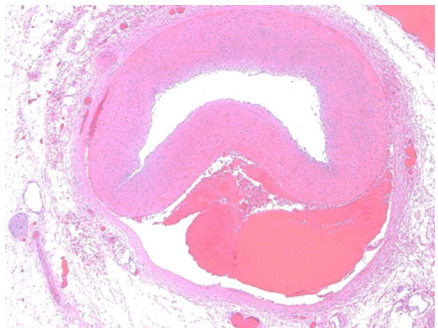

Fig. No. 5. Carotid Artery Dissection - Histopathology

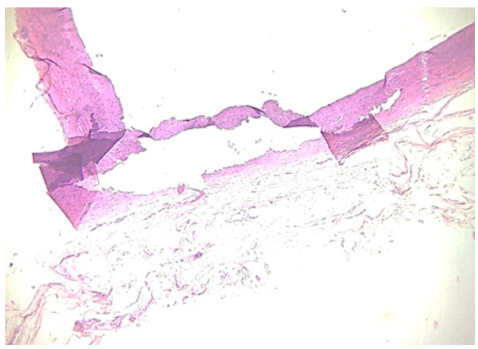

Fig. No.6: Left Carotid Artery Showing Longitudinal Intimal Tear in a Case of Strangulation – Histopathology

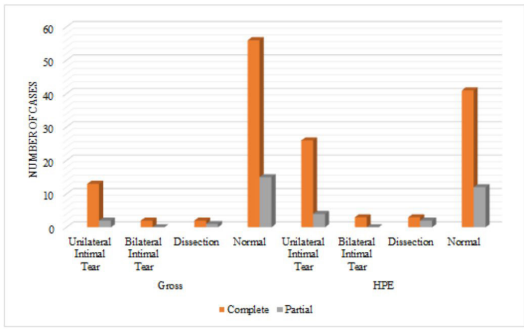

Fig. No. 7: Carotid Artery Injury and Completeness of Hanging

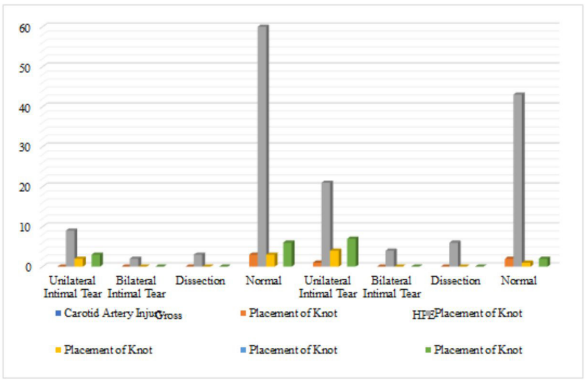

Fig. No. 8: Carotid Artery Injury and Position of Knot

(e) Out of 91 hanging-related deaths, 73 were instances of complete hanging. Among these complete hanging cases, 52 were males and 21 were females. Regarding complete hanging cases in males, an anterior knot was observed in 2 cases (3.85%), a posterior knot in 43 cases (82.69%), a left-side knot in 2 cases (3.85%), and a right-side knot in 5 cases (9.62%). In females with complete hanging cases (21 in total), an anterior knot was observed in 1 case (4.76%), a posterior knot in 17 cases (80.95%), a left-sided knot in 1 case (4.76%), and a right-sided knot in 2 cases (9.52%).

(f) There were 18 instances of partial hanging in total, with 14 involving males and 4 involving females. There were no cases of partial hanging observed with an anterior knot. Among males with partial hanging cases, a posterior knot in 11 cases (78.57%), a left-side knot in1 cases (7.14%), and a right-side knot in 2 cases (14.29%). For females with partial hanging cases (4 in total), a posterior knot in 3 cases (75%), a left-sided knot in 1 case (25%). Female cases of partial hanging with right sided knot were not observed in the study.

(g) In Gross examination of complete hanging cases (73 cases), 13 (17.81%) cases had unilateral intimal tears, 2 (2.74%) cases had bilateral intimal tears and dissection was seen in 2 (2.74%) cases. In Partial Hanging Cases (18 cases), unilateral intimal tear was seen in 2 cases (11.11%) and dissection was seen in 1 case (5.56%). During histopathological examination of 73 cases of complete hanging, unilateral intimal tear was found in 26 cases (35.62%), bilateral intimal tear in 3 cases (4.11%), and dissection was observed in 3 cases (4.11%). In the case of partial hanging (18 cases), unilateral intimal tear was present in 4 cases (22.22%), and dissection was observed in 2 cases (11.11%). (Fig. No.7)

(h) No vessel wall injury was noted in cases with anterior knot ligature upon gross examination. Among cases with a posterior knot ligature (74 cases), gross examination revealed unilateral intimal tear in 9 cases, bilateral intimal tear in 2 cases, and dissection in 3 cases. For cases with a left-side knot, gross examination showed unilateral intimal tear in 2 cases. Among the 9 cases with a right-sided knot, gross examination revealed unilateral intimal tear in 3 cases. (Fig. No.8)

(i) In histopathological examination, one case with anterior knot displayed unilateral intimal tear. Among cases with a posterior knot ligature (74 cases), histopathological examination unveiled unilateral intimal tear in 21 cases, bilateral intimal tear in 4 cases, and dissection in 6 cases. Regarding cases with a left-side knot, histopathological examination identified unilateral intimal tear in 4 cases. Among the 9 cases with a right-sided knot, histopathological examination revealed unilateral intimal tear in 7 cases. (Fig.No.8)

(j) In 14 cases of unilateral intimal tear in gross examination, Amussat's sign was found in 11 (78.57%) cases and rest were longitudinal laceration of intimal layer. Both the cases of bilateral tears seen by gross examination were transverse tear of intima (Amussat's sign). In histopathological Examination, out of 33

unilateral tears, transverse tear was seen in 23 (69.70%) cases and all the 4 (100%) cases of bilateral tears were transverse lacerations.

(k) Carotid Body Hemorrhage was exclusively observed in hanging cases with posterior knot during both gross and histopathological examination. 2 cases in gross examination and 5 case in histopathological examination showed carotid body haemorrhage.

Discussion

In the present study, the distribution of blunt cervical trauma cases across different mechanisms highlights the diverse nature of injuries encountered in forensic settings. Hanging stands out as the primary cause, followed by road traffic accidents. This corresponds with the study done by Ashok Subash Jiwane et al. The demographic distribution of cases reveals a male predominance, consistent with previous studies on traumatic deaths done by Sharija Jayaprakash et al.The peak incidence of blunt cervical trauma in the 21-40 age group, reflecting the active and potentially risky behaviours of this demographic, corresponds with the findings of a study by B.R. Sharma et al.

Analysis of the vascular injuries observed in non-penetrating neck trauma cases reveals a spectrum of findings, including intimal tears, artery dissection, and carotid body hemorrhage. Interestingly, while gross examination identified a substantial proportion of cases with no vessel wall injury, histopathological examination revealed a higher prevalence of intimal tears and dissections, emphasizing the importance of histopathological assessment in identifying vascular injuries that may not be apparent during gross examination.

The incidence of carotid artery injury in hanging cases are consistent with study of Hejna P, Ashok Subhash Jiwane et al.[3,] In the current study, incidence of carotid artery tear was high in cases of complete hanging compared to partial hanging. In anterior hanging cases, only one case had vessel wall injury. A statistically significant association was found between incidence of carotid artery injury and the position of knot which is supported by similar studies conducted by Petr Hejna et al.[6]

The distribution of knot positions in hanging cases provides additional insights into the mechanism of injury. Posterior knot ligatures predominate in both complete (82.19%) and partial hanging (77.78%) cases, aligning with the biomechanics of hanging and the typical orientation of ligature marks. Partial hanging with anterior knot was not seen in the study. This observation corresponds with the study conducted by Vijayakumari et al.

Amussat's sign highlights the significance of this histopathological feature in hanging cases, whichreinforces the understanding that hanging-related vascular injuries result from mechanical stretching or shearing forces as described by Mahmut Asirdizer et al.Additionally, there was increased incidence of transverse lacerations in the intimal layer compared to longitudinal lacerations in the present study.

In cases of strangulation, carotid artery injury was observed only in histopathological examination. In a study conducted by Le Blanc - Louvry I et al it was seen that extra cranialcarotid artery injuries are more common in strangulation than intracranial lesions.In a study by Amadasi et al., carotid artery tears were noted in both gross and histopathological examinations of road traffic accident cases, with more vessel injuries detected histopathologically in gross examination, supporting findings in the present study. Similarly in cases of railway accidents, workplace accidents and fall from height, histopathological examination revealed more vessel wall injury compared to gross examination.

Height of descent, position of body on landing, rate of deceleration, impact surface, clothing etc influences the incidence of injuries associated with fall from height. Skeletal injuries are predominantly found in cases of fall from height. Hence it can be presumed that vascular injuries associated with skeletal injuries may occur. Also, vascular injuries may occur independently due to direct trauma from impact surface. Carotid body haemorrhage was seen in cases of posterior hanging only (2 cases in gross examination and 5 cases in histopathology). This corresponds with the increased incidence of carotid artery injury in this study. The association between posterior knot position and carotid body haemorrhage further substantiates previous research

findings indicating that the posterior aspect of the neck is particularly vulnerable to vascular injury during hanging.

Conclusion

In conclusion, the present autopsy-based cross-sectional study provides critical insights into carotid artery injuries resulting from non-penetrative trauma to the neck in terms of epidemiology, patterns, and associated factors of carotid artery injury. The findings of the study underscore the importance of thorough forensic investigations in cases of blunt neck trauma. We have identified demographic factors, such as age and comorbidities, as well as the mechanism and severity of trauma, as key determinants of carotid artery injury risk. A comparative study of vascular injuries in live patients and autopsy-based study will provide deep insight into mechanism of the injury. MSCT (Multislice computed tomography) angiography can be used to identify vascular lesions better than traditional autopsy methods and histopathological examination. Identifying the vitality of Amussat sign is important to differentiate hanging death from postmortem hanging of the body. In cases where vascular injury is observed in gross or histopathological examination, the brain tissue can also be subjected to histopathological examination to gain knowledge about the effect of vascular injuries on brain tissue. Moving forward, continued research in this field is essential for improving diagnostic accuracy, improving patient outcomes, and advancing forensic science methodologies.

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Ethical Clearance: Government Stanley Medical College & Hospital, Chennai - 0 I, Institutional Ethics Committee - 24/03/2021

Conflicts of interest statement: Nil

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Original Article

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Study of Blunt Trauma to Abdomen and Associated Mortality after Admission in a Tertiary Care Hospital in Moradabad District

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Abstract

Introduction: The abdomen area is the 3rd most common area which is injured and surgery required in almost about 25% of civilian cases(1). Blunt abdominal trauma (BAT) is one of the most important causes of mortality among trauma victims. It is the main cause of death in people under 35 years of age in worldwide. (2) Most common cause of blunt trauma abdomen in our country (India) is road traffic accident which is followed by abdominal blows and fall from heights. This ever-expanding out break targeting the youth and useful generations is likely to take a serious burden on their socioeconomic growth and quality of life.

Material & Method: All the cases admitted in the Casualty of T.M.M.C & R.C from district Moradabad and its adjoining area from 1stJanuary 2014 to 30thDecember 2015 with history of blunt trauma to the abdomen were included in the study. All data were compared to similar studies.

Result: Highest number of patients i.e. 36 (32.7%) belonged to 21-30 years age group. There were 91 (82.7%) male patients and 19 (17.3%) female patients. There were 82 (74.5%) accidental deaths and 23 (20.9%) homicidal deaths while only 5 (4.5%) suicidal deaths. In present study, majority of patients in accidental victims in males belongs to rural community 50 (61%) followed by urban community 12 (14.6%).

Keywords: Road traffic accident, blunt trauma, abdomen, mortality.

Introduction

In older times, the abdomino-pelvic cavity was looked upon as one of the most important area of the body and the cause of injuries occurring in the body have always been measured very dangerous. In 460 BC, Hippocrates was conscious about the seriousness to the life caused by injury to visceral organs. Blunt

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trauma abdomen is one of the leading preventable causes of the unnatural death in developing and developed countries. [3]

Abdomen is counted as 3rd most common injured area with injuries requiring surgery in almost about 25% of civilian trauma sufferers.[4]It is the main cause of death in people under 35 years of age in worldwide.[2]

Most common cause of blunt trauma abdomen in our country (India) is road traffic accident which is followed by abdominal blows and fall from heights. This ever-expanding out break targeting the youth and useful generations is likely to take a serious burden on their socioeconomic and quality of life.[5]

Sometimes, the mechanism of death in such cases may be difficult to interpret and may require lengthy explanation. Blunt traumas are always produced by the external force, in a form of external energy.[6,7,8] Variety of injuries are caused to human beings by application of blunt force ranging in severity from minor to massive destruction. Thus heterogeneous lesions can be divided into two leading groups.[9]

1. (Closed) includes contusions (or bruise), hematomas, simple fracture and lacerations in viscera.
2. (Open) includes lacerations, abrasions, avulsions and scratches, and also compound fractures.[10]

In cases of abdominal trauma in order to minimize mortality, it should be systematically identified and studied. Many risk factors have been identified in recent years as gender of patient, the time interval between abdominal injury and surgery, all kinds of shocks at the time of admission and all kinds of cranial injury.[11]

Despite the numerous studies on blunt abdominal trauma (BAT), this research is essential for several reasons. Firstly, it focuses on a specific geographic and demographic context, examining cases from Moradabad and its surrounding areas in India. This localized study provides insights into regional patterns of injury, which may differ from those in other parts of the world. Additionally, it addresses the socioeconomic impact of BAT on the youth and economically active populations, highlighting the burden on their socioeconomic growth and quality of life. By focusing on a high-risk group and a significant cause of mortality among young people under 35, this study contributes valuable data that can inform targeted prevention and intervention strategies

Material & Method

After obtaining the ethical clearance from the institutional ethical committee, the present prospective study on blunt trauma to the abdomen was done by Department of Forensic Medicine and Toxicology and Department of Surgery. All the cases admitted in the Casualty of T.M.M.C & R.C from district Moradabad and its adjoining area from 1st January 2014 to 30th December 2015 with history of blunt trauma to the abdomen were included in the study.

Exclusion criteria

1. Patient not having the history of medico-legal injury to the abdomen.
2. Patient having injuries on other part of body.
3. Patient referred to higher center.
4. Patient who are absconded or LAMA.
5. Patient not having the proper record in the medical record department.

Ethical Considerations: Informed consent was obtained from patient and if not possible then by relatives of the deceased at the time of admission in the casualty. Ethical committee approval was obtained from Institutional Ethical Committee.

Observations and Results

In the present study, following findings noted as shown in concerned table.

Table 1: Age and gender distribution of studied victims

Age (years)	Male		Female		Total	
	No.	%age	No.	%age	No.	%age
0-10	9	8.2	4	3.6	13	11.8
11-20	13	11.8	2	1.8	15	13.6
21-30	29	26.4	7	6.4	36	32.7
31-40	22	20.0	2	1.8	24	21.8
41-50	16	14.5	4	3.6	20	18.2
51-60	2	1.8	0	0.0	2	1.8
Total	91	82.7	19	17.3	110	100

Table 1 shows gender distribution, were 91 (82.7%) male patients and 19 (17.3%) female patients. Male/Female ratio is 5:1 (Approx).

Table 2: Manner of studied victims

Etiology	No.	% age
Accidental	82	74.5
Homicidal	23	20.9
Suicidal	5	4.5
Total	110	100

Table 2 showing manner of studied victims, where accidents are most common etiology.

Table 3: Residence wise victims

Residence	Male		Female		Total	
	No.	%age	No.	%age	No.	%age
Rural	66	60.0	9	8.2	75	68.2
Urban	18	16.4	9	8.2	27	24.5
Unknown	7	6.4	1	0.9	8	7.3
Total	91	82.7	19	17.3	110	100

Table 3 showing, residence wise victims, where most common were from rural area.

Table 4: Educational status of studied victims

Educational Status	Male		Female		Total	
	No.	%age	No.	%age	No.	%age
Literate	64	58.2	14	12.7	78	70.9
Illiterate	21	19.1	4	3.6	25	22.7
Unknown	6	5.5	1	0.9	7	6.4
Total	91	82.7	19	17.3	110	100

Table 4 showing Educational status of studied victims, where most common patients were literate.

Table 5: Seasonal incidence of studied victims

Season	Male		Female		Total	
	No.	%age	No.	%age	No.	%age
Summer March to June	18	16.4	6	5.5	24	21.8
Rainy July to Oct.	33	30.0	6	5.5	39	35.5
Winter Nov. to Feb.	40	36.4	7	6.4	47	42.7
Total	91	82.7	19	17.3	110	100

Table 5 showing Seasonal incidence of studied victims, where winter was most common season.

Table 6: Mode of injury of studied victims

Mode of Injury	Male		Female		Total	
	No.	%age	No.	%age	No.	%age
Assault	9	8.2	1	0.9	10	9.1
RTA	59	53.6	7	6.4	66	60.0
Fall from height	11	10.0	5	4.5	16	14.5
Industrial	6	5.5	2	1.8	8	7.3
Others	6	5.5	4	3.6	10	9.1
Total	91	82.7	19	17.3	110	100

Table 6 showing mode of injury of studied victims where RTA was most common findings.

Table 7: Organ Involvement of studied victims

Organ	Male		Female		Total	
	No.	%age	No.	%age	No.	%age
Liver	31	28.2	7	6.4	38	34.5
Spleen	30	27.3	6	5.5	36	32.7
Small intestine	18	16.4	4	3.6	22	20.0
Stomach	3	2.7	1	0.9	4	3.6
UB	4	3.6	1	0.9	5	4.5
Pancreas	3	2.7	-	-	3	2.7
Genitals	2	1.8	-	-	2	1.8
Total	91	82.7	19	17.3	110	100

Table 7 showing Organ Involvement of studied victims, where liver was most common involved.

Table 8: Mechanism of death involved in studied victims

Mechanism of Death	Male		Female		Total	
	No.	%age	No.	%age	No.	%age
Neurogenic Shock	5	4.6	1	0.9	6	5.5
Hemorrhagic Shock	48	43.6	10	9.3	58	52.7
Infection	38	34.5	8	7.1	46	41.8
Total	91	82.7	19	17.3	110	100

Table 8 showing Mechanism of death involved in studied victims where hemorrhagic shock was most common findings.

Table 9: Pattern of External Injuries

Mechanism	Male		Female		Total	
	No.	%age	No.	%age	No.	%age
Abrasion	27	24.5	5	4.6	32	29.1
Bruise/ contusion	46	41.8	10	9.1	56	50.9
laceration	18	16.4	4	3.6	22	20
Total	91	82.7	19	17.3	110	100

Table 9 showing Pattern of External Injuries, where bruise was the most common findings.

Discussion

Blunt trauma abdominal is foremost stoppable causes of the unnatural death in both developed and developing countries.[3] In civilian life almost 75% of abdominal trauma is non-penetrating injuries. The motive of this research work is to do a prospective study of injuries of abdomen blunt weapon which causes blunt trauma. Blunt traumas are always produced by the external force, in a form of external energy.[6,7,8] Variety of injuries to the human being by application of blunt force ranging in severity from minor to massive destruction.

Age wise distribution of patients in present study revealed that Highest number of patients i.e. 36 (32.7%) belongs to 21-30 years age group. In present study, out of 110 patients 91(82%) were male patients and 19 (17.3%) were female patients may be because males usually are involved in work outside home. Age and sex distribution shows close resemblance with reports of various authors like the study conducted by N. Bayapa Reddy, Hanumantha, Pallavi Madithati et al (2014) in their study[12], study conducted by Roshan Chanchlani, Krisnanand et al[13] (2013) and Mariam Arif, M Maqsood, et al[14] (2014).

In our study accidental cases were most common cause among blunt injury abdomen which was similar to the study conducted by Mousami Singh, Amit Kumar et al[15] (2012).

In our study the majority of male patients belongs to rural community 66 (60%) and 18 (16.4%) belongs to urban community and 7(6.4%) to unknown community, while in females 9(8.2%) belongs to rural community and 9(8.2%) belongs to urban community and 1 (0.9%) to unknown community. The other studies were in contradiction to our study because participants taken by me belong to rural areas. The study conducted by P. Shruthi,V.T. Venkatesh et al[16] (2013) observed that incidents were more in city areas than rural areas, the victims most commonly belong to urban and semi-urban areas.

Accidental deaths was found to be most frequent cause for unnatural deaths (59%), suicidal deaths was found to be (34%) and homicidal deaths was found to be (7%). Traumas were found to be most frequent cases in unnatural death (77.3%) undetermined causes were found to be (16.6%) and toxicological causes were found to be (6.1%). The most common causes of traumatic deaths were blunt head injuries (34%).

In present study majority of victims were literate in both male 64 (58.2%) and female 14 (12.7%) groups. While the study conducted by Nilambar Jha, D.K. Srinivasa, et al[17] (2004) is contradict to our study, in their study, among 494 victims who could be interviewed, 107(21.4%) had education up to 5th class. Ninety-five (19.3%) were educated up to 8th class while 82(16.6%) were illiterates.

In present study, the organ involvement in male victims is liver 31 (28.2%), followed by spleen 30 (27.3%) while in female victims is liver 7 (6.4%) followed by spleen 6 (5.5%). This is because liver is the largest of all organs and more anteriorly placed, thus more susceptible to injury by blunt trauma. Similar results were found in the study conducted by N. Bayapa Reddy, Hanumantha et al (2014)[12].

In present study, mode of injury in studied victims in male group is RTA 59 (53.6%) followed by fall from height 11 (10%) while female victims it is RTA 7(6.4%) followed by fall from height 5 (4.5%). The most outstanding feature is absence of female victims is assault group similar finding was found in study conducted by Mariam Arif, M Maqsood et al (2014)[14] .

In present study, the seasonal incidence of victims in male group is winter (Nov to Feb) 40(36.4%) followed by rainy (July to Oct) 33(30%) and in female victims the seasonal incidence is winter 7 (6.4%) followed by rainy 6(5.5%) and summer 6 (5.5%) which is similar to study done by Ganesh Govekar, Gaurang Patel et al (2007)[18].

In our study, the mechanism of death in studied victims in both male & female group was haemorrhagic shock followed by infection which is smilar to study done by Dr. Y.N. Singh, Dr. Kaustav kr. Bairagi et al (2005)[19]

Figure 1 showing intestinal perforation with gangrenic changes, resection of whole loop were done. Perforation was because of road traffic accident.

Figure 2 showing mesenteric trauma

Figure 3 showing Abrasion on abdomen surrounded with contusion

Conclusion

The study concludes several key findings regarding blunt trauma abdomen. Firstly, it predominantly affects the young and economically active population. Males are significantly more susceptible to abdominal visceral injuries than females, comprising 82.7% of cases. Accidental trauma is the leading cause (74.5%), followed by homicidal (23%) and suicidal (5%) incidents, with road traffic accidents accounting for the majority (59%) of injuries, followed by falls from height (11%). The majority of cases originate from rural areas (60%) compared to urban settings (16.4%), and most victims are literate (58.2%). Liver injuries are the most prevalent among abdominal solid organs (28.2%), followed closely by spleen injuries (27.3%), and pancreas injuries are less frequent (2.7%). The peak incidence occurs during winter (36.4%), followed by the rainy season (30%), with a smaller proportion in the summer (16.4%). Hemorrhagic shock is identified as the primary cause of death (43.6%), followed by infection (34.5%) and neurogenic shock (3.6%).

This study reveals a significant rural-urban disparity, with a majority of accidental victims coming from rural areas (61%) compared to urban areas (14.6%). These findings emphasize the need for tailored prevention and intervention measures in rural communities, addressing the specific risks and barriers to healthcare access in these areas.

Recommendations

Longitudinal studies could provide insights into the long-term economic and social impacts on survivors and their families. Future research should focus on identifying specific risk factors and barriers to healthcare access in rural settings. Comparative studies between rural and urban populations could help develop tailored prevention and intervention strategies. Additionally, future studies should explore these seasonal trends in more detail, considering variables such as weather conditions, seasonal activities, and changes in road conditions. Studies could evaluate the effectiveness of existing road safety policies and explore innovative approaches to reduce the incidence of road traffic accidents. Furthermore, research should also focus on understanding the factors contributing to hemorrhagic and neurogenic shock to develop better prevention and management strategies.

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Original Article

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Knowledge, Attitude and Practice among Health Care Professionals in a Tertiary Hospital Regarding Handling COVID 19 Deceased Bodies: A Questionnaire Based Study

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Abstract

Objective: To assess the knowledge, attitude and practice in handling Covid 19 deceased bodies among health care professionals.

Methodology: A pre validated questionnaire consisting of questions to assess the knowledge, attitude and practice towards dead body care handling and disposal of Covid 19 bodies was given in using google forms to the study participant which included the healthcare professionals working at present in a tertiary care hospital. The responses were categorized into two professional categories: nursing staff and medical doctors. The average positive responses for knowledge, attitude, and practice questions were calculated for each category.

Results: The study was conducted among 140 participants (61 nurses and 79 doctors). It was found that on comparing their knowledge of handling COVID-19 deceased individuals, 73.31% of nursing staff and only 67.88% of medical doctors had accurate knowledge on the subject. When it comes to the attitude while handling COVID-19 deceased individuals, 45.07% of nursing staff and 44.3% of medical doctors exhibited a positive attitude. When it comes to practice of handling COVID-19 deceased individuals, 40.97% of nursing staff and only 34.17% of medical doctors exhibited proper practice.

Conclusion: The findings reveal that nursing staff possess higher levels of accurate knowledge and a positive attitude, though the difference is not statistically significant. However, both groups demonstrate gaps in proper practices concerning the handling of COVID-19 deceased bodies. This study highlights the importance of ongoing training and awareness to improve safe handling procedures, thereby reducing the risk of infection transmission to healthcare professionals.

Keywords: COVID-19 infection, Deceased, Knowledge, Attitude, Practice, Healthcare Professionals.

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Introduction

The Coronavirus Disease-2019(COVID-19) caused by the novel coronavirus SARS CoV-2 were first reported in the month of December 2019 at Wuhan city, China. On 30th January 2020 the World Health Organization had declared it as a Public health emergency of International concern[1]. The mortality rate of COVID 19 infection had drastically increased from a few hundred in the year 2019 to millions in the year 2022. The transmission of virus can occur either directly via secretions from the infected person or indirectly while coming in contact through fomites. Aerosol generating procedures hold the maximum risk of transmitting the infections among health care professionals[2].

The risk of transmission of infection from dead bodies of the patient who died of COVID 19 to the people who are handling it, remains a major concern. Health care professionals are the majority who are under highest risk of acquiring infection as they are in the maximum contact with covid infected patients under many circumstances. Among those, procedures like death care and handling of dead bodies infected with COVID 19 pose a significant role in the risk of transmission[3].

Following death due to COVID 19 infection, the procedure involved in handling, packing, intimation to the authorities, and handing over the body requires adequate knowledge and practice[4,5]. Disinfection of the body and the surrounding surface plays an important role in prevention of disease transmission. Though various studies have been conducted worldwide to assess the knowledge about covid 19 among healthcare providers, very few studies are conducted in India[8,21]. This explorative questionnaire based study aims to assess the knowledge, attitude and practice towards handling of COVID 19 infected dead bodies among health professionals working in a tertiary care hospital in south India.

Objectives

Primary objective:

To assess the knowledge, attitude and practice in handling Covid 19 deceased bodies among health care professionals.

Secondary objective:

To assess the level of association between the profession and the knowledge, attitude and practice in handling Covid 19 deceased bodies.

Methodology

This study is a questionnaire-based study conducted in a tertiary care hospital in South India. The study participants included all the healthcare professionals working at present in a tertiary care hospital in Puducherry. In the study convenient sampling technique is followed. From Previous similar study conducted among staff nurses, prevalence of good knowledge, positive attitude and good practise were 70%, 33% and 91%. Taking the prevalence of 91%, absolute precision of 5 % and 95 % confidence interval the rational sample size is 126 and with 10 % additional participants the sample size is calculated as 140. Based on the existing standard guidelines on Covid body handling, a set of 19 questions was prepared. The questionnaire consisted of all three domains which included knowledge, attitude, and practice related to handling of COVID-19 dead bodies and it was given to a group of experts from the medical fraternity for validation. This validated and pretested questionnaire was prepared using Google Forms and was sent to the participants after obtaining their informed consent. The responses for each question were tabulated in Microsoft Excel (MS office 365 version). The responses were categorized into two professional categories: nursing staff and medical doctors. The frequency and percentage were used to measure knowledge, attitude and practice among each professional category. (Table 1,2 & 3). The chi square test was used to assess the association. P value less than 0.05 is considered as statistical significant.

Table 1: Association between knowledge regarding COVID19 infection and health care professionals

Knowledge questions	Doctors	Nurses	P value
Legal requirement of MLC registration in cases of death due to COVID 19.	87.34%	91.8%	0.248
Legal requirement of post mortem examination in cases of death due to COVID 19.	55.69%	65.57%	1.471
Dead body wrapping in cases of death due to COVID 19.	98.73%	93.44%	0.030
Disinfection of intervention site on dead body wrapping in cases of death due to COVID 19.	84.81%	90.16%	0.285
Dead body wrapping in cases of death due to *SUSPECTED* COVID19.	83.54%	67.21%	0.005
Embalming of a patient who has died due toCOVID19.	43.03%	62.29%	0.007
Transmission of infection from COVID 19infected dead bodies.	16.45%	13.11%	0.546
Disinfection of dead body in cases of death due to COVID 19.	68.35%	91.8%	0.0002
Disinfectants ideally used to disinfect the dead body and the surfaces in cases of death due to COVID 19.	94.93%	98.36%	0.248
Handing over the dead body in cases of death due to COVID 19 to relatives.	22.78%	37.7%	0.013
Government protocols to be followed while handing over the dead body in cases of death due to COVID 19 to relatives.	91.13%	95%	0.267
Total	67.88%	73.31%	0.438

Table 2: Association between attitude and health care professionals towards COVID19 infected dead bodies

Attitude questions	Doctors	Nurses	P value
Giving instructions to the relatives about appropriate behavior while handling the COVID19 infected body at the cremation site	69.62%	88.52%	0.0008
Giving instructions to the relatives that they can collect the ashes (remains of dead bodies after cremation) ofCOVID19 infected dead bodies.	18.98%	1.63%	0.0008
Total	44.3%	45.07%	0.886

Table 3: Association between practice and healthcare Professionals towards handling COVID 19 dead bodies

Practice questions	Doctors	Nurses	P value
Body donation in cases of death due to COVID 19 infection.	74.68%	85.24%	0.077
Appropriate bodypacking for a COVID19 dead body.	29.11%	39.34%	0.135
Bio-safety level (BSL) precaution practiced during COVID 19 pandemic?	34.17%	31.14%	0.650
Decontamination of vehicle used for transportation of COVID 19 dead body to the cremation site.	16.45%	8.19%	0.081
Total	38.60%	40.97%	0.772

* There was no statistical significance between professional categories and knowledge, attitude and practice regarding handling Covid 19 deaths except for questions on knowledge on dead body wrapping in cases of death due to COVID 19, suspected COVID 19 cases, about embalming of a patient who has died due to COVID 19, on disinfection of dead body in cases of death due to COVID 19 and on attitude questions at 5% level of significance.

Results

The study was conducted among 140 participants (61 nurses and 79 doctors) in a tertiary care hospital in South India. The clinical speciality of participants of this study and designations are shown in Figure 1 & 2. The average positive responses for each question and for each parameter like knowledge, attitude and practice were tabulated for each professional category. (Table 1, 2 & 3). The participant's working experience in wards catering health care needs to COVID-19 infected individuals and handling deceased bodies were tabulated in Table 4.

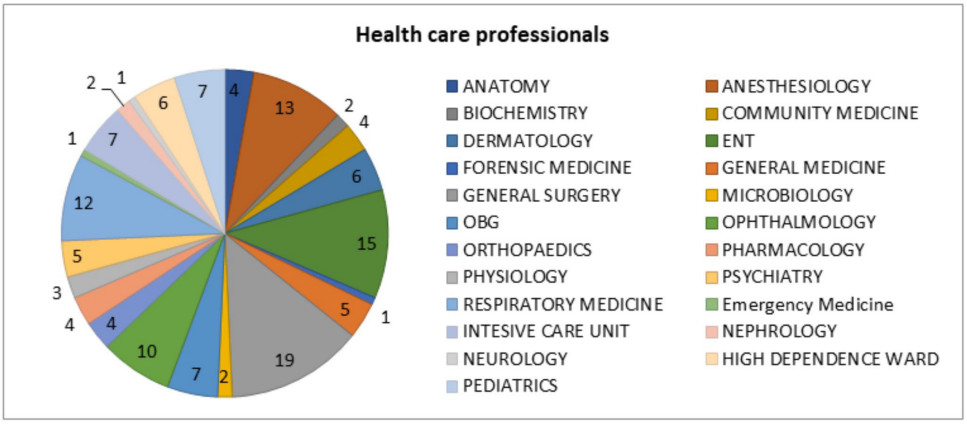

Figure 1: Speciality representation of participants

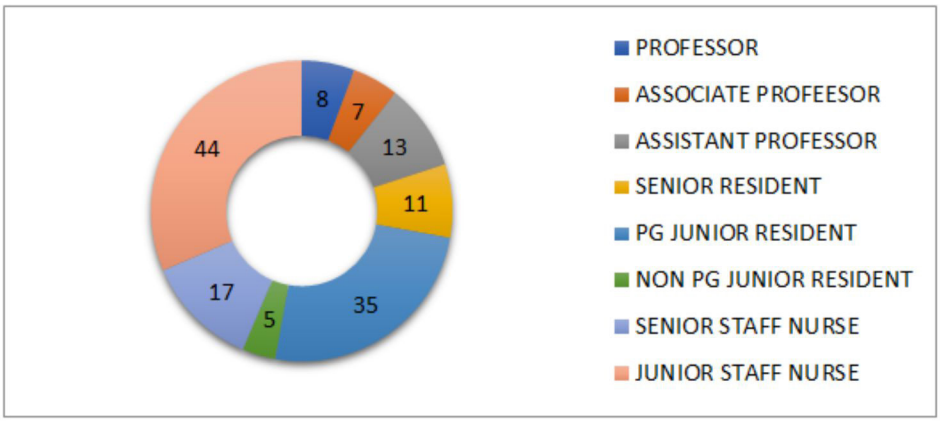

Figure 2: Designation of participants

Table 4: COVID 19 - working experience of healthcare professionals

S.No	Working experience	Doctors (%)	Nurses (%)	Total (%)
1	Working in COVID – 19 ward	54 (68.35%)	50 (81.96%)	104 (74.3%)
2	Providing death care to COVID – 19 deceased individuals	19 (24.05%)	22 (36.06%)	41 (29.28%)
3	Handing over of dead bodies of individual died due to COVID 19 infection to relatives or government authorities	24 (30.37%)	18 (29.5%)	42 (30%)

The knowledge, attitude and Practice of health care professional categories of various other studies were compared in Table 5, 6 & 7. Though in this study the nursing staff exhibited higher levels of correct knowledge, positive attitude and demonstrated proper practice than medical doctors the difference showed by them is not statistically significant except for few questions (P value more than 0.05).

Discussion

Knowledge regarding handling covid-19 infected individuals and dead bodies:

Worldwide, most studies conducted have shown that nurses possess adequate knowledge about COVID-19[6-20], and very few studies show that they have moderate knowledge[21-23](Table 5). In our study, 73.31% of nursing staff possessed accurate knowledge, while only 67.88% of medical doctors had correct knowledge on the subject.

The disparity in knowledge levels between nursing staff and medical doctors on the subject of COVID-19 can be attributed to several factors. First, nurses often have more direct and frequent patient interactions, which could necessitate a more immediate and practical understanding of COVID-19 protocols and safety measures. They may also participate in ongoing in-service training and professional development programs to stay updated on emerging information about COVID-19 focused to ensure the safety of themselves and their patients. On the other hand, while medical doctors may have a strong foundation in general medical knowledge, their focus may be more specialized, depending on their area of practice. They may rely on their nursing staff to implement and carry out day-to-day infection control measures, potentially leading to less emphasis on acquiring detailed knowledge about COVID-19 procedures and protocols.

Table 5: Comparison of knowledge level among healthcare providers in various studies about Covid 19 infection.

Country	Study population	Knowledge level
Saudi Arabia	527 nurses	89–90% had good knowledge [6]
Saudi Arabia	Nurses	96.85% had very good knowledge [7]
India	380 nurses	Sufficient awareness[8]
Northern Ethiopia	415 nurses	74% had good knowledge[9]
Pakistan	78 nurses	Good knowledge[10]
Iran	85 nurses	56.5% had good knowledge [11]
Lebanon	311 nurses	Majority had sufficient knowledge [12]
Ghana	196 nurses	Adequate knowledge [13]
Indonesia	368 nurses	77.4% had good knowledge [14]
Indonesia	305 nurses	99.7% had good knowledge[15]
Bangladesh	380 nurses	73.42% had good knowledge[16]
Turkey	102 nurses and 149 doctors	Nurses mean score 90.26; doctors mean score 92.78 [17]
Turkey	123 nurses	89.43% had extensive knowledge[18]
Egypt	183 nurses	Satisfactory knowledge [19]
Nepal	750 nurses	44.8% had moderate knowledge[20]
India	315 nurses	Clinical features knowledge satisfactory; diagnosis, treatment, and vaccine knowledge 56.2%[21]
China	237 interns	Good knowledge about origin and prevention; insufficient knowledge about treatment and incubation[22]
Bangladesh	384 nurses	Moderate knowledge (mean score 34.20) [23]

Attitude regarding handling covid-19 infected individuals and dead bodies:

Regarding the attitude of the participants, it was observed that though in most of the studies the health care professionals exhibited a positive attitude (Table 6), but in our study, 45.07% of nursing staff only exhibited a positive attitude, whereas only 44.3% of medical doctors displayed a positive attitude.

The variations in positive attitudes towards COVID-19 among nursing staff and medical doctors across different studies and regions can be attributed to several factors. Access to high-quality training and education, along with institutional support and resources, may foster a more proactive attitude. Conversely, high workload and stress levels can contribute to negative attitudes due to burnout. Additionally, public perception and media coverage of COVID-19 may influence healthcare workers' attitudes, as well as their personal assessments of safety and risk. Together, these factors explain the observed differences in the positive attitudes of healthcare professionals towards COVID-19.

Table 6: Comparison of Attitude among healthcare providers in various studies towards Covid 19 infected Individuals

Country	Study population	Positive attitude percentage/score
Saudi Arabia	527 nurses	87% well adapted to open learning attitude[6]
Saudi Arabia	Nurses	60.4% high positive attitude[7]
Northern Ethiopia	415 nurses	72% had a good attitude[9]
Indonesia	Majority of nurses	Average score of 33.0[14]
Indonesia	305 nurses	99.3% positive attitude[15]
India	315 nurses	73.3% had good attitude scores[21]
Egypt	183 nurses	98% positive attitude[19]
Pakistan	78 nurses	Positive attitude towards COVID-19[10]
Ghana	196 nurses	Good attitude towards COVID-19[13]
Bangladesh	384 nurses	Moderate mean score of 27.60[23]

Practice regarding handling covid-19 infected individuals and dead bodies:

Regarding the proper practice of the participants, though it was observed in the following studies that they exhibited proper practice towards Covid 19 infected patients (Table 7), in our study, only 40.97% of nursing staff demonstrated proper practice, while only 34.17% of medical doctors exhibited proper practice. The variations in proper practice observed among nursing staff and medical doctors across different studies and regions can be attributed to several factors: Differences in access to resources, training, workload, institutional support, risk perception, and cultural factors influence how healthcare professionals adhere to COVID-19 protocols. Limited access to PPE, training, and support, combined with high workloads and varying perceptions of risk, leads to inconsistent practices across regions and studies.

Table 7: Comparison of proper practiceamong healthcare providers in various studies towards handling Covid 19 infected Individuals

Country	Study population	Proper practice percentage/score
Northern Ethiopia	415 nurses	67% had good prevention practices[9]
Pakistan	78 nurses	Followed correct protocols to prevent infection[10]
Lebanon	311 nurses	84.6% followed infection prevention and control measures[12]
Bangladesh	380 nurses	73.42% had good practice[16]
Indonesia	368 nurses	Good practice[14]
Indonesia	305 nurses	88.2% had good practice[15]
Egypt	183 nurses	Satisfactory practice[19]
Ghana	196 nurses	Good practices towards COVID-19[13]
Bangladesh	384 nurses	Moderate mean score of practice (13.10)[23]

Conclusion

This study explores the knowledge, attitude, and practice among healthcare professionals in a tertiary hospital located in south India regarding the handling of deceased bodies of individuals who died from COVID-19. This research underscores the necessity of strengthening educational initiatives and adherence to standard guidelines for the safe and respectful handling of deceased bodies in the context of the pandemic. To better handle future epidemics like COVID-19, several proactive initiatives can be implemented. Firstly, ongoing education and training programs for healthcare professionals on infectious disease management and proper handling of deceased bodies should be established. These programs would include up-to-date information on protocols and safety measures. Secondly, healthcare institutions should invest in robust infection control measures, including the use of advanced personal protective equipment (PPE) and sanitation technologies. Thirdly, protocols for efficient communication and coordination between different healthcare departments and public health authorities are essential to ensure timely responses to emerging health crises. Lastly, fostering public awareness and education campaigns on preventive measures and the importance of early detection and treatment can contribute significantly to controlling the spread of infections. By adopting these initiatives, healthcare systems can enhance their preparedness and resilience against future epidemics.

Ethical Clearance: This study was conducted after the approval of Institutional Ethics Committee clearance of with reference number **RC/2022/165 dated 03.10.2023.**

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Conflict of Interest: Nil

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Original Article

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A Cross-Sectional Study on Age-Related Changes in Knowledge and Perception of Medico-Legal Autopsies

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Abstract

Our study investigated the knowledge, attitudes, and perceptions of medical students, residents, and the general public towards medicolegal autopsies in Northern region, India, in the year 2023. Significant disparities were identified in knowledge perspectives, influenced by age. Younger adults, particularly those falling in the age group of 20-29 years showed higher levels of knowledge (35.33%) about autopsies as compared to the older adults falling in the age group of 60 and above showed lower levels of knowledge (100%). Overall, 802 participants (72.6%) had a negative perception in regards to medicolegal autopsy while 302 participants (27.4%) had a positive perception towards medico legal autopsy. This research study highlights the varying levels of knowledge and perception towards medicolegal autopsies among different age groups, emphasizing the need for targeted educational strategies to bridge the knowledge gaps and calls for collaborative efforts among stakeholders to build public trust, advance forensic medicine practices, and improve public health outcomes.

Keywords: Autopsy, Communication, Death, Knowledge, Perception.

Introduction

Autopsy is derived from a Greek word "Autos" which means oneself and "Opsis" which implies sight and the word together denotes "to see for oneself". Autopsy aims at establishing the identity in case of unknown bodies, determining the time since death, and aids in reaching towards the cause of death. It helps in understanding the manner of death whether natural or unnatural (homicidal, accidental, or suicidal.[1] Whenever a medical practitioner is acting as an expert witness in the court of law, he should possess a fair knowledge of all the branches of medical sciences. Global trends of medicolegal issues are gradually on the rising numbers and are gaining the attention of the general public. Likewise, many complaints which are being lodged against the physicians are also on the rise in the developing

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countries.[2] The autopsy is divided into various types namely, forensic or medicolegal autopsy, pathological autopsy, and clinical autopsy.[3] In India, a medico-legal autopsy is conducted by a qualified registered medical person which includes medical officers. There exist multiple myths and misapprehensions amongst the common people regarding the importance and procedure of medicolegal autopsy. The people concerned with the conduction of medicolegal autopsy which includes police personnel and medical officers have an inherent duty of explaining the various queries regarding medicolegal autopsy to the family members of the deceased. Medical professionals should know what a layperson thinks of and their reaction to their exposure to autopsy protocol. The attitude of the public to be positive will largely depend upon how well the details and procedure of the autopsy are being told.[4]

This study is timely and necessary, as it provides critical insights into how knowledge and perceptions regarding medico-legal autopsies change with age. It also contributes to the sparse research available on this topic in India, highlighting the need for targeted public education to overcome myths and misconceptions. By identifying age-related gaps in knowledge and perception, the study can guide future educational strategies and policies, improving public trust in forensic medicine and supporting better legal and health outcomes.

Materials and Methods

This cross-sectional anonymous knowledge and perception questionnaire-based study was conducted at our medical college which investigated the knowledge and perceptions of public towards medico legal autopsies. The questionnaire consisted of:

- Age
- Knowledge Assessment: Multiple-choice questions assessing participants'knowledge related to medico legal autopsy.
- Perception: Multiple choice questions to gauge participants' perceptions and confidence regarding medico legal autopsy.

Utilizing a validated questionnaire, the sample size of the study was 1104 participants of different age groups. Data was analyzed using statistical methods to provide insights into these disparities and formulated in the form of tables so that it can be compared with studies conducted in the other parts of the world.

The sample size was selected to ensure a diverse representation of medical students, residents, and the general public from Northern India, allowing for meaningful age-based comparisons. Participants were sourced through random sampling. The questionnaire tested knowledge, attitudes, and perceptions of medico-legal autopsies, referencing similar studies but without conducting a pilot.

Results & Discussion

In this study a self-structured validated anonymous questionnaire with 30 questions related to medicolegal autopsy in knowledge and perception domains was distributed to the participants of the research study who have given informed consent to participate in the study.

Table 1: Showing age wise distribution of the study population.

Age Group	No. of participants	%
20-29 Years	917	83.06%
30-39 Years	74	6.70%
40-49 Years	80	7.25%
50-59 Years	25	2.26%
≥60 Years	8	0.72%
Total	1104	100%

Knowledge towards Medico legal Autopsy

Table 2 represents the comprehensive comparison of the study population based on their age with the level of knowledge which they possess towards medicolegal autopsy. As depicted by the data in the table, the age group of 20-29 years shows the highest score of knowledge with a percentage level of 35.33% and 324 individuals falling in this category. While the age group of = or > 60 years age group are the highest among the individuals having a lower score of knowledge towards medico legal autopsy.

Table 2: Comparison of age groups in years of the study population with their level ofknowledge towards medico legal autopsy.

Age Group(Years)	Knowledge				Total	%	Fisher's Exact	p value
	Low (N=743)		High (N=361)					
	N	%	N	%				
20-29 Years	593	64.67%	324	35.33%	917	83.06%	32.090	0.001
30-39 Years	51	68.92%	23	31.08%	74	6.70%		
40-49 Years	73	91.25%	7	8.75%	80	7.25%		
50-59 Years	18	72%	7	28%	25	2.26%		
≥60 Years	8	100%	0	0%	8	0.72%		
Total	743	67.30%	361	32.70%	1104	100%		

Age appeared to influence participants' knowledge of medico legal autopsy procedures in this study. Younger participants, such as undergraduate medical students and postgraduates, demonstrated higher familiarity with the process compared to older individuals, possibly due to recent exposure to academic curricula and clinical settings.

The studies conducted in Eastern Province, SaudiArabia (West Asia) [5] Edo, Benin (West Africa) [6], Cotonou, Benin (West Africa[7], Ile-Ife, Nigeria (Africa[8], Awolowo University, Nigeria (Africa) [9], Assam, India (Asia)[1],Chitradurga, Karnataka, India (Asia)[10], Malaysia (South- east Asia)[11], Nepal (South Asia)[12], Stockholm, Sweden (Northern Europe)[13], Cambridge, United Kingdom (North West Europe) [14], While it is higher in 30 – 40 years age group in a study conductedat Imphal, Manipur, India (Asia)[15]. These interventions suggest tailored educational strategies to address age-related disparities in knowledge acquisition and retention.

Study	Study Year	Age group withhigh level of knowledge (in years)	Age group with lowlevel of knowledge (in years)
Present study	2023	20 - 29	= or > 60
Eastern Province, Saudi Arabia (West Asia)[5]	2015	21 - 30	30 - 40 +
Edo, Benin (West Africa)[6]	2019	19 - 25	40 – 60
Cotonou, Benin (West Africa)[7]	2022	17 - 24	35 – 64
Ile- Ife, Nigeria (Africa)[8]	2019	22 - 35	40 – 65
Awolowo University, Nigeria (Africa)[9]	2020	25 - 35	36 – 49
Assam, India (Asia)[1]	2022	20 - 30	40 – 60
Imphal, Manipur, India (Asia)[15]	2023	30 - 40	50 – 60
Chitradurga, Karnataka, India (Asia)[10]	2013	20 - 30	31 - 50 +
Malaysia(South-east Asia)[11]	2016	18 - 25	30 - 40+
Nepal (South Asia)[22]	2018	20 - 30	31 – 50
Stockholm, Sweden (Northern Europe)[13]	2016	20 - 30	31 - 50+
Cambridge, United Kingdom (North West Europe)[14]	2015	20 - 30	31 – 40 +

Perception towards Medico legal Autopsy

Table 3 illustrates the comparative analysis of the age of the study participants with their level of perception towards medicolegal autopsy. The tabular representation demonstrates the significant association between the age in years of the study participants with their level of perception, which is either positive or negative in the respective study, towards medico legal autopsy.

Table 4: Comparison of age in years of the study population with their perception towards medico legal autopsy.

Age Group (Years)	Perception				Total	%	Fisher's Exact	p value
	Negative (N=802)		Positive (N=302)					
	N	%	N	83.06%				
20-29 Years	649	70.78%	268	6.70%	917	83.06%	15.316	0.004
30-39 Years	55	74.32%	19	7.25%	74	6.70%		
40-49 Years	71	88.75%	9	2.26%	80	7.25%		
50-59 Years	19	76%	6	0.72%	25	2.26%		
≥60 Years	8	100%	0	100%	8	0.72%		
Total	802	72.64%	302	27.36%	1104	100%		

The general public's understanding varied widely across age groups, with younger respondents showing greater interest and awareness compared to older individuals, who might rely more on traditional beliefs or limited exposure to medical information. The findings indicate that younger participants, typically aged 20 to 30 years, generally hold positive perceptions of medico legal autopsy in most studies, including those from Stockholm[13], Cambridge[14], Nepal[12], Chitradurga[10] and Malaysia[11]. In contrast, older age groups tend to exhibit negative perceptions, with notable variations across studies. For instance, the Present Study and the Malaysian[11] study highlight a significant negative perception among individuals aged 60 years and above, while the Imphal[15], India study identifies a negative perception among younger adults (18-34 years). Additionally, the Awolowo University study reveals a negative perception among those aged 35 to 49 years. Table 5 : patterns suggest a regional and age-related variability in perceptions, reflecting how age and possibly cultural context influence attitudes towards medico legal autopsy.

Table 5: The table provides a comparative overview of how different age groups perceive medico legal autopsy across various studies conducted in different regions over the years.

Study	Study Year	Age group with positive perception (in years)	Age group with negative perception (in years)
Present study	2023	20 - 29	= or > 60
Awolowo University, Nigeria (Africa)[9]	2020	25 - 34	35 – 49
Imphal, Manipur, India (Asia)[15]	2023	34 - 60	18-34
Malaysia (South-east Asia)[11]	2016	18 - 25	30 - 40+
Nepal (South Asia)[12]	2018	20 - 30	31 – 50
Stockholm, Sweden (Northern Europe)[13]	2016	20 - 30	31 - 50+
Cambridge, United Kingdom (North West Europe)[14]	2015	20 - 30	31 - 40 +
Chitradurga, Karnataka, India (Asia)[10]	2013	20 - 30	31 - 50+

Conclusion

In conclusion, the comparative analysis of public knowledge and perception towards medico-legal autopsies reveals distinct differences, particularly between younger and older individuals. The general public's perception is often shaped by limited exposure and misinformation, especially among aged individuals, where misconceptions are prevalent. Media depictions of autopsies frequently exaggerate or misrepresent their purpose and procedures, further misleading the public and fostering negative views. This study underscores the need for educational initiatives and transparent communication to correct these misconceptions, fostering a better understanding of the critical role autopsies play in healthcare and the legal system. For forensic experts, the findings are invaluable as they highlight public knowledge gaps, enabling targeted outreach efforts. By addressing these disparities, forensic professionals can build trust, improve collaboration with families and communities, and ultimately enhance the quality of medico-legal investigations.

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Original Article

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Forensic Analysis of Electrical Injury Patterns: A Study of Electrocution Fatalities at SMS Medical College Jaipur

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Abstract

Objective: To provide an in-depth forensic analysis of the types and locations of electrical injuries observed in electrocution deaths, focusing on the presence of entry and exit wounds, the voltage involved, and associated burns.

Methods: This hospital-based observational study examined 75 cases of electrocution fatalities autopsied at the mortuary of SMS Medical College Jaipur from June 2021 to June 2022. Data on demographics, injury types, wound locations, voltage levels, and burn patterns were collected and analyzed. Descriptive statistics were used to summarize the data, and chi-square tests assessed the significance of categorical variables.

Results: Among the 75 cases, males accounted for 92% of the victims, with the majority aged 21-30 years (34.4%). Upper limb injuries were predominant (38.67%), and both entry and exit wounds were present in 48% of cases. Low voltage (65.33%) was the most common electrical source, and flame burns were observed in 44% of the cases. Shock – Septicaemia was the primary cause of death (58.66%).

Conclusions: This study highlights the forensic significance of analysing injury patterns in electrocution deaths. Understanding these patterns aids in determining the cause and manner of death, emphasizing the need for preventive measures and public awareness to reduce such fatalities.

Keywords: Electrocution, Forensic Analysis, Electrical Injuries, Injury Patterns, Autopsy, Jaipur.

Introduction

Electrocution, a fatal consequence of electrical injuries, remains a significant public health issue with substantial forensic implications. The advent of electricity, while revolutionizing modern society, has also introduced a pervasive hazard, capable of causing

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severe injury and death. Understanding the forensic characteristics of electrical injuries is essential for the accurate determination of the cause and manner of death, crucial in both legal contexts and preventive strategies. Electrical injuries can result from various sources, including household appliances, industrial equipment, and natural phenomena like lightning. The forensic investigation of such injuries involves meticulous examination of the scene, the victim, and the pattern of injuries. Electrocution fatalities typically present with characteristic injuries, such as entry and exit wounds, which are critical for determining the path of the electrical current through the body. Studies have consistently shown that the entry wound is often located on the hands or fingers, suggesting that the victim grasped the electrical source. Exit wounds, if present, are frequently found on the feet, indicating that the current traversed the entire body. These injuries are accompanied by thermal burns, tissue charring, and sometimes internal organ damage due to the high voltage involved.[1]

Forensic pathology plays a vital role in the investigation of electrocution deaths. Autopsies reveal specific patterns of injury that can differentiate electrocution from other causes of death. For instance, the presence of Lichtenberg figures, a fern-like pattern on the skin, is a unique marker of lightning strikes.[2] Histopathological examination can further elucidate the extent of tissue damage and confirm the diagnosis of electrical injury.[3]

In addition to physical examination, the investigation involves assessing the circumstances of death. This includes examining the electrical source, the environment, and any safety violations. Forensic experts collaborate with electrical engineers to reconstruct the event, ensuring a comprehensive understanding of the incident.[4]

Epidemiological studies indicate that electrocution deaths exhibit certain demographic patterns. Males are disproportionately affected, often due to occupational hazards in industries such as construction and maintenance.[5] Seasonal variations are also observed, with a higher incidence of electrocution deaths during the summer months, likely due to increased outdoor activities and the use of electrical devices.[6]

In developing countries, the risk is exacerbated by inadequate safety measures and lack of awareness. Public health initiatives aimed at education and stringent enforcement of safety regulations are crucial in mitigating these risks. The forensic community must advocate for such measures to prevent future fatalities.[7]

Numerous studies have documented the forensic characteristics of electrocution deaths. Pathak and Disania[1] conducted a retrospective study highlighting the common patterns of electrical injuries and their forensic implications. They emphasized the importance of detailed scene examination and autopsy in establishing the cause of death. Similarly, Marak et al.[8] examined the demographic profile and injury patterns in electrocution deaths, underscoring the role of forensic analysis in identifying safety lapses and preventing future incidents.

Kiran et al.[9] analyzed autopsy findings in electrocution cases, noting the prevalence of entry and exit wounds and associated burns. Their study reinforced the need for forensic pathologists to be vigilant in detecting subtle signs of electrical injury. Dokov[6] provided a comprehensive review of suicide cases involving electrocution, revealing a distinct pattern and suggesting preventive measures.

The present study aims to expand on the existing knowledge by providing an in-depth forensic analysis of electrocution fatalities at SMS Medical College, Jaipur. The study focuses on identifying the types and locations of electrical injuries, the voltage involved, and the presence of entry and exit wounds. By analysing these factors, the study seeks to contribute to the body of forensic knowledge and enhance the accuracy of electrocution death investigations.

Materials and Methods

This hospital-based observational study was conducted at the mortuary of SMS Medical College Jaipur after approval from the Institutional Ethical Committee (224/MC/EC/2021 – 19/03/2022)..The study included 75 cases of electrocution deaths. Eligibility criteria included fatalities resulting from electrical injuries autopsied at SMS Hospital, with informed consent obtained from legal heirs. Exclusion criteria comprised suspected electrocution deaths not verified on autopsy and decomposed or mutilated bodies. The sample was selected to ensure a representative population, accounting for variables such as age, sex, and domicile. This approach

aligns with the SAGER guidelines for reporting demographic data on sex and gender, ensuring that the study's findings are applicable to the broader population .Data was gathered from autopsy reports, police inquest papers, and eyewitness accounts. Variables studied included age, gender, domicile, site of injury, presence of entry and exit wounds, voltage involved, and associated burns. A detailed examination was conducted on each body to identify the types and locations of electrical injuries. The presence of entry and exit wounds was meticulously recorded, along with any associated burns. The voltage of the electrical source was determined based on witness accounts and the examination of the incident site. Primary and secondary outcomes were clearly outlined. The primary objective was to analyze the patterns of electrical injuries in electrocution fatalities. Secondary objectives included investigating the presence of entry and exit wounds, the voltage involved, and associated burns.

Statistical Analysis

Descriptive statistics summarized demographic data and injury patterns. Chi-square tests assessed the significance of categorical variables, with a p-value <0.05 considered statistically significant. Statistical analyses were performed using SPSS software (version 25).

Quantitative findings were presented with appropriate indicators of measurement error or uncertainty, such as confidence intervals. Statistical terms, abbreviations, and symbols were clearly defined to ensure transparency and reproducibility.

Results

Demographic Data

Gender: Out of 75 cases, 69 (92%) were male and 6 (8%) were female, resulting in a male-to-female ratio of 11.5:1.

Table 1: Distribution of Subjects According to Gender

Gender	No. Of Subjects	Percentage
Male	69	92 %
Female	6	8 %
Total	75	100.00

Age Group: The majority of the victims fell within the 21-30 years age group (34.4%), followed by those aged 31-40 years (26.6%). This demographic trend is consistent with previous studies, which have demonstrated a higher risk of injuries among younger males. The predominance of male victims can be attributed to the fact that many are employed in occupations with higher exposure to electrical hazards. Specifically, 23 individuals sustained injuries in indoor work environments, while 21 were injured in outdoor settings.

Table 2: Age Group wise Distribution among Subjects.

Age Group	No. of Male	No. of Female	No. of Subjects	Percentage
1-10	1	1	2	2.66%
11-20	11	0	11	14.66%
21-30	24	2	26	34.4%
31-40	18	2	20	26.6%
41-50	8	0	8	10.6%
51-60	6	0	6	8%
61-70	1	1	2	2.66%
Total	69	6	75	100%

Injury Patterns

Site of Injury: Upper limbs were the most common site of injury (38.67%), followed by lower limbs (36%). Injuries to the head and neck were less frequent (2.66%). The predominance of upper limb injuries suggests that victims often come into contact with electrical sources using their hands.

Table 3: Distribution of Subjects According to Site of Electric Injury

Site Of Electric Injury	No. of Subjects	Percentage
Head, Neck & Lower Limb	2	2.66%
Abdomen	2	2.66%
Chest	1	1.33%
Abdomen & Lower Limb	1	1.33%
Chest & Lower Limb	1	1.33%
Chest, Abdomen & Upper Limb	1	1.33%
Chest, Upper Limb & Lower Limb	2	2.66%
Lower Limb	6	8%
Upper Limb	29	38.67%
Upper Limb & Lower Limb	27	36%
No injury	3	4%
Total	75	100

Entry and Exit Wounds: Entry wounds were present in 44% of cases, while both entry and exit wounds were observed in 48%. Exit wounds alone were found in 4% of the cases. The presence of both entry and exit wounds is crucial for confirming electrocution as the cause of death.

Table 4: Distribution of Subjects According to Presence of Wound

Wound	No. Of Subjects	Percentage
Entry & Exit Present	36	48%
Entry Only	33	44%
Exit Only	3	4%
Entry & Exit Absent	3	4%
Total	75	100%

Figure 1: Entry wound over hidden area in the incidence of Electrocution by desert cooler

Figure 2: Entry wound of Electrocution on index and middle finger

Figure 3: Exit marks of Electric current on Sole

Figure 4: Showing Exit wound of Electric injury on great toe and sole

Voltage: Most fatalities involved low voltage (65.33%), while high voltage accounted for 34.66%. Low voltage injuries were primarily associated with domestic incidents, whereas high voltage injuries were more common in occupational settings.

Table 5: Distribution of Subjects According to Voltage

Voltage	No. of Subjects	Percentage
High Voltage	26	34.66%
Low Voltage	49	65.33%
Total	75	100%

Burns: Flame burns were more common (44%) than flash burns (13.33%). No burns were observed in 42.67% of the cases. Flame burns often indicate prolonged contact with an electrical source, whereas flash burns result from brief exposure.

Table 6: Distribution of Subjects According to Associated Burn

Associated Burn	No. of Subjects	Percentage
Flash	10	13.33%
Flame	33	44%
No Burn	32	42.66%
Total	75	100%

Cause of Death

The primary cause of death was Shock – Septicaemia (58.66%), followed by Shock – Electrocution (36%). Shock – Septicaemia often results from extensive tissue damage and subsequent infection, highlighting the severe internal injuries caused by electrical currents.

Table 7: Distribution of Subjects According to Cause Of Death

Cause of Death	No. of Subjects	Percentage
Coma	1	1.33%
Shock - Electrocution	27	36%
Shock - Hemorrhagic	2	2.66%
Shock - Septicemia	44	58.66%
Shock – Spinal	1	1.33%
Total	75	100%

Table 8: Distribution of Subjects According to Cause of Death and Type of Associated Injury and Degree of Voltage

Cause of Death	Type of Associated Injury	Degree of Voltage	No. of Subjects
Coma (1)	Flash	High	0
		Low	0
	Flame	High	0
		Low	0
	No Burn	High	1
		Low	0
Shock - Electrocution (27)	Flash	High	0
		Low	4
	Flame	High	7
		Low	3
	No Burn	High	6
		Low	7
Shock - Hemorrhagic (2)	Flash	High	0
		Low	0
	Flame	High	0
		Low	0
	No Burn	High	2
		Low	0
Shock - Septicemia (44)	Flash	High	0
		Low	6
	Flame	High	6
		Low	17
	No Burn	High	3
		Low	12
Shock - Spinal (1)	Flash	High	0
		Low	0
	Flame	High	0
		Low	0
	No Burn	High	1
		Low	0

Discussion

The findings of this study align with those reported in previous literature. Gupta et al. (2012) found that electrocution deaths predominantly affected males, with a male-to-female ratio similar to our study.[10] Saha and Joe (2010) also reported a high incidence of electrocution fatalities among young adults, with most incidents occurring in domestic settings.[5]

Ragui et al. (2013) observed that electrocution deaths were more common in males aged 21-30 years, which is consistent with our findings. They also noted that high-tension wires were a significant cause of electrocution deaths, whereas our study found that low voltage was more common.[11] This discrepancy could be attributed to regional differences in electrical infrastructure and safety practices.

Pathak et al. (2015) reported a seasonal variation in electrocution deaths, with a higher incidence during the monsoon season. Our study did not specifically analyze seasonal trends, but the predominance of domestic incidents suggests that weather-related factors might influence the occurrence of electrocution injuries.[1]

Balasubramaniam (2016) conducted an autopsy-based study and found that most electrocution deaths involved entry wounds on the upper limbs, similar to our findings.[12] The presence of both entry and exit wounds was also commonly observed, emphasizing the importance of these markers in confirming electrocution as the cause of death.

Kanchan and Menezes (2015) reported that the majority of electrocution deaths in their study involved contact with low voltage sources, which aligns with our findings.[13] They also observed that upper limb injuries were predominant, highlighting the risk associated with handling electrical equipment.

Adhi et al. (2017) found that flame burns were more common in electrocution deaths, which is consistent with our findings.[14] Their study also emphasized the forensic significance of analyzing burn patterns to determine the circumstances of death.

The forensic analysis of electrocution injuries provides critical insights into the circumstances of death. The presence of entry and exit wounds is a key indicator of electrocution, helping to differentiate it from other causes of death. In our study, 48% of cases had both entry and exit wounds, which aligns with the findings of previous studies.[12]

The location of injuries is also significant. Upper limb injuries were the most common in our study, consistent with the findings of Gupta et al. (2012) and Saha and Joe (2010). This pattern suggests that victims often make contact with electrical sources using their hands, highlighting the need for protective measures when handling electrical equipment.[5,10]

Understanding the voltage involved in electrocution deaths is crucial for forensic investigations. Low voltage was the most common in our study, similar to the findings of Marak et al. (2017) and Choudhary et al. (2017).[8,15] However, high voltage injuries, which accounted for 34.66% of cases in our study, are often associated with more severe injuries and higher fatality rates.

Burn patterns provide additional forensic evidence. Flame burns were more common than flash burns in our study, indicating prolonged contact with the electrical source. This finding is supported by the work of Pathak et al. (2015), who also observed a higher prevalence of flame burns in electrocution deaths.[1]

Preventive Measures

Public awareness campaigns and strict adherence to electrical safety standards can significantly reduce the incidence of electrocution deaths. Regular maintenance of electrical appliances and infrastructure is essential. The study highlights the need for targeted safety interventions, particularly in domestic settings where most incidents occur.[16]

Educational programs should emphasize the dangers of electrical currents, especially low voltage, which is often perceived as less dangerous. Proper handling and maintenance of electrical appliances, use of safety equipment, and adherence to safety protocols can prevent many fatalities.[17]

Implementing safety measures such as the use of residual current devices (RCDs) and ensuring proper grounding of electrical systems can prevent electrocution incidents. Public health policies should focus on regular inspections and enforcement of electrical safety regulations in both residential and occupational settings.[18]

Conclusions

This study provides valuable insights into the forensic analysis of electrocution fatalities. Young males are the most affected, with injuries commonly occurring at home due to low voltage. Forensic

examination of injury patterns is vital for accurate cause-of-death determinations. Enhanced public awareness and safety measures are necessary to prevent such fatalities. The findings underscore the importance of detailed forensic investigations in electrocution cases. By understanding the specific patterns of injury, forensic pathologists can more accurately determine the cause and manner of death, contributing to the broader goal of improving public safety. Future research should focus on developing more effective preventive strategies and exploring the underlying factors contributing to high-risk behaviours. Collaborative efforts between forensic experts, public health officials, and policymakers are essential to reduce the incidence of electrocution deaths and improve overall safety standards.

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Original Article

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Innovative e-learning Methods in Building Competency in Court Room Skills for MBBS Students: An Experience in Medical Learning During Covid-19 Times

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Abstract

Introduction: With the introduction of Competency Based Medical Education (CBME) Curriculum, students have to acquire competency in the listed items and skills, including court room skills (FM 14.22). Medico-legal reports are used at trials whereupon medical officers tender expert witness testimony. During COVID19 lockdown, Phase II MBBS students were trained completely via e-learning. Establishment of Corpus Delicti, Age Report, in trial of Juveniles in conflict with law was selected for imparting testimonial skills and understanding of courts and legal procedures as well as Juvenile Justice Act (JJAct) and Child Welfare Committee (CWC).

Objectives: Training Phase II MBBS students of KMCT Medical College, Kozhikode by e-learning methods in 6 weeks and assessing the competency via Moot Court presentation.

1. To provide a clear understanding of Indian legal system, courts and its procedures.
2. To provide a clear understanding of elements of Corpus Delicti and establishment of Corpus delicti via evidential testimony.

Competencies addressed: FM3.1-3.2,FM 1.3-1.6,FM 14.22(skills)

Methods: Surrogate court room was created by students via zoom platform under guidance to familiarize deposition of evidence in a court of law. E-learning methods were used-Google classroom, Zoom, YouTube, WhatsApp. Creative writing of case by students and online sessions on steps of evidence tendering by faculty were done.

"Moot Court" Role Play by students (in three teams-Juvenile Justice Board Child Welfare Committee, Prosecution, Defence) was guided by faculty and evaluated by RUBRIC.

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Results & discussion:

- During 6weeks period Phase II CBME students underwent training and acquired competency in Identity, Legal procedures & Court Room skills completely by e-learning methods.
- The SLOs were acquired by most students by single session.

Conclusion: Through only online sessions the students were enabled with the basic understanding of practical aspects of corpus delicti, summons, court room procedures and expert testimony deposition. The student feedbacks were testimonials of their appreciation for active learning and success of innovative e-learning.

KEYWORDS: e- learning, courtroom skills, Forensic Medicine, competency, Corpus Delicti.

Introduction

With the introduction of the Competency Based Medical Education (CBME) Curriculumin 2019, the students are to acquire competency in the different listed items and skills, one of which is court room skills as per FM 14.22. Medico-legal reports are prepared by medical officers primarily for use at trials whereupon they tender expert witness testimony. As a part of training of Forensic Medicine as per the new curriculum Phase II MBBS students were to be given training in the above topics when the colleges all over India were locked down and education was completely e-learning for a period.

Age Report (Identity Reports) concerns establishment of Corpus Delicti especially in trial of Juveniles in conflict with law and this background was selected for imparting testimonial skills and also understanding of courts and legal procedures as well as elements regarding Juvenile Justice Act (JJ Act) and Child Welfare Committee (CWC).

As per the earlier curriculum, before 2019 introduction of the CBME curriculum, there was no specific skills training and student attainment of skills mandated for competency in courtroom skills and establishment of Corpus Delicti. Hence, the topic was taught with discussion in interactive lecture sessions and practical sessions for clarity of the concept. But, with introduction of CBME curriculum, students have to be competent in certain certified skills, in which are included Corpus Delicti, age estimation report and expert evidence deposition by a doctor in a court of law.

Due to COVID 19 lockdown in the entire nation, it was impossible for the faculty to train the students by giving them first hand exposure by visualising the court room procedures in a court of law. Hence, we decided to create a simulated environment utilising the e-learning platforms available - Google classroom and Zoom to give in-person first-hand experience to the students to overcome the above challenges and attain the required skills and competencies.

There was a need to evaluate the success of the outcome of training the students using this innovative method, to understand if the students have attained clarity in understanding the court room procedures and establishment of elements of Corpus Delicti via only e-learning methods. Hence an evaluation analysis was also conducted to ascertain the efficacy of this teaching-learning method implemented by the faculty.

Objectives

Surrogate exposure to court room procedures to the Indian Medical Graduate in making, to competently deliver the duty of medical expert witness in a court of law.

To understand if students trained only via e learning are provided with clear understanding of Indian legal system, courts and court room procedures of expert evidence deposition, elements of corpus delicti and establishment of corpus delicti in a court of law via evidential testimony.

Competencies addressed: FM3.1-3.2,FM 1.3-1.6, FM 14.22(skills)

Methods Implemented:

Training 150 Phase II MBBS students of KMCT Medical College, Kozhikode in Courts and Legal Procedures by suitable e-learning methods in a period of 6weeks (24/5/2021 to 05/07/2021) and

assessing the attainment of competency via Moot Court presentation at the end of the period.

Competencies addressed included FM 3.1-3.2, FM 1.3-1.6, FM 14.22(skills)[1]

As a preparation for the surrogate court room presentation, the students were given lecture, small group discussions (SGD) and online creative writing workshop on topics of Corpus delicti, summons and court room procedures, from which one of the story lines was picked up for the theme of Moot Court – a Juvenile in conflict with law. The students were provided with several selected video clippings on court room procedures to watch, followed by critical appraisal session in groups under faculty guidance.

E-learning platforms used included- Google classroom, Zoom, WhatsApp, YouTube

Google classroom was utilised for sharing reading materials prepared by faculty. It was also used along with Whatsapp academic group for conveying instructions and guidelines regarding preparation and discussion of the script. Step by step guidance and corrections were also conveyed using these two platforms. YouTube was perused for searching and sharing videos depicting different aspects of court room procedures. It was also useful for understanding and critical analysis of each depicted step since it provided with wide exposure of scenarios in different languages. Evaluation and analysis by students, guidance and correction of concepts by faculty was made easier with the use of Whatsapp academic group and Zoom sessions.

- Preparation Phase :
    - The students were made competent in biometric identification, age assessment methods and the concept of Corpus Delicti before planning the moot court sessions. For this, they were divided into small groups of 10 members each, who then had competitions on creative writing on Corpus Delicti during which they created crime stories bearing medico- legal significance of age.
    - One of these story lines was selected for trial in a Juvenile Court setting – of Jamie, a homeless juvenile in conflict with law, involved in a theft case being tried in JJB and CWC offering care and support at the end of the trial.
    - Short interactive sessions on Indian Legal System-Laws, Courts & Legal Procedures, Juvenile Justice system and relevant AETCOM Components were carried out via Zoom platform for the entire class by faculty members in different sessions.

All classes for preparatory session were taken online live streaming via Google classroom and Zoom. Printed materials prepared by faculty were shared online via Google classroom and Whatsapp academic group for perusal by students.

- **Execution Phase:**
    - **Selection of educational material:** 15 Student small groups of (10 members each, total of 150 students) communicated through "Whatsapp" academic group actively collecting multiple short video clippings, of duration 10 to 15 minutes, available online, depicting different angles of court room procedures i.e roll call, swearing in, chief examination, cross examination, re examination, questions by court. These video clippings available in different languages were collected , segregated and selected under continuous guidance of faculty. One video each was selected from these by each small group.
    - **Analysis:** Each video depicting one or more components of testimony was critically appraised by the student groups using a predesigned outline supplied as to correctness of different steps in evidence tendering in a court of law namely (a) Oath / swearing in (b) conduct and testimony during chief examination and cross examinations (c)questions by the court and responses to them (d)witness turning hostile (e) elements of perjury (f) AETCOM elements including conduct & dos and don'ts during testimony deposition. The students were given a briefing on dos and don'ts pertaining to each step in evidence deposition i.e., not swearing in for the evidence deposition,

asking leading questions, prompting in chief examination, introduction of new evidence in cross examination without prior presentation of it, accepted manners in maintaining a proper demeanour in a court of law, contempt of court, declaring a witness as hostile, or declaration of perjury. Some of the elements were invariably present in all the video clippings and the students under faculty guidance were able to identify and point out the mistakes in the video clippings streamed by the other team members. Elements like types of witnesses, hostile witness, perjury were also highlighted in certain videos which were clearly analysed. An outline for critical appraisal was given to the students in advance, to be used while viewing/ observing the videos to comment on the videos of other groups at the end. Any team other than the presenting team would, after watching the video is streamed, analyse the streamed video clipping by discussing among them selves and sort out what element is rightly and wrongly represented in the video and give reasons for their final observation and impression. These were approved or corrected by the presenting team, other teams and faculty. Faculty would then give the final impression on each video case session.

This drill helped the students to have a clear idea of each step of evidence deposition in a court of law. Each team was to select a video, which according to them depicted all steps of evidence tendering correctly but with one element that is wrongly featured in the video. The elements that are correctly represented and also the incorrect elements with reasons had to be identified and analysed by the students.

- **Synthesis:** "Moot Court" (Role Play) [4] was presented on 5th July 2021 by students in sequential groups. The whole batch of 150 students were divided into three natural sequential groups of 50 each. The students were given a broad outline of the trial sequence and offered guidance in developing it and clearance of doubts online. The students were guided by the faculty and maximum student participation was ensured by the faculty.

  The groups were:

  - **A**. Court officials, Juvenile Justice Board Members, Child Welfare Committee Members and Judges. A role of Court Master was created for smooth conduct of the T-L session
  - **B.** Prosecutors and Prosecution witnesses including common witness (layman), Medical Experts for age and Injury, Fingerprint Expert and Investigating Police Officer
  - **C.** Defence Lawyers and their witnesses. Several students enacted the role of JJB Member or Prosecutor or Defence Lawyer – since each witness was chief examined and cross examined by different student role players and JJB member was also different to ensure maximum student participation in online role play of the trial (Moot Court).

- **Evaluation Phase:**

  - The performance was evaluated by faculty by RUBRIC. At the end of the moot court session, the students were assessed using a form for points regarding topics on steps of evidence tendering in the court.

    Students' perception of usefulness of the sessions for future performance as Indian Medical Graduate was analysed using a feedback form.

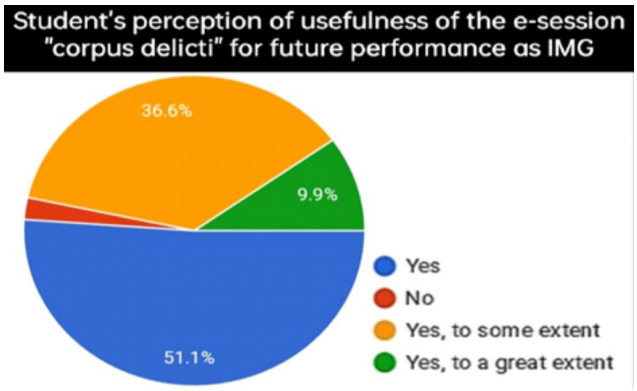

Figure 1

Results and Discussion

The sessions enabled the students with the basic understanding of elements of corpus delicti, practical aspects of summons and court room procedures including conduct rules that an expert witness is expected to follow with dignity[3]to maintain good demeanour in a court of law.

- During a period of 6 weeks, extending from 24/5/2021 to 05/07/2021, Phase II CBME students underwent training in Identity, Indian legal system, Legal procedures & Court Room skills with respect to expert witness evidence testimony, completely by e-learning methods to the satisfaction of students and faculty to acquire competency in these topics.
- The set learning objectives were found to be acquired by 80 % of the students by single training exposure.80% of students had clarity on steps of court room proceedings, apart from which,60% of students had clear answers on all the types of witnesses also and20% of students had only partially acquired the clarity on details of steps of expert evidence deposition in a court of law.
- Blooms cognitive levels classifies learning into different levels including knowledge, comprehension, analysis, synthesis and evaluation. The set learning objectives included all 6 levels of cognitive domains (Bloom)[5] & were found to be acquired by most of the students by one session as evaluated by role play since it included skills also. Students were found to have understood clearly by performance the facts related to the steps of evidence tendering, applied it in analysing the video clippings and evaluated the steps depicted in it. They recreated and performed scenario compiling all the steps of evidence tendering by an expert in a flawless manner.
- It was trying for the faculty to continuously monitor all the groups simultaneously and correct them, but the active interest shown by the students even after study hours and enthusiasm for learning and doing the roles appropriately brought energy to the CBME programme implementation. The students were in awe of such experience and after completion of the session they volunteered to upload the video of the online moot court Zoom session in the YouTube[4] as an appreciation for the innovative active learning techniques implemented by the faculty. This unplanned expressive move of positive feedback from the students was unexpected by the faculty and brought much joy and gave hope to proceed further with more similar sessions with active student involvement.

This innovative method was one of a kind, an earl venture and not implemented in Undergraduate training since implementation of CBME curriculum since it was implemented in the very first batch of CBME MBBS students and during complete lockdown and introduction of complete online e-learning sessions in the country, which was first of a kind to happen in India since introduction of CBME curriculum in undergraduate training.

Conclusion

- 2019 MBBS (CBME) batch students of KMCT Medical college, in their Phase II, during a period of 6 weeks, were imparted training in Court Room skills using online platform and critical appraisal as educational tools for understanding court room expert testimony deposition.
- They were evaluated by Rubric during the Court Room Drama enacted by the students.
- Student feedbacks were testimonials for their appreciation for active innovative methods of learning.
- As faculty members, we also found the experience quite satisfying to attain the set SLOs in this regard efficiently.

- **Challenges:**
- Arranging a real court room observation for 150 students was practically unfeasible, especially during COVID 19 lockdown situation, whereas critically appraising simulated scenes proved equally or more effective.
- The project demanded more input and involvement of faculty well beyond the department working hours.
- Planning meticulously made it possible to overcome the possible foreseeable challenges during the execution phase.

Further Plan Scheduled: In stage 2, the phase III part 1 students be made to perform multiple role plays as expert witness in the court room to develop the testimonial skills in different practical sessions wherein the faculty will be playing the role of legal professionals in the court for guidance.

Here we intend to share our experience on the effective coverage of multiple topics with active involvement of the fresh batch of 150 students via hybrid teaching sessions, online- in Phase II (preparatory sessions of 2 hours each every week for 6 weeks using multiple online platforms and presentation and evaluation during the 1 hour online moot court session via zoom platform) and offline - in Phase III part1, to attain the learning outcomes of rendering the Indian Medical Graduate (IMG) capable of preparation of valid medico legal reports, understanding the Indian Legal System, courts and its procedures and giving the expert evidence testimony in a court of law in addition to attaining the right attitude of positive demeanour in a court and that of the concept of a 'good doctor'.

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Ethical Clearance: NA

Conflicts of Interest statement: NA

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Original Article

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Association of ABO Blood Group with Coronary Atherosclerosis: An Autopsy Based Cross Sectional Study Conducted in a Tertiary Care Hospital

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Abstract

The incidence of the cases of sudden unexpected deaths due to cardiovascular causes are readily increasing worldwide. The coronary arterial heart disease is considered to be epidemic in India. Previous literatures show that ABO blood group is an inherent risk factor for the development of coronary atherosclerosis apart from the conventional risk factors. The present study was conducted during June 2020 to April 2021with a sample size of 100 cases aged 25 to 50years whose hearts were examined by routine techniques and blood grouping done by slide agglutination technique. It showed that there was a statistically significant association between the ABO blood group and coronary atherosclerosis with p-value of 0.012. In general, the non-O blood group especially the blood group-A had higher risk for coronary atherosclerosis when compared to the O-blood group individuals. As this incidence occurs at a much younger age group, it is recommended that the screening for coronary atherosclerosis should begin at a much younger age especially by including the screening for ABO blood group apart from the conventional risk factors as blood group A had higher risk. Further, this study also opens up the gate for genetic studies in future in order to understand the exact association between ABO blood group and the coronary atherosclerosis at the gene level in detail.

Keywords: ABO blood group, Coronary atherosclerosis, Inherent risk factor, Younger age.

Introduction

Non – communicable diseases are the diseases of long duration and slow progression. The diseases of the cardiovascular system tops in the list of non – communicable diseases followed by diabetes mellitus, diseases of the respiratory system and cancer, etc. They together besides producing significant morbidity and disability, they are also

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the leading cause of mortality worldwide. Among the various causes of the sudden unexpected deaths, the cardiovascular cause is the most common cause of the sudden unexpected death. About 8 percentage of the cardiovascular deaths is due to the disease of the coronary arteries[1]. About more than 19 million people die of acute coronary event consequent upon coronary artery disease every year worldwide[2].

According to the report of Registrar General of India, it was reported that the mortality rate due to coronary artery disease is higher in the Southern India whereas the mortality rate in Northern India was mainly due to stroke[3]. It was also estimated that the incidence of the cardiac diseases occurs about 10 to 15 years earlier in Indian population than the people of other countries [4]. The atherosclerotic coronary artery disease is of greater concern among the young adults because of its potential to cause a greater incapacitation. As the coronary atherosclerosis and its complications pose a serious health concern among the society, this study aimed to find out the association between the ABO blood groups and the coronary atherosclerosis.

Materials and Methodolgy

The study of the atherosclerotic coronary arterial diseases is an extremely difficult task in the living subjects and so the postmortem examination is the best possible method to study them. The present study is conducted in the Department of Forensic Medicine and Toxicology at the Government Stanley Medical College, Chennai. The cases which were subjected to postmortem examination in the age group of 25 to 50 years were studied. The study was conducted during the one year period from June 2020 to April 2021 in this centre. After receiving the request for the postmortem examination, the autopsy is conducted. During the autopsy, the heart was taken out by the routine dissection technique. Then about 2ml of blood is collected from the right ventricle using a sterile syringe and needle for the purpose of doing blood grouping. The blood grouping is done by the standard slide agglutination technique. Then the heart specimen is subjected for examination. All the coronary vessels are examined for the presence of atherosclerosis by making serial sections at an interval of 2 to 3mm. After making gross examination of the vessels, then multiple sections are taken from the coronary arteries and subjected to histopathological examination.

Study Design: Cross – Sectional Study.

Study Population: All the cases in the age group of 25 to 50 years subjected to postmortem examination in Govt. Stanley Medical College and Hospital Mortuary.

Place of the Study: Department of Forensic Medicine and Toxicology at the Government Stanley Medical College, Chennai.

Study Period: One year (from June 2020 to April 2021).

Inclusion criteria:

- All cases in the age group of 25 to 50 years subjected to postmortem examination in Govt. Stanley Medical College, Chennai Mortuary on receiving requisition from the concerned Investigating Officer.

Exclusion criteria:

- All the cases where the bodies are decomposed.
- Heavily mutilated dead bodies where organs are heavily damaged.
- Cases with previous history of any cardiac surgeries like CABG, etc.
- People belonging to different ethnic and racial groups.

Results and Observations

The collected data was analysed with IBM SPSS Statistics for Windows, Version 23.0 (Armonk, NY: IBM Corp). To describe about the data descriptive statistics, frequency analysis, percentage analysis was used for categorical variables and the mean and S.D were used for continuous variables. To find the significance in categorical data Chi-Square test was used. In the above statistical tool, the probability value 0.05 is considered as significant level.

Table 1: Comparison between Coronaries with ABO Blood group:

			Blood group				Total
			A	B	O	AB	
Coronaries	Normal lumen without atherosclerosis	Count	5	20	25	4	54
		%	23.8%	55.6%	67.6%	66.7%	54.0%
	With atherosclerotic changes	Count	16	16	12	2	46
		%	76.2%	44.4%	32.4%	33.3%	46.0%
Total		Count	21	36	37	6	100
		%	100.0%	100.0%	100.0%	100.0%	100.0%

χ 2- value= 10.870, p=0.012*

* Statistically significant difference as p < 0.05 level

The above table 1 shows the comparison between coronary atherosclerosis with ABO Blood groups by Pearson's chi-square test which shows χ^2 =10.870, p value = 0.012. It shows that there is statistically significant association between Coronary atherosclerosis and ABO Blood groups as the p value is less than 0.05.

This shows that blood group A has highest percentage followed by blood group B, O and AB. This is in concordance with the study conducted by KANCHANA SUJIRACHATO et al [5].The study conducted by P.H.WHINCUP et al [6] also showed that the prevalence of coronary atherosclerosis and ischaemic heart disease was higher among the A – blood group individuals. The study conducted by YOUNIS A.M. SKAIK also showed that the blood group – A was most commonly associated with the myocardial infarction[7].

The systematic review and meta-analysis conducted by ZHUO CHEN et al., also showed that the risk of CAD was higher in non – O blood group than the O-blood group individuals with an Odds ratio of 0.85[8]. The study conducted by CLARA CARPEGGIANI et al., showed that the non – O blood group was significantly associated with the family history of coronary atherosclerosis[9]. Few studies such as conducted by MITCHELL et al.,[10] and PRIYANKA GARG et al.,[11] showed that O-blood group has higher risk for coronary atherosclerosis.

In a study conducted among the young patients with myocardial infarction at London, about 39% of the participants of the study showed positive family history with the findings of premature coronary arterial heart disease [13]. The children born to the parents with the premature coronary arterial heart disease had an increased rate of prevalence for the insulin resistance, abnormalities in the lipid metabolism and obesity which strengthens the belief that all these are having a common genetic lineage which will be inherited as well [12]. These group of individuals with a positive family history will have more number of arterial abnormalities than the other persons who had myocardial infarction without any positive family history for coronary atherosclerosis especially among the individuals aged less than 45 years [14].

Recently several studies conducted by genome – wide association showed that the variants at the ABO locus in the chromosome was associated with the plasma lipids. This in turn will lead to increased levels of the plasma lipid in certain ABO blood groups thereby increasing the risk for the development of the atherosclerosis [15, 16]. There are also several other studies which showed that the variants at the ABO blood group locus was associated with the certain inflammatory markers such as the soluble intercellular adhesion molecule – 1 (ICAM -1), plasma soluble P – Selectin and E – Selectin levels and TNF – α (Tumour Necrosis Factor – α) in the blood. These inflammatory markers were the markers of inflammation for the development of the coronary heart disease [17-21].

Table 2: Comparison between LAD (Left Anterior Descending Artery) Atherosclerosis with ABO Blood group:

			Blood group				Total
			A	B	O	AB	
LAD	0 - 25% occlusion	Count	7	10	8	1	26
		%	43.8%	66.7%	66.7%	50.0%	57.8%
	26 - 50% occlusion	Count	6	3	2	1	12
		%	37.5%	20.0%	16.7%	50.0%	26.7%
	51 - 75% occlusion	Count	3	2	1	0	6
		%	18.8%	13.3%	8.3%	0.0%	13.3%
	75 - 100% occlusion	Count	0	0	1	0	1
		%	0.0%	0.0%	8.3%	0.0%	2.2%
Total		Count	16	15	12	2	45
		%	100.0%	100.0%	100.0%	100.0%	100.0%

χ 2- value= 6.341, p=0.705*

*No Statistically significant difference as p > 0.05 level

The above table shows comparison between different grades of atherosclerosis in LAD with ABO Blood group by Pearson's Chi-square test which shows χ^2 = 6.341, p value = 0.705. This shows that there is no statistically significant association between different grades of atherosclerosis in LAD and ABO Blood group.

Table 3: Comparison between RCA (Right Coronary Artery) Atherosclerosis with ABO Blood group:

			Blood group				Total
			A	B	O	AB	
RCA	0 - 25% occlusion	Count	4	5	3	1	13
		%	80.0%	83.3%	60.0%	100.0%	76.5%
	26 - 50% occlusion	Count	1	1	1	0	3
		%	20.0%	16.7%	20.0%	0.0%	17.6%
	51 - 75% occlusion	Count	0	0	1	0	1
		%	0.0%	0.0%	20.0%	0.0%	5.9%
Total		Count	5	6	5	1	17
		%	100.0%	100.0%	100.0%	100.0%	100.0%

χ 2- value= 2.906, p=0.821*

*No Statistically significant difference at p value > 0.05 level

The above table shows comparison between different grades of atherosclerosis in RCA with ABO Blood groups by Pearson's chi-square test which showed χ^2=2.906, p value = 0.821. It shows that there is no statistically significant association between different grades of atherosclerosis in RCA and ABO Blood groups.

Table 4: Comparison between LCX (Left Circumflex Artery) Atherosclerosis with ABO Blood group:

			Blood group			Total
			A	B	O	
LCX	0 - 25% occlusion	Count	0	5	4	9
		%	0.0%	100.0%	100.0%	90.0%
	26 - 50% occlusion	Count	1	0	0	1
		%	100.0%	0.0%	0.0%	10.0%
Total		Count	1	5	4	10
		%	100.0%	100.0%	100.0%	100.0%

χ 2- value= 10.000, p=0.007 **

** Highly Statistically significant difference at p < 0.01 level

The above table shows comparison between different grades of atherosclerosis in LCX with ABO Blood group by Pearson's chi-square test which shows χ^2=10.000, p value = 0.007. It shows that there is statistically significant association between different grades of atherosclerosis in LCX with ABO Blood group.

Table 5: Comparison between LCA (Left Coronary Artery) Atherosclerosis with ABO Blood group:

			Blood group	Total
			O	
LCA	0 - 25% occlusion	Count	2	2
		%	100.0%	100.0%
Total		Count	2	2
		%	100.0%	100.0%

NA-Not Applicable

The above table shows comparison between different grades of atherosclerosis in LCA with ABO Blood group by Pearson's Chi-Square test were χ2-value, p-value is not applicable as 2x2 table is not formed.

Conclusion

The main purpose of this study was to determine the association of ABO blood group with coronary atherosclerosis. From the results of this study, it may be concluded that there was statistically significant association between the ABO blood group and the coronary atherosclerosis. The persons with blood group – A were at the highest risk of developing coronary atherosclerosis followed by the blood group – B individuals, then by the blood group – O individuals and then least by the individuals with blood group – AB.

In general, the persons with Non – O blood groups (A, B, AB) had higher risk for coronary atherosclerosis when compared to the persons with O blood group. But when individual coronary artery is considered, there was no statistically significant association of coronary atherosclerosis with the ABO blood group except in the LCX. The left anterior descending artery is the most common coronary artery involved in atherosclerosis. In all the coronary arteries, 0 – 25% occlusion of the lumen by coronary atherosclerosis was most commonly seen.

Limitations:

This study was conducted among the individuals in the age group of 25 to 50 years in a single centre only with a sample size of 100 during the study period. Although the association between the ABO blood group was established with the development of coronary atherosclerosis significantly, but the exact mechanism of association between ABO blood group and the coronary atherosclerosis is still unclear. Also, the subgroups of A-blood group (A1 and A2) could not be studied in detail.

Recommendations:

As the present study showed that apart from the traditional risk factors for CAD like diabetes, hypertension, smoking and alcohol, utmost care should be given to the ABO blood group also as it plays a vital role in association with the development of coronary atherosclerosis as evident from the present study. So, the blood grouping should be included in the routine screening for coronary atherosclerosis

and the persons with Non – O blood group especially Blood group – A must be educated to be extra cautious and avoid the other modifiable risk factors in order to prevent the development of atherosclerotic coronary artery disease and its consequences.

Health education has to be provided to the general population regarding the association of ABO blood group and coronary atherosclerosis in order to reduce the death rate of the disease and thereby improving the quality of life.

Further, the present study also recommends for multicentric studies with a large sample size including all the age groups and all the ethnic groups of population in future inorder to study the association between ABO blood group and coronary atherosclerosis in detail. It also recommends genetic studies regarding the association of ABO blood group and coronary atherosclerosis in future can be conducted inorder to find out the exact nature of this association at the gene level so that the family members can also be screened and prevent the morbidity and mortality of the disease.

Conflict Of Interest: Nil.

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Original Article

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Human Cranial Vault Thickness in Relation to Age, Sex and General Body Build in a South Indian Population

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Abstract

Background & Objectives: During legal investigations, the forensic pathologist is often required to give an opinion regarding personal identification of the deceased. The bone that is among the most helpful for these investigations is the skull. As to my knowledge, this is the first study of its kind in this part of the world where an attempt is made to find any correlation between cranial vault thickness, age sex and general body build in a population group.

Methods: The study was commenced after obtaining Institutional Ethics Committee clearance certificate (AJEC/REV/95/2016). Materials for the present study consists of eighty-two South Indian origin victims autopsied at the mortuary of A. J. Institute of Medical Sciences, Mangaluru, Karnataka between November 2016 and October 2018. The victims comprised of both the genders in the age group of 18-80 years belonging to various parts of South India (Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Telangana & Union territories of Lakshadweep & Pondicherry).

Results: The victims in the age group of 18-80 years belonging to various parts of South India The average stature among males was 168.69 ± 10.98 and ranged from 148cm and 192cm. There was found to be a significant correlation between the occipital thickness and the sexes. There was found to be no significant correlation between different areas of cranial vault thickness with respect to each other and also between cranial vault thickness with height, weight or general body build.

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Interpretation & Conclusion: The present study emphasizes the utility of cranial vault thickness in identifying individuals. It also provides useful insights in the fields of calvarial bone grafting and neurosurgery.

Keywords: Autopsy; Cranial Vault Thickness; Fragmentary remains; General body build;

Introduction

Identity is the aggregate of characteristics by which an individual is recognized by himself and others. Identification is an easy process in the living, but when it comes to unknown, mutilated, decomposed of skeletonized bodies, it becomes difficult.. In medico-legal practice, the establishment of the identity of an individual is of paramount importance in civil as well as criminal disputes. [1]

This study is an attempt to identify the existence of any relation between cranial vault thickness and whether any points regarding the age, sex or body build of a person can be deduced from cranial vault thickness alone.

Another application for knowing the cranial vault thickness is in neurosurgery, especially while drilling burr holes for decompression surgeries. Knowing the depth up to which the hole should be drilled will help in better planning of the surgical team and will help in being better equipped during emergency procedures.

Aims & Objectives of the study:

The aims of this study is to report the variation in cranial vault thickness in a contemporary South Indian population and to provide insight into the relation between cranial vault thickness and body mass index, stature, age, and sex.

Three measurements are taken at each location and the average of the three values is taken to minimize the observer error and bias.

Association between the cranial thickness measurements and the categorical variables (sex) was evaluated with and were compared between the sexes, for different age groups, different heights, weights and body mass index by means of an independent samples t test. All statistical analyses were performed with IBM SPSS Statistics 21.

Sample and sampling technique:

Materials for the present study consists of 82 South Indian (Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Telengana & Union territories of Lakshadweep & Pondicherry) origin victims aged between 18 years and 80 years autopsied at the mortuary of A. J. Institute of Medical Sciences, Mangaluru, Karnataka between November 2016 and October 2018.

Inclusion criteria:

Materials for the present study consists of 82 South Indian (Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Telengana & Union territories of Lakshadweep & Pondicherry) origin victims autopsied at the mortuary of A. J. Institute of Medical Sciences, Mangaluru, Karnataka between November 2016 and October 2018.

All victims were between the ages of 18 years and 80 years provided there are no exclusion factors.

Exclusion criteria:

- Victims who originate from parts of India other than Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Telangana and Union Territories of Lakshadweep and Pondicherry are excluded as the area where the hospital serves has a diverse south Indian population from 3 states and 1 union territory
- Victims, who were either below the age of 18 years or above the age of 80 years, are excluded, as there will be increased bone resorption with age and this will result in a false thinner average[2]
- Those who had a known history of Alcohol abuse or were on chronic psychiatric medication are excluded. It has also been documented and studied that chronic alcoholics and those on chronic psychiatric medications will have increased skull thickness. If included this would result in an increased false average thickness[3]
- Any pathological conditions and head trauma that hampered correct measurements or cases with missing data or obviously flawed measurements (e.g., body weight in a severely burnt individual) are excluded from the study.

Results

Among the 82 cases, 61 (74.4%) were males and 21 (25.6%) were females as shown below in Table no.1 and Fig.12. The male female ratio was 2.9:1.

Most of the cases (31.7%) of our study were in the age group of 30 to 45 years. This was followed by the age group between 45 to 60 years which accounted for 26.8% of the total cases. The youngest victim was 18 years old and the oldest was 80 years old.

Majority of the study population (54.9%) had body weight ranging from 40-60 kg followed by body weight ranging from 60-80 kg. Only 4 of the victims had body weight exceeding 80kg.

The largest group comprising of 42.7% of the study population belong to the stature ranging from 170-180cm followed by 29.3% having stature ranging from 160-170cm.

Majority of the victims (59.8%) had ideal body mass index whereas 17 victims (20.7%) were overweight.

The mean frontal thickness in males is 6.45±1.52mm and the mean frontal thickness in females is 7.62±2.50mm. The difference in mean was not found to be statistically significant with independent T test as the P value is 0.054.

The mean euryon thickness in males is 6.98±1.60mm and the mean euryon thickness in females is 6.90±1.54mm. The difference in mean was not found to be statistically significant with independent T test as the P value is 0.829.

The mean occipital thickness in males is 8.67±1.75mm and the mean occipital thickness in females is 7.61±1.76mm. The difference in mean was found to be statistically significant with independent T test as the P value is 0.019.

Males and females did not differ significantly in cranial thickness except for the occipital region where there was statistically significant difference with males having thickest measures.

There is no statistically significant correlation between the thicknesses of the cranial vault sites in relation to each other as the P values are all greater than 0.05.

There was no statistically significant correlation between cranial thickness and age for frontal thickness, euryon thickness and occipital thickness as shown in table 1.

Table No 1: Pearson correlation matrix for cranial thickness for age and sex

		Age	
		Correlation coefficient	**P value**
Frontal	Male	-0.071	0.585
	Female	-0.169	0.463
Euryon	Male	0.009	0.943
	Female	-0.217	0.344
Occipital	Male	-0.202	0.118
	Female	0.377	0.092

There was no statistically significant correlation between cranial thickness and weight for frontal thickness, euryon thickness and occipital thickness as shown in Table 2.

Table No 2: Pearson correlation matrix for cranial thickness for weight and sex

		Weight	
		Correlation coefficient	**P value**
Frontal	Male	0.066	0.616
	Female	0.133	0.567
Euryon	Male	0.098	0.450
	Female	0.327	0.148
occipital	Male	-0.123	0.345
	Female	0.088	0.703

There was no statistically significant correlation between cranial thickness and height for frontal thickness, euryon thickness and occipital thickness as shown in Table 3.

Table No 3: Pearson correlation matrix for cranial thickness for height and sex

		Height	
		Correlation coefficient	P value
Frontal	Male	0.191	0.141

	Female	0.273	0.232
Euryon	Male	-0.137	0.291
	Female	0.291	0.201
Occipital	Male	0.074	0.571
	Female	0.203	0.378

Discussion

Cranial thickness has been studied by several authors and attempts have been made to correlate thickness with other parameters such as sex, age, height and weight. This study did not show any statistically significant sexual dimorphism in cranial thickness. Although the calculated means did indicate that except for the occipital region where there was statistically significant difference with males having thickest measures. Research conducted by Ross et al. and Lynnerup, showed female skulls were thicker than male skulls at euryon.[4,5] Roche found that ``the average cranial thickness of the males exceeds that of the females at all points where measurements were made except at euryon[6]. Ross MD investigated skull thickness of Black and White races and found that White women have the thickest and White men the thinnest skulls[4]. The skulls of women were statistically significant thicker than those of men in both ethnic groups Ross AH had done research on cranial thickness in American females and males with an objective to examine sex and age variation in cranial thickness in a White sample.[4] An increase in cranial thickness with age was observed and there was no statistical difference in calvarial thickness between male and female.[4] Females having thicker skulls than males (and for both whites and South African blacks), and also reported by Ishida and Dodo for a Japanese sample [7](statistically significant for two measures), and by Smith et al.[8] for Near Eastern populations (a trend, not statistically significant), while Getz reported no sexual dimorphism[9]. The latter studies do not mention examination for hyperostosis frontalis or data on possible bone-related diseases, aside from Ross et al., who mention a frequency of 10% among the females investigated[10]. In a recent study, Ross et al. did not find an overall sexual dimorphic difference until onset of hypostasis frontalis interna, the condition being prevalent among older females[4]. In older individuals (i.e. 55 years and older), Ross et al. found that thickness above a certain measure indicated a female[4]

Roche found no differences in cranial thickness on right and left sides, which is in agreement with the present study[6] .Right and left sides were highly and statistically significantly correlated. This is the reason for opting for measurement from either right or left side.

In this study there was no statistically significant correlation between age and cranial thickness, thus, reflecting results of Schmitt and Saternus, Ishida and Dodo and Ross et al. Todd found a slight increase in one of his measures (vertex) up to 60 years of age, but it is not possible to adequately test this result statistically[11,12,4]

Summary

The present study group comprised of 82 cases of autopsies conducted at the mortuary of A. J. Institute of Medical Sciences & Research Centre. The cranial vault thickness (CVT) measurements were correlated with age, sex and general body build.

- Majority of the study population belongs to male gender (74%). The male female ratio was 2.9:1.
- Significant proportion of the study population (31.7%) was in the age group of 30 to 45 years, followed by the age group between 45 to 60 years which accounted for 26.8% of the total cases. The youngest victim was 18 years old and the oldest was 80 years old.
- Majority of the study population (54.9%) had body weight ranging from 40-60 kg followed by body weight ranging from 60-80 kg.
- The largest group comprising of 42.7% of the study population belong to the stature ranging from 170-180cm followed by 29.3% having stature ranging from 160-170cm.
- Majority of the victims (59.8%) had ideal body mass index whereas 17 victims (20.7%) were overweight.
- The mean frontal thickness in males is 6.45±1.52mm and the mean frontal thickness in females is 7.62±2.50mm. The difference in mean was not found to be statistically significant with independent T test as the P value is 0.054.
- The mean euryon thickness in males is 6.98±1.60mm and the mean euryon thickness

in females is 6.90±1.54mm. The difference in mean was not found to be statistically significant with independent T test as the P value is 0.829.

- The mean occipital thickness in males is 8.67±1.75mm and the mean occipital thickness in females is 7.61±1.76mm. The difference in mean was found to be statistically significant with independent T test as the P value is 0.019.
- Males and females did not differ significantly in cranial thickness except for the occipital region where there was statistically significant difference with males having thickest measures.
- There is no statistically significant correlation between the thicknesses of the cranial vault sites in relation to each other as the P values are all greater than 0.05**.**
- Strong points- Possibly this could be the only research undertaken in this part of the world correlating Cranial Vault Thickness (CVT) to age, sex, and general body build. The results of which could be of great clinical significance wherein they could be used for estimating the depth of burr holes, in neurosurgical interventions, or in estimating the thickness of bone to be grafted in case of loss of significant thickness of bone, or planning and executing craniotomy and cranioplasties in addition to determining the identity forensically.
- **Limitations**: this study can be further valuated by increasing the sample size and by coupling autopsy measurements of calvarial vault thickness wit5h that of measurements obtained from imaging technologies. More impetus to the results can be done by incorporating pre-existing pathological conditions or addictive states which could be having a role in increasing or decreasing the dimensions of cranial vault thickness.

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Ethical Clearance : The study was commenced after obtaining Institutional Ethics Committee clearance certificate (AJEC/REV/95/2016).

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Original Article

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An Autopsy Based Epidemiological Study of Abdominal Injuries in a South India Population

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Abstract

Background: Trauma to the abdomen is a major cause of mortality in India. It is important clinically because abdominal injury poses difficulty in diagnosis and has lethal potential if not immediately treated.

Methodology: This autopsy-based study was aimed at finding the nature and pattern of injuries in the abdomen region. After autopsy examinations of 134 trauma cases involving abdominal injuries, the epidemiological data was compiled and analysed.

Results: Most victims belonged to the age group of 21–40 years (44%), and males outnumbered females in the ratio of 9:1.Road traffic and railway accidents together (77%) accounted for most abdominal injuries. Common intra-abdominal organs injured were liver, spleen, intestines, and kidneys. Liver sustained lacerations (69%) more than contusions (11%). The most frequent associated injuries involved the head (35%), chest, limbs, and spine.

Conclusion: This study concluded that road accidents were the main cause of abdominal trauma, and males in the working age group (21–50 years) were the most affected. Most of the injured persons died on the spot, and hemorrhagic shock (47%), followed by head injury, were the main causes of death. These findings reiterate that efforts could be made to decrease these preventable forms of deaths by creating public awareness about safety measures, both on the road and at workplaces. The fact that many of the injured persons died on the spot highlighted the urgent need for better pre-hospital trauma care and appropriate actions by policymakers.

Keywords: Trauma; Abdominal injuries; Road traffic accidents (RTA); Spot death.

Introduction

Trauma remains the most common cause of death for all individuals between the ages of 1 and 44 years and is the third most common cause of death regardless of age. (1) The abdomen is the largest cavity in the body, which is not protected by any

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bony cage, thus prone to both blunt and penetrative force injuries. Stabbing of the abdomen may lead to the opening of large blood vessels, leading to profuse bleeding. Protrusion of abdominal organs, especially the bowel, out through the wound may be seen in cases of penetrative injury to the abdomen. [2]

Injuries to the chest wall are often associated with significant injury to the liver, and the liver is the second most injured organ in penetrating abdominal trauma. The liver and spleen may bleed extensively, causing a hemoperitoneum. Among patients with blunt injuries, motor vehicle collision is the most common injury mechanism.[3] Around 168491 lives were lost on Indian roads in 2022—an all-time high.[4] Extensive bruising of the gut and its vascular mesentery may occur while the intestines are particularly vulnerable to transection from being compressed against the spine. Ruptures of the liver and spleen are common lesions following serious abdominal trauma, such as a fall from a height or a crush injury, as in traffic impacts. The most common fatal sequel to intra-abdominal trauma is hemorrhage from any of the contained organs.[5]

Injuries to the abdomen are not always isolated but often associated with injuries to other parts, and their involvement may be overlooked. Accurate determination of the nature, extent and cause of abdominal injuries assumes great importance in medico-legal autopsies of RTA victims. However, there is paucity of studies focussing on abdominal injuries in the context of RTAs and other forms of trauma in South India. The present study aimed to bridge this knowledge gap by conducting an autopsy-based analysis of trauma cases reported to a tertiary care hospital. This study tried to analyze the pattern and nature of abdominal injuries, and the findings could serve to extend our knowledge in trauma pathology.

Materials and Methods

Study design & sample size: This was a prospective observational study of 18 months conducted in a teaching hospital in South India during 2014-2016, involving 134 cases with abdominal and other concomitant injuries undergoing autopsy.

Inclusion criteria: All trauma-related deaths subjected to autopsy and found to have abdominal and other associated injuries.

Exclusion criteria: All cases without any involvement of the thoraco-abdominal region, decomposed bodies and burn cases. Cases where trauma type could not be precisely established were also left out.

Data collection and analysis: Relevant information regarding the circumstances of trauma and the course of death was obtained from friends, relatives, and police sources. The details were noted in a pro forma prepared for the study, and data was analyzed using descriptive statistics, where calculations were applied to determine percentages. A formal approval from the Institutions' Ethics Committee (IEC) was taken prior to starting the study.

Results

The profile of injuries obtained from our study are presented in the form of tables below.

Table 1: Genderwise and age group wise distribution of victims (n-134)

Sex	**Numbers**	**Percentage**
Male	121	90.3%
Female	13	9.7%
Total	134	100%
Age Group in years	**Total number of victims**	**Percentage**
0 – 19	13	9.7%
20 – 29	32	23.8%
30 – 39	29	21.7%
40 – 49	24	17.9%
50 – 59	17	12.7%
60 – 69	12	8.9%
70 – 79 & over	7	5.2%
Total	134	100%

Of the 134 autopsied abdominal trauma cases considered, 90% were male, and most belonged to the age group of 21–40 years (n = 61, 45.5%).

Table 2: Mode of abdominal injuries(n-134)

Mode of injuries	Number of cases	Percentage
Road Traffic Accidents (RTA)	89	66.4%
Railway injuries	15	11.2%
Assault by sharp force(Stab/Firearm)	11	8.2%
Fall from height, Fall over sharp object	7	5.3%
Assault by blunt force	03	2.2%
Others (ex. Wall collapse, Bull gore, industrial injury)	09	6.7%

RTAs were the most common cause of chest trauma (66%), followed by railway injuries (11.2%) and assault cases (8.2%), including both sharp and blunt force injuries.

Table 3: Period of survival after trauma(n-134)

Period of survival	Number of cases	Percentage
Spot death (and <1 hour)	73	54.5%
During transport & hospitalized (1- 24 hours)	29	21.6%
In hospital deaths (1-7 days)	25	18.7%
After 7 days	7	5.2%

Table 3 shows the distribution of abdominal trauma in relation to the period of survival of victims. More than half of the victims were found spot dead or immediately within an hour (54%), and 22% died within 24 hours of trauma, after hospitalization.

Table 4: Profile of external and internal injuries to abdomen (n-134)

External injuries	Total number of cases	Percentage
Abrasions	97	72%
Contusions	59	44%
Lacerations	24	18%
Internal injuries		
to liver	107	79%
to spleen	53	39%
to abdominal wall & diaphragm	34	25%
to peritoneum	25	19%
to stomach (n-10) & intestines (n-19)	29	14%

Table 5: Type and distribution of abdominal injuries (n-134)

Type of injury	No. of cases	Percentage
Liver lacerations (n-91) & contusions	102	76.1%
Spleen lacerations (n-43) and contusions	47	35.1%
Kidney lacerations and contusions	17	12.7%
Stomach rupture & contusions	16	12%
Intestine rupture & contusions	15	11.2%
Liver & Spleen ruptures	11	8.2%
Pancreas rupture and contusions	07	5.2%
Lumbar vertebral / pelvic injuries	21	15.6%
Miscellaneous- Liver stab wound (n-2), mesentery, bladder injury etc	8	5.9%

Tables 4 and 5 illustrate the location and type of external and internal injuries in relation to abdomen. Abrasion (72%) was the most common type of external injury, followed by contusion (44%) while major internal injuries noted were lacerations of the liver (67%) and spleen (32%).

Table 6: Other injuries in association with abdominal injuries (n-134)

Associated Injuries	Number of cases	Percentage
Head & neck	61	45.5%
Thorax	93	69.4%
Limb fractures	39	29.1%
Vertebral injuries	15	11.2%
Pelvis structures	17	12.7%
Abdomen alone	4	2.9%

The most frequent associated injuries involved the head (45%), chest (69%), limbs (long bone # in 29% cases), and spine, while injuries limited to the abdomen region alone were found in 4 cases.

Table 7: Types of RTA victims in the study sample. (n=91)

Type of victim	Total cases (n-91)	Percentage
Pedestrian	27	29.6%
2-Wheeler riders	21	23.1%
2-Wheeler pillion riders.	10	10.9%
3-Wheeler occupants (Auto, Tractor)	09	9.9%
4-wheeler occupants (Cars, Truck, Lorry, Tanker)	17	18.6%
Others	07	8.5%

Among the road users, pedestrians comprised the greatest number of victims, involving 29% of cases, followed by two-wheeler riders (23%), and pillion riders (11%).

Table 8: Causes of death in the study sample.(n-134)

Cause of death	Number of cases	Percentage
Hemorrhagic shock	63	47.1%
Trauma to head	35	26.2%
Trauma to spine	7	5.2%
Thoracic-abdominal injury (combined)	11	8.2%
Abdominal injury (alone)	4	2.9%
Peritonitis & Septicemia	3	2.2%
Miscellaneous (traumatic asphyxia, multiple injuries etc)	11	8.2%

In our study sample, we observed that the main cause of death was hemorrhagic shock (47%), followed by, trauma to the head (26%), trauma to the spine(5.2%), and multiple injuries (8%).

Fig 1. Firearm Injury

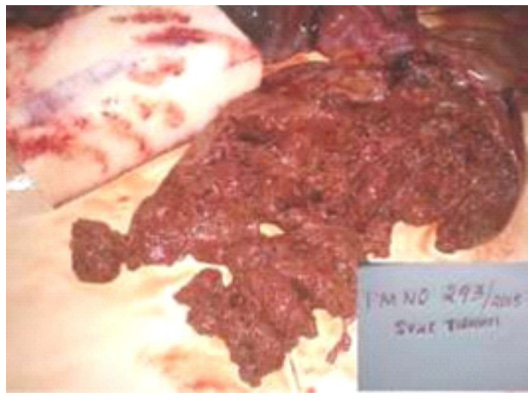

Fig 2. Rupture of liver

Fig 3. Lacerations of liver

Fig 4. Contusions of liver

Discussion

Injuries to the abdomen are mostly accidental and occasionally homicidal, due to the accessible anatomical nature of the abdomen region. As abdominal injury is a diagnostic black box, expedient diagnosis and treatment of intra-abdominal injuries are essential to prevent morbidity and death. The present study focussed on the epidemiologic aspects of thoraco-abdominal trauma and related variables.

Table 1 depicted that 89% of victims were malein our study, and peak incidence was noticed in the age group of 21–40 years (45.5%). The male preponderance of victims was in accordance with studies. [6,7], as men are more exposed to the outside hazards of the modern world. In a study on the profile of RTA victims in Jammu, [8] males constituted 86%of the total number. The most vulnerable age groups are between 21-30 and 30-40 years, which was quite similar to studies [9, 10] explained by the fact that persons in these age groups tend to take risks, thereby subjecting themselves to the danger of accidents.

Table 2 showed that injury due to RTA (n-91, 68%) outnumbered the other modes, followed by assault cases at 8%, which was consistent with studies. [9, 11] Our study partially agrees with a study [12] which found out that RTA (48%) was the most common cause, followed by fall (32%) and stab injury (18%). As persome studies, [7,13] RTA accounted for nearly 70% of cases, followed by falls from height and assaults accounting for 14% and 09% of cases, respectively. The high number of RTAs can be attributed to a lack of road safety sense and ignoring traffic rules. Bad road conditions, speeding, poor visibility, not using helmets, consuming alcohol, and using phones while driving have contributed to the occurrences of RTAs in India.

Table 3 showed that, more than half of the victims died on the spot, which is in accordance with the studies [8,13] and 22% of victims died later, but within 24 hours of hospitalization, while 18% died in subsequent 7 days. Out of total 73 cases of spot death in our study, most victims died due to the injury to the head, thorax, and abdomen region, followed by polytrauma. A few studies [10,12] found that most victims passed away within 1-6 hours of the incident. However, the incidence of spot deaths was mere 19% in a study.[14] In a 2-year study by Gushinge,[15] about 48 victims died on the spot or were brought dead to hospitals, while another 48 victims succumbed within 6 hours of admission. These findings highlight the necessity of basic life support ambulances and quick transfer to the hospital. The fatal outcomes in those who survived for a while but eventually died in due course, emphasize the need of robust pre-hospital emergency care services in the country.

As per tables 4 & 5, internal injuries were more common than external injuries. The study identified abrasions (72%), and contusions (44%), as the most prevalent external injuries on the abdomen, which is comparable to a study by Abymon [16]. The liver (79%) and the spleen (39%) were the most injured intra-abdominal organs, followed by the intestines (14%) and kidneys (12%). Liver sustained more lacerations (67%) than contusions. These findings stood in accordance with many studies [6-7, 9-12], where the liver and intestines were found to be more involved than the spleen.

Bordoni[17] reported proportionally more hepatic and splenic lesions in blunt traumas than in the penetrating trauma. Although the most injured abdominal organ in penetrating trauma was the liver, they found predominantly more lesions in the intestines, stomach, and blood vessels of individuals of penetrating trauma. Interestingly, Naik[13] found liver injury (35% cases) as the commonest, followed by the intestine's (31%), while Khan[14] found that the second most common abdominal organ to be injured, after the liver, was the kidney in a study on fatal RTAs. Hemorrhage is more common with parenchymatous injury where death has occurred, and contusion of the liver was seen in more cases than laceration, as per Sugadha.[18]

An abdominal injury may be associated with extra abdominal injuries, and frequently, the abdominal wall usually escapes gross injury by transmitting the force of violence to more resistant organs inside the abdominal cavity. In our study (table 6), the most frequently associated injuries involved the head (45%), chest (69%), limbs (29%), and spine (15%). This picture varied significantly with the findings of Naik[13] which revealed no association in 47% of cases and association with the head (7%), chest (17%), limb

(11%), and multiple injuries (18%).Blunt abdominal injuries were most associated with thoracic and head injuries in a Qatar trauma canterstudy[19] on 1036 patients of abdominal trauma. The common associated extra-abdominal injuries included chest (35%), musculoskeletal (32%), and head injury (24%). These results are generally consistent with our focus on the lethality of combined thoracic and abdominal injuries, emphasizing the urgent need for prompt medical attention to treat serious internal injuries in RTA victims.

Among the road users (table 7), pedestrians comprised the greatest number of victims, involving 29% of cases in our study, followed by two-wheeler riders (23%), and pillion riders (10%). This composition was consistent with the studies [11-14] which is understandable as most of the road users are pedestrians, thus exposed to a higher risk of accidents and injuries. However, a study done in Manipal [9] on RTAs stated that most of the victims were two-wheeler occupants (35%), followed by pedestrians (23%). Panchal(12) found that bike riders (38.5%) constituted the maximum number of cases, followed by pillion riders (31.8%) rather than pedestrians. The causes of accidents could be defects in motor vehicle condition and bad road conditions, coupled with drivers' fault in many cases. Road safety measures like wearing seat belts by passengers in motor vehicles, using certified helmets by 2-wheeler riders driving at safe speed, and obeying the traffic rules by pedestrians, will avoid accidents and resultant injuries. Driving under the influence of alcohol and using mobile phones, which can distract while driving, should be avoided. Robust pre-hospital care and preventive measures symbiotically help mitigate these kinds of injuries and fatalities.

Due to the soft and yielding nature of the abdominal wall, the application of even a heavy force may not cause any external wound on the abdominal wall, but the transmitted force may cause some serious internal wound. Subcapsular tears produce intrahepatic hematoma, which may eventually rupture into the peritoneal cavity, causing death hours or days after the injury. [15] The current study focused on the impact of abdominal injuries on fatal outcomes in relation to the immediate causes of death, where internal organ damage was identified as a critical factor.

Our study aligned with many studies [2, 7-12, 16-18] in revealing that the primary causes of death were hemorrhagic shock (47%) and head injury (26%), more so when the individual died within a few hours. This could be explained by the fact that thoracoabdominal trauma frequently accompanies head injuries in high impact accidents or falls from height. However, Abymon [16] reported that among RTAs, head injury (47%) was the commoner cause of death, followed by thoraco-abdominal injury (20%). Abdominal injury alone had caused death in 3% of cases, mainly due to rupture of splenic or hepatic hematomas, causing torrential internal bleeding. Cases of peritonitis (3%) and septicemia combined with trivial head injury showed delayed death.

Conclusion

Abdominal injuries constitute a prime factor in increasing the amount of morbidity and mortality in trauma cases. As per our study, the most likely person to experience abdominal trauma is a healthy young adult male in an age range of 21–40 years. The most frequently observed causes of abdomen trauma were RTA and railway accidents, followed by assault. The main cause of death was haemorrhagic shock due to multiple injuries followed by head injury.

A thorough and meticulous examination should bedonein all trauma and accident cases as many of them show fatalvisceral organ damage without external injury. Our study finding that many of the injured persons died on the spot highlighted the urgent need for better pre-hospital trauma care and appropriate actions by policymakers. It reiterates that efforts could be made to decrease these preventable forms of deaths by creating public awareness about safety norms and preventive measures.

Given that spot fatalities and death rates within one hour of experiencing trauma, were considerably higher, it is crucial to begin pre-hospital care and primary resuscitation as soon as possible during the first hour of trauma, rightly called the "golden hour of trauma." The first 60 minutes post-trauma which is the most crucial period that determines the patient's outcome has been termed the "golden hour."[20]

The stakeholders may benefit from this study in identifying the vulnerable population to trauma, and educating them on various elements of safety. The existing trauma services at primary and secondary levels of healthcare may be improved and enhanced so that many lives can be saved.

Conflict of Interest: Nil.

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Ethical clearance: Approved from the Institutional Research Ethics committee, wide letter dated November 26, 2014.

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Original Article

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Study of Histomorphological Changes in the Subarachnoid Hemorrhage at Different Time Intervals Between Injury Infliction and Death

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Abstract

Newer biochemical and molecular techniques are under research for wound dating purpose, but histology is still the mainstay of wound dating technique. Significance of knowing how old the wound is, can have major implication in the delivery of justice. Similarly, subarachnoid hemorrhage may need to be dated in cases where other data for wound dating are scarce. This study is designed to study the histomorphological changes in the subarachnoid hemorrhages of different time interval since injury and aim to use this information for dating of subarachnoid hemorrhage for medicolegal purpose. The histology samples of subarachnoid hemorrhage of the deceased with head injuries with known post injury interval were taken during the autopsies and divided into different groups. The gross color changes and histomorphological parameters were evaluated in each group and statistical inference was made. The result showed gross color, RBC lysis, macrophage infiltration, hemosiderin laden macrophage, fibrin deposition, collagen deposition and meningeal reactive changes significantly correlated with post injury interval. Whereas, Neutrophils, lymphocytes and phagocytosis did not correlate. RBC lysis also correlated with gross color change as well. In conclusion, histology of subarachnoid hemorrhage can be a useful tool in dating subarachnoid hemorrhage in cases where it is required.

Key words: Subarachnoid hemorrhage, Wound dating, Histopathology, Forensic pathology

Introduction

Subarachnoid hemorrhage (SAH) can either be traumatic or spontaneous. Of all thetraumatic brain injury, 11 to 60% develops subarachnoid

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hemorrhagewhich is more than spontaneous subarachnoid hemorrhage (incidence of 7.9 per 100000 population)[1,2]. While the mechanism of bleeding in both types are different, the pathophysiology leading to brain injury and death, are similar. [34] This study is about the histomorphology of traumatic subarachnoid hemorrhages and therefore, spontaneous subarachnoid hemorrhages are excluded. Subarachnoid hemorrhage is the second most-common type of intracranial bleed in blunt head trauma cases in Nepal. Meanwhile, common causes of head trauma are road traffic incidents followed by fall and assaults.[56] Post-mortem examination of subarachnoid hemorrhage in these cases can present with a challenge especially when there is a need to know about the age of the subarachnoid hemorrhage.

During the investigation of death, knowing the time since injury can make a difference between delivery and miscarriage of justice, it is also one of the most researched topics in the field of forensic medicine. Even after decades of study on dating of the wound, wound dating has still not gained the reliability as its importance. The principle of dating of wound is based on the examination of the stages of wound healing. The studies on vitality and wound healing have led to the development of guidelines for establishing time since injury. The histological examination of the wound also helps to identify the wound as antemortem or postmortem nature by studying the vitality of the wound. The wound can also be dated by observation of the gross color change. Numerous techniques have evolved over time, yet, histological method is still the gold standard for dating of injury. [7] While abundant literatures regarding extradural and subdural hemorrhages can be found but the study regarding the dating of subarachnoid hemorrhage is scarce. Therefore, study of this kind broadens our knowledge in wound dating work as well as gives valuable information for the future research.

Material and Methods

This study was conducted at Tribhuvan University, Institute of Medicine, Maharajgunj Campus at the Department of Forensic Medicine from the year 2019 to 2021. Ethical clearance was obtained from the Institutional Review Board of the Tribhuvan University. (Dated 16th August, 2019, Ref No.55/(6-11)E2/077/078) Study was conducted on the autopsy cases of traumatic head injury. The inclusion criteria for this study included; all cases with traumatic subarachnoid hemorrhage, both isolated and associated with other intracranial injuries, with known post-injury interval well-preserved brain, and exclusion criteria included; liquefactive changes, spontaneous subarachnoid hemorrhage, unknown post-injury interval and those with signs or history of disease affecting circulatory system. Accordingly, 120 deceased were studied. According to issues discussed in previous studies such as hospital presentation time, survival time anddelayed deaths and according to the availability of the cases in the department,the deceased were grouped according to following post trauma intervals; less than 4 hours, 4 to 12 hours, 12 to 24 hours, 1 to 5 days, 5 to 14 days and 14 to 30 days.[8–11]

During autopsy, brain with subarachnoid hemorrhage were cut into 3 cm x 2 cm x 2 cm block and fixed in a 10% formalin. The sample containers werelabeled and stored until next day.

The gross color *(Red, Purplish, purplish black, Rusty brown, yellowish)*, of the samples was noted before fixing the samples. After the samples were fixed for a minimum of 12 hours, the samples were grossed and processed at the Department of Pathology, Institute of Medicine, where it was processed for slide preparation. After the slides were prepared, the slides were evaluated by two pathologists and scored for each parameters *(RBC lysis, Neutrophils, Lymphocytes, Macrophages, Hemosiderin laden macrophage, Fibrin deposition, Phagocytosis, Meningeal reactive changes)* according to the technique described by P. Tak et al. (1995).[12] The data were analyzed in PASW using Chi Square test. The statistical significance between the groups were analyzed using post hoc test, wherever applicable.

Results

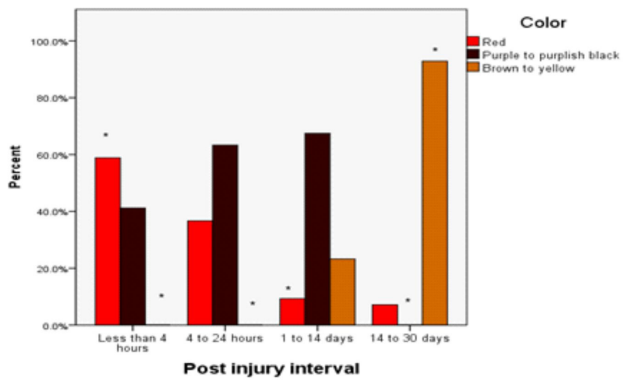


Figure 1: Correlations between the post injury interval and gross color change. (c) (* = p < 0.004)

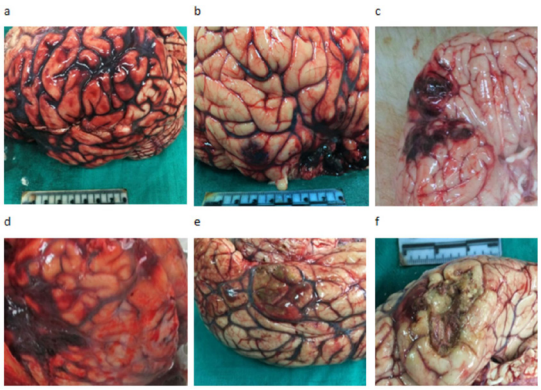
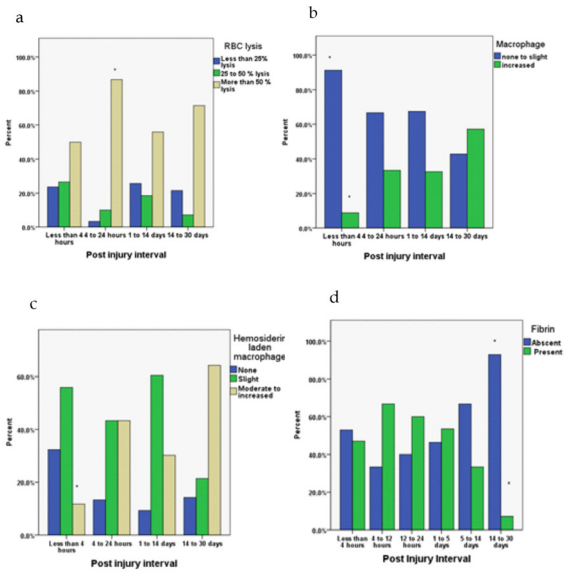


Figure 2: Illustration of SAH of less than 4 hours. (a) purple to purplish black colored subarachnoid hemorrhage of 12 to 24 hours' time interval (b) and 1 to 5 days (c) time interval. Illustration of brown to yellow colored SAH in 1 to 14 days interval group(d) and (e) and in 14 to 30 days interval group (f). Brownish to yellowish transition can be seen on the same case.

Gross color changes

The total of 121 cases were studied. Among them, purple to purplish black color (62, 51.2%) was the most commonly observed, followed by red (36, 29.8%), yellow (13, 10.7%) and brown (10, 8.3%). Post injury interval and gross color changes showed significant correlation. Color red showed decreasing trend with increase in interval up until day 14.The presence of brown and yellow color was significantly associated with interval of 14 to 30 days. Absence of purple and purplish black color was significantly associated with interval of 14 to 30 days. Figure 1 and Figure 2.



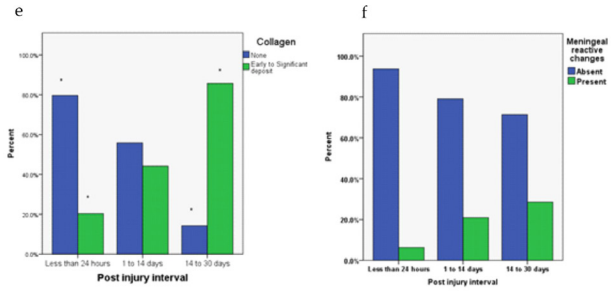


Figure 3: Correlation between post injury interval and RBC lysis. (* = (p < 0.0042) (a). Correlation between the post injury interval and macrophage infiltration. (* = p < 0.0063) (b). Correlation between the post injury interval and amount of hemosiderin laden macrophage. (* = p < 0.0042) (c). Correlation between the post injury interval and level of fibrin deposition. (* = p < 0.0042) (d). Correlation between post injury interval and collagen deposition (* = p < 0.0083) (e). Correlation between the post injury interval and meningeal reactive changes. No significant correlations were seen between the variables.(f)

Histomorphology

Each slide was analyzed for degree of RBC lysis, slides were semi quantified for lysis of less than 25%, 25 to 50% and more than 50%. Post injury interval and RBC lysis showed significant correlation but the correlation was significant only between interval of 4 to 24 hours and more than 50% lysis. Figure 3a, Figure 4

The slides were scored as slight infiltration if neutrophil or lymphocytes were seen as few scattered cells and as increased if aggregates of cells were seen. The analysis between post injury interval and neutrophil and between post injury interval and lymphocytes showed no significant correlation.

The cells were analyzed for both phagocytic and non-phagocytic macrophages and were designated as slight infiltration if less than 10 macrophages were seen in a high-power field and as increased infiltration if more than 10 macrophages were seen in a high-power field in an active field. There was a significant association between post injury interval and macrophage. On post hoc test, none to slight infiltration was significantly associated with post injury interval of less than 4 hours and Increased infiltration was significantly associated with post injury interval of less than 4 hours. Figure 3b

Hemosiderin laden macrophage was evaluated as none if absent, slight if less than 10 per high power field and moderate to increase if more than 10. There was a significant correlation between post injury interval and detection of hemosiderin laden macrophage. The post hoc test showed moderate to increase hemosiderin laden macrophages were less likely to be seen in post injury interval of less than 4 hours. Figure 3c5a

There is a significant correlation between post injury interval and fibrin deposition. On post hoc test, the post injury interval of 14 to 30 days is more likely to have absent fibrin deposition. Figure 3d5b

Slides were evaluated for absence or presence (early to significant) of collagen deposit. There was a significant correlation between post injury interval and collagen deposition. On post hoc test, absence of collagen deposition was more likely to be seen in post injury interval of less than 24 hours and presence of collagen deposition were more likely to be seen in post injury interval of 14 to 30 days. Figure 3e5c

Slides were evaluated for presence or absence of meningeal reactive changes. Changes observed in arachnoid were mesothelial cell proliferation, leucocytes infiltrations, fibrosis and subarachnoid space obliteration. In the early groups the changes were predominantly cellular proliferations, swelling and leucocyte infiltrations where as in the later groups, the changes were collagen deposition and thickening of membranes. Detection of meningeal reactive changes showed increasing trend with increase in post injury interval. Figure 3f, Figure5c

a. b.

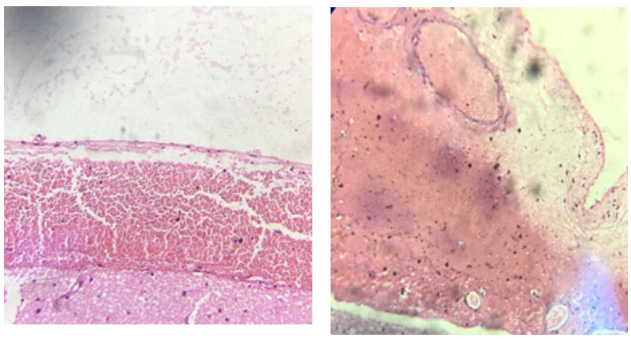
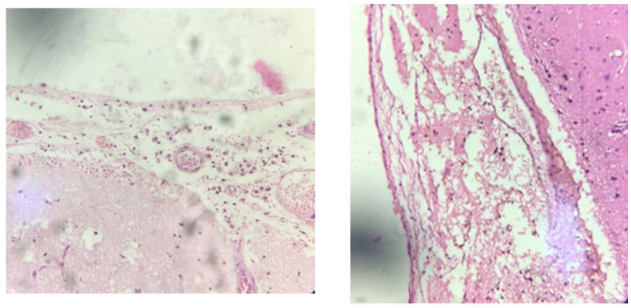


Figure 4: The images show different levels of RBC lysis within the hemorrhage of the same time interval of 4 hours. Fresh RBC (a), more than 75 % lysis with hemosiderin pigments (b)

a. b.



c.

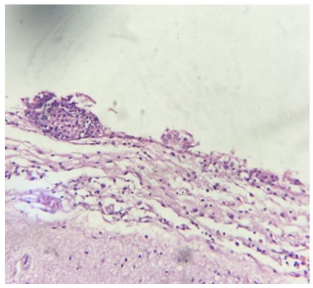


Figure 5: a:Hemosiderin-laden macrophages seen as a golden-brown pigment containing cells, in a 5 to 14 days old SAH. b: Fibrin deposition seen in a 4 to 12 hours old SAH. c:Meningeal reactive changes and collagen deposition seen in a 15 to 30 days old SAH.

Discussions

In this study, postinjury interval significantly correlated with color changes in the SAH, especially red and brown-yellow color, as the injury gets older the red color began disappearing while the brownish to yellow began appearing, the finding were consistent with previous studies. [13,14,15]However, the color interpretation was done with naked eyes, therefore it could not be free of interobserver bias, especially during interpretation of different shades of red color. According to P. Vanezis (2001), naked-eye interpretation of color is highly subjective and use of colorimetry or spectrophotometry is advised. [16] The effect of amount and duration of bleeding on color appearance was not studied. According to J. Ross et. al. (2012), the purplish black color can persist for days if the SAH is large.

On histological evaluation, RBC lysis of 50% or more was significantly associated with SAH of 4 to 24 hours, which is consistent with other studies. [17]Even though, RBC lysis correlated with post injury interval, but it did not correlate with gross color, which could be due to the size of hemorrhage, where RBC in small hemorrhagehemolyze late. It is also seen in a large bleeding where the RBCs in the

center of the hematoma undergo early deformation than the RBCson the periphery. [18]The association in some of the cases was not seen may be because of re bleeding episode, such cases were mostly seenin the post injury interval of 14 to 30 days which featured mixed features of later stages of healing with fresh RBCs. According to the study, rebleed episodes are not uncommon in traumatic SAH. [19–21]

Macrophage pattern seen in this study was consistent with the general principle of wound healing.[22] Neutrophils and lymphocytes did not show correlation similar to study of J. Alpers (1945), where occasional phagocytosis was seen as early as after 12 hours and increased after 3 days, but appearance of leucocytes did not correlate with any time interval. D. Munro (1936) also reported the appearance of phagocytosis in a SDH specimen collected 5days after bleeding. The detection of siderophages was consistent to the pattern described by J. Lee (2010), the author reported that the enzyme responsible for degrading hemoglobin was detected in the SAH as early as 6 hours and peaks at day 3. [23]

Fibrin is an important biological compound that plays an important role in hemostasis, wound healing and other biological functions. [24] During the wound healing process, the fibrin begins to appear as fibrin strands from 12 hours onward and later serves as a framework for connective tissue organization. Slight connective tissue organization begins after 4 days and becomes marked at around day 28, and as the wound organization continues, the fibrin becomes less marked. [25]Decrease in fibrin deposition in this study corresponds to the time of wound organization and might as well becomes useful for estimating the age of the wound, especially if it is nearing later stage of wound healing.

Absence of collagen was associated with early hours of hemorrhage, whereas presence was associated with later days of hemorrhage. According to literatures, collagen begins to appear from 4 to 5 days and becomes marked at 13 to 14 days. [13,19,25] However, in this study, collagen was present even in the SAH of less than 3 days, which was not reported previously. These collagens could betype 3 collagen that were deposited earlier, which later gets replaced by type 1 collagen or it could just be a disrupted subarachnoid trabecula, which are also a collagen structure.[26.27] Therefore, presence of organized collagen supported by ancillary test may give us hint of significantly older hemorrhage.

In order not to over interpret or misinterpret, it is also worthwhile to note that collagen deposition is not only limited to the site of the SAH but can also be at sites remote to the SA Hand also its distribution can be patchy, both of which could lead to miss sampling. Also, some of the post SAH fibrosis could be senility changes which could be easily over interpreted.[28,29] Meningeal reactive changes were also significantly correlated with post injury interval; the pattern shows increasing trend with increase in duration. The studies show, meningeal reaction persists as long as there is blood or blood related product present in the subarachnoid space. Also, meningeal reactions can be present in the form of polymorphonuclear cell infiltration, mesothelial cell proliferation and fibrosis in varying degree according to the post injury interval. Therefore, caution should be applied against coming to conclusion by simply observing presence or absence of reaction.[30] The overall findings are summarized in table 1.

Table 1: **Summary of gross and histological findings across the post-injury intervals.**

Post injury interval	Gross findings	Microscopic findings
Less than 4 hours interval	Red color, occasional purple to purplish black color	More than 50 % RBC lysis in most of the cases. Few macrophages. * Few hemosiderin laden macrophages. * Moderate to increased fibrin. Absent collagen. Meningeal reaction only in a few cases.
4 to 24 hours	Purple to purplish black color	More than 50 % lysis in more than 80 % of the cases. * Moderate macrophage. Mild to moderate hemosiderin laden macrophages. Moderate to increased fibrin. Absent to few collagens. * Meningeal reaction in only 6 % of the cases.

Continue.....

1 to 14 days	Purplish black color Brownish color in the later phase	More than 50 % lysis in 55 % of the cases. Moderate macrophages. Mild to moderate hemosiderin laden macrophages. Moderate to increased fibrin. Few collagens. Meningeal reaction in 20 % of the cases.
14 to 30 days	Exclusively brown to yellowish color Occasionally red color in case of re-bleeding	More than 50 % lysis in 72 % of the cases. Increased macrophages. Moderate to increased hemosiderin laden macrophages. Absent to few fibrins. * Moderate to increased collagen. * Meningeal reaction in 30 % of the cases.

Note: Polymorphonuclear cellsdid not correlate with any post-injury intervals.

"*" – Statistically significant

Conclusions

Histological examination of wounds can be very useful in medicolegal investigation by providing the age of the wound and correlating it with the chain of events. Histology also helps investigation by telling the antemortem vs postmortem nature of the wounds. This information will be helpful to answer questions such as how old is the wound, is the wound inflicted before or after death? Even though the histological method of dating wound will not yield an exact answer to the above questions, but it can sure narrow down the possibilities. Both gross and histological parameters were analyzed in this study, and not all the parameters' reactions were consistent during the reparative process. Influencing factors such as age, size, health and individual variations becomes determining factors. Therefore, in future studies it is advised to design a study with proper control of the confounding factors.

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Toxicological Trends of Poisoning at Tertiary Care Hospital in Ahmedabad: A Retrospective Study

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Abstract

Poisoning is a major problem all over the world, though the type of poison and the associated morbidity and mortality varies from place to place and changes over a period of time. A retrospective study of 154 cases of poisoning received in the casualty of G.C.S. Medical College, Hospital and Research Centre, Ahmedabad during a span of last 3 years (Jan 2021 to Dec 2023) was done to know the demographic profile and pattern of acute poisoning in the region. Knowing the pattern of poisoning cases in a region helps in suggesting proper earliest preventive measures and also in early management of cases. Out of total cases majority of the cases were male (36 %), unmarried (54.5 %), and most commonly affected age group was 31 to 40 years (19.5 %). Household poisoning cases (21.43 %) were the most common type of poisoning. Majority of the cases intentionally consumed poison(56.50 %). Oral ingestion was the most common route of exposure (94.8 %).

Key words: Poisoning, Toxins, Suicide, Exposure

Introduction

Poison is "any substance that, when relatively small amounts are ingested, inhaled, absorbed, applied to, injected into, or developed within the body, has chemical action that causes damage to structure or disturbance of function, producing symptoms, illness, or death".[1]Poisoning is a major problem all over the world, though the type of poison and the associated morbidity and mortality varies from place to place and changes over a period of time.[2]

With advancement in science and technology large number of harmful chemicals especially insecticides and pesticides are invented to protect farming. But now they become a serious threat to human lives. The last quarter of century has seen tremendous advances in the fields of agriculture, industrial technology and medical pharmacology.[3]

The commonest agents of poisoning in India appear to be pesticides, sedatives, chemicals, alcohol, plant toxins, household poison and snake bite, etc.

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Among children kerosene, house hold chemicals, plant toxin, drugs and pesticide are more common.[4-7]

Knowing the pattern of poisoning cases in a region helps in suggesting proper earliest preventive measures and also in early management of cases. Modern toxicology played a major role in early diagnosis, treatment and detection of poison. This study will aim at determining sociodemographic profile, pattern of poisoning reported to Tertiary Care Hospital, Ahmedabad during the study period. Therefore, the findings of this study will be helpful for the government authorities to plan and implement strategies to decrease the easy accessibility and availability of poisons, providing health education to adolescents and establishing poison information centre and toxicological unit at every district.

Materials and Methods

After taking prior approval letter dated on 12/08/2024 from the Institutional Ethics Committee, G.C.S. Medical College, Hospital and Research Centre, Ahmedabad we performed a retrospective cross-sectional study on poisoning cases treated in Casualty, G.C.S. Medical College, Hospital and Research Centre, Ahmedabad for a period of three years from Jan 2021 to Dec 2023.

All the poisoning cases reported to Casualty, G.C.S.Medical College, Hospital &Research Centre, Ahmedabad, during study period were included & their sociodemographic profile, pattern of poisoning and the outcomes were determined. Poisoning cases which have been treated elsewhere before reporting to Casualty were excluded.

The data was collected from Medical Record Department and Medicolegal Case Register after obtaining permission from Hospital Authority. There was no involvement of patient and public.

The master chart was created using Microsoft Excel software as per columns in the preformed case record proforma & data was entered as per case records and analysis was done by Microsoft Excel software & manual statistical analysis. Data was checked for completeness, accuracy and consistency immediately after collection and appropriately arranged and kept in a secured place for compilation and analysis. Conclusions were drawn after reviewing and discussing with studies of similar type performed by other researchers.

Results

During our study period 154 cases were reported to the hospital with history of acute poisoning. Males were more prone to poisoning (63 %) as compared to females (37 %)(Table1). Out of the total poisoning cases, 25 (16.23%) cases were from rural area and 129 (83.77%) cases were from urban area.

Table 1: Sex Wise Distribution of Cases (N=154)

Sex	Cases	Percentage (%)
Male	97	63
Female	57	37
Total	154	100

The incidence of poisoning according to age revealed that majority of cases (37%) were from 21 – 30 years age group, followed by (19.5 %) of cases from 31 – 40 years and the fewest cases (5.2 %) were reported above 50 years of age. (Table 2)

Table 2: Age Wise Distribution of Cases (N=154)

Age (in years)	Cases	Percentage (%)
0-10	12	7.8
11-20	29	18.8
21-30	57	37
31-40	30	19.5
41-50	18	11.7
51-60	4	2.6
> 60	4	2.6
Total	154	100

Of the total 97 male, 34 (35 %) were married and 63 (65 %) were unmarried while in females out of 57, unmarried were 36 (63.2 %) and 21 (36.8 %) married. (Table 3) Incidence of poisoning were more detected among the unmarried population.

Table 3: Distribution of Cases According to Marital Status (N=154)

Marital status	Male	Female	Total (%)
Married	34	36	70 (45.5)
Unmarried	63	21	84 (54.5)
Total	97	57	154 (100)

Out of all poisoning cases, 87 (56.50%) were intentionally poisoned, 66 (42.85%) were unintentionally poisoned and manner of poisoning was unknown only in 1 (0.65 %) case. (Table 4)

Table 4: Distribution of Cases According to Manner of Poisoning (N=154)

Manner of poisoning	Cases	Percentage (%)
Intentional	87	56.50
Unintentional	66	42.85
Unknown	1	0.65
Total	154	100

Most Common poison found was Household poisons (33 cases), which includes poisoning due to ingestion of Phenyl, Rat killer, Kerosene, Turpentine oil, Bleaching agent, & Naphthalene balls. In present study 33 cases of food poisoning were reported, followed by ingestion of unknown substances (22 cases). Total 17 cases of sedatives & CNS depressants pills ingestion reported which includes poisoning due to Alcohol, Alprazolam, Benzodiazepines, Escitalopram, Clonazepam, Lorazepam, Lithium, Oxcarbazepine, Nitrazepam and Zolpidem. Of 154 cases, 14 cases were of ingestion of Medical Termination of Pregnancy pills. 10 cases each of Corrosive & Agriculture poisoning were reported. 5 cases of CNS stimulants were noted which includes cases of Cannabis & Dhatura seed ingestion. Least 3 cases of Drug overdose were reported which includes ingestion of paracetamol, aspirin and combiflam tablets. (Table 5)

Table 5: Distribution of cases according to type of poisons. (N=154)

Type of poison	Cases	Percentage (%)
Household / Domestic poisons	33	21.43
Bacterial toxins	33	21.43
Unknown substance	22	14.28
Sedatives & CNS Depressants	17	11.04
Abortifacient drugs	14	9.1
Corrosive	10	6.5
Agricultural	10	6.5
Unknown insect bite	6	3.90
CNS Stimulants / Deliriant poisons	5	3.24
Drug overdose	3	1.94
Snake bite	1	0.64
Total	154	100

In this study, maximum number of intentional poisoning cases were seen in females, and maximum number of unintentional poisoning cases were seen in males. Females were more likely to be involved in acute poisoning incidents with suicidal intent compared to males. The highest incidence of intentional and unintentional poisoning was seen in (21-30 years) age group followed by one unknown manner of poisoning in (41-50 years) age group. Intentional poisoning was highest in married people and unintentional poisoning was highest in unmarried people and 1 unknown manner of poisoning was seen in married male. (Table 6)

Table 6: Correlation Manner of poisoning according to marital status, gender and age

Factors	Manner of Poisoning			
	Intentional	Unintentional	Unknown	Total
Gender				
Male	43	53	1	97
Female	44	13	0	57
Age (in years)				
0-10	0	12	0	12
11-20	13	16	0	29
21-30	36	21	0	57
31-40	23	7	0	30
41-50	11	6	1	18
51-60	2	2	0	4
>60	2	2	0	4

Continue.....

Marital Status				
Married	49	20	1	70
Unmarried	38	46	0	84
Total	87	66	1	154

In this study, household poisons (18 cases) were mostly consumed intentionally followed by unintentional consumption of bacterial toxins. Unknown substances (14 cases)were consumed intentionally followed by only one cases of unknown manner of poisoning. All sedatives (17 cases) and abortifacient drugs (14 cases) were consumed intentionally. Corrosives (9 cases) and agricultural poisons (8 cases) were consumed intentionally followed by accidental ingestion. All 6 cases of unknown insect bites occurred unintentionally. All deliriant poisons (4 cases) and drug overdose (3 cases)were consumed intentionally. Only 1 case of snake bite occurred unintentionally. (Table 7)

Table 7: Correlation between Manner of poisoning and type of poison

Type of poison	**Manner of poisoning**			
	Intentional	**Unintentional**	**Unknown**	**Total**
Household / Domestic poisons	18	15	0	33
Bacterial toxins	0	33	0	33
Unknown substance	14	7	1	22
Sedatives & CNS depressants	17	0	0	17
Abortifacient drugs	14	0	0	14
Corrosive	9	1	0	10
Agricultural	8	2	0	10
Unknown insect bite	0	6	0	6
CNS Stimulants / Deliriant poisons	4	1	0	5
Drug overdose	3	0	0	3
Snake bite	0	1	0	1
Total	87	66	1	154

In present study, all intentional cases (87 cases) of poisoning were by oral route of exposure followed by unintentional (59 cases) poisoning. Unintentional (7 cases) poisoning were seen in unknown insect and snake bites. Only one case of unknown manner of poisoning by unknown route of exposure was recorded. (Table 8)

Table 8: Correlation between Manner of poisoning and route of exposure

Route of Exposure	**Manner of poisoning**			
	Intentional	**Unintentional**	**Unknown**	**Total**
Oral	87	59	0	146
Bites	0	7	0	7
Unknown	0	0	1	1
Total	87	66	1	154

Out of 154 poisoning cases 5 cases (3.25 %) resulted in death. Out of five death cases, 3 cases of acid ingestion and 2 cases of organophosphorus poisoning were confirmed. (Table 7)

Table 7: Distribution of Cases According to Outcome

Outcome	Cases	Percentage (%)
Survived	149	96.75
Death	5	3.25
Total	154	100

Discussion

Poisoning is an acute medical condition that requires prompt medical intervention. This is a record based retrospective study of poisoning cases reported to Casualty, G.C.S. Medical College, Hospital &Research Centre, Ahmedabad during the study period of three year. 154 cases with alleged history of poisoning were analysed. Many retrospective studies on poisoning pattern were done by various authors of different parts of India. The present study when compared with previous studies is useful in understanding the pattern of poisoning in this area. In the present study of 154 cases, 97 cases (63%) were males and 57 cases (37%) were females. Male gender predominance of this study correlated with the study conducted by Agarwal PK et al[2], Dash SK et al[5], Batra AK et al[6], Kumar M et al[7], Verma P et al[12] and Suraj et al[13] but in contrast female predominance is noted in few other studies.[8,9,10] The finding could be related to the fact that men were prone to stress due to unemployment, stress of the modern life style, and being bread earner of the family. The most commonly affected age group was 21-30 years (37 %). It was observed that this age group was affected in most of the studies.[2,5,7,8,9,10,11,13] These young age groups being in the most active periods of their lives were frequently affected. In present study majority of the cases were unmarried (54.5 %). But studies of Dash SK et al[5], Kumar M et al[7], Naveen N et al[9], and Verma P et al[12] reported maximum incidence in married individuals. The most common mode of poisoning was oral ingestion (94.80 %). Similarly, most studies report that oral ingestion is the most common route of administration.[10,14,15] This is common probably because it is the accessible mode of administration. According to present study, it was found that most common type of poisoning cases due to household poisons (21.43 %). Similar type of findings were noted by other authors.[8,12] But in contrast majority of the studies show that most common poisoning cases were due to insecticide & pesticide poisons.[2,5,7,12] We could attribute this to fact that the present study was conducted in urban area where the use of certain poisons mainly depends on its availability and accessibility to the individual.In present study, intentional poisoning was the commonest manner of poisoning followed by accident and this observation was on the basis of history from the medical records. Suicide is the most common manner of poisoning and reported in 56.50 % cases which is similar to other studies.[6,7,10,13] In present study, Highest mortality was due to corrosive followed by organophosphorus poisoning which is in contrast with study conducted by Shumet et al[8] where Aluminium phosphate poisoning mortality rates were higher.

Conclusion

Poisoning is an acute medical condition that requires prompt medical intervention. The poisoning rate has increased around the world and it has been a serious health and socio-economical problem.

Mortality and morbidity due to poisoning can be reduced by safety measures for storage and use of pharmaceutical products and strict vigilance of sale of insecticides. Industrial and agricultural chemicals should only be sold to licensed and authorized users which would limit the access for its wrongful use by the victims who ingested intentionally. To limit the access to medications, there should be strict rules on prescribing and dispensing of medications which can prevent misuse and overuse of medications which could be harmful if ingested improperly. Providing easy access to safe disposal programs for unused or expired medications and chemicals can help prevent accidental poisonings.

Highly equipped treatment facilities and establishment of poisoning centres have become the necessity of the hour. Extending psychiatric services to the community may help in identifying high risk population who are likely to commit deliberate self-harm. A further, community-based, large scale mixed study is recommended to determine the magnitude of poisoning, identify contributing factors and design mitigating mechanisms.

Conflict of Interest: Nil

Source of Funding: Nil

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Original Article

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A Study on the Pattern and Distribution of Skull Fractures in Fatal Road Traffic Accidents

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Abstract

Introduction: Road traffic accidents (RTAs) are a leading cause of mortality and serious injury worldwide, with skull fractures frequently emerging as a significant consequence of such incidents. The pattern and distribution of skull fractures can provide valuable insights into the mechanisms of injury and the severity of accidents. Understanding these patterns is crucial for improving both preventive measures and clinical responses.

Materials and Methods: This is a retrospective cross- sectional study of one year duration**.** All the cases of road traffic accident death with skull fracture were included in the present study. A total of 342 cases of death due to fatal RTA were present and 140 cases had skull fractures.

Results: The commonest site of fracture was the vault, observed in (64.28%) of cases. In fractures involving single bones of vault, Frontal bone fractures were seen in the highest number of cases, in 29 cases (32.22%). In fractures involving the base of the skull, the highest number of fractures were seen in MCF, in (7.14%) of the cases.

Conclusion: A high number of fatalities due to road accidents occur in India every year. Its effect extends to the society at large. The financial burden produced on the family and healthcare system can be substantial. There can be adverse effect on the economic output of the country as well. Therefore, measures should be sought to reduce the road traffic accidents as a number of lives can be saved, as most of these are avoidable.

Keywords: skull fractures, road traffic accidents, two-wheelers

Introduction

Head injury is a morbid state resulting from gross or subtle structural changes in the scalp, skull, and/or the contents of the skull, produced by mechanical forces.[1] The head, being the most exposed part of the body, is often involved in incidents and is a major contributor to both morbidity and mortality in road

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traffic accidents.[2] RTAs are a leading cause of death among children and young adults aged 5-29 years, with around 1.3 million deaths annually.[3]These accidents also result in substantial economic losses for individuals, families, and nations.[3]

In 2021, Karnataka reported 34,647 road accidents, leading to 19,038 deaths and 40,754 injuries, marking a 1.37% increase in accidents and a 2.84% rise in fatalities compared to the previous year. Specifically, Kalaburagi reported 762 accidents, with 454 occurring in Kalaburagi city alone.[4] Accurate assessment of head injuries is crucial for forensic medicine to reconstruct events and provide reliable data to policymakers. Autopsy findings are essential for understanding head injuries and improving treatment by the medical community.[5]This study aims to investigate the pattern and distribution of skull fractures in fatal road traffic accidents, focusing on identifying common fracture types, their locations etc to enhance the understanding of injury patterns and support the formulation of strategies to mitigate the impact of such accidents on public health and safety.

Material and Methods

This was are trospective cross- sectional study, conducted in a one-year period from January 2023 to Dec 2023, at Gulbarga Institute of Medical Sciences**.** All the cases which satisfy the inclusion criteria will be included in the present study. The approval and clearance from the Institutional Ethics Committee was obtained, (ref no. GIMS/KLB/PHARMA/ IEC/223/2024-25, dated: 25-01-2024)and previous autopsy reports were screened for cases fulfilling the inclusion criteria. The reports of all the cases of RTA with head injury were collected and analysed. A total of 342 cases of death due to fatal RTA were present. 239 cases had head injuries, of which, 140 cases had skull fractures. Data from post mortem reports and police inquest were recorded in the proforma prepared. Convenience sampling technique will be used to collect the samples.

Skull fractures significantly increase the risk of death in road traffic accidents. Skull fractures with associated brain injuries have a higher mortality rate. In this study we aim to determine the pattern and distribution of skull fractures and to identify the potential risk factors and the high-risk group involved.

Inclusion criteria

- All the cases of road traffic accident death with skull fractures brought for medico-legal autopsy to Gulbarga Institute of Medical Sciences, Kalaburagi.

Exclusion criteria

- Cases of RTA deaths without skull fractures.
- Cases of skull fractures other than RTA-cases such as railway accidents, fall from height, operated cases etc.
- Bodies found in advanced stages of decomposition.
- Accidents with no definite history.

Assessment tools:

Microsoft office excel 2021. SPSS software version 22 has been used for statistical analysis. Data are presented as statistical tables and charts.

Results

The total number of autopsies conducted during the study period was 923. Out of which, 342 cases were of RTA's. Head injury was present in 239 cases (out of 342 cases) and 140 number of cases presented with skull fractures.

Age wise distribution of the victims

Majority of the victims were in the age group of 21-30 years,47 cases (33.58%), followed by 30 cases in the age group of 31-40 years (21.42%) and 26 cases in 41-50 years (18.58%). The least number of cases were seen in extremes of age group, 3 cases (2.14%) in 71-80 years and 04 cases (2.85%) in 0-10 years.

Table No.1: Age wise distribution of the victims

Age (in years)	Number	Percentage
0 – 10	04	2.85%
11-20	12	8.58%
21-30	47	33.58%
31-40	30	21.42%
41-50	26	18.58%
51-60	13	9.28%
61-70	05	3.57%
71-80	03	2.14%
Total	140	100%

Gender wise distribution of victims

Incidence of skull fractures in males was 121 (86.42%) and 19 (13.58%) in females. The male: female ratio is 6.36:1.

Table No. 2: Gender wise distribution of victims

Gender	Number	Percentage
Male	121	86.42%
Female	19	13.58%
Total	140	100%

Type of vehicle involved

Two wheelers were most commonly involved in the accidents, 102 cases (74.29%), followed by three wheelers in 07 cases(5%) and 4 wheelers in 06 cases (4.29%).

Table No.3: Type of vehicle involved

Vehicle	Number	Percentage
Two-wheeler	104	74.29%
Three-wheeler	07	5%
Four-wheeler	06	4.29%
Pedestrian	22	15.71%
Bus	01	0.71%
Total	140	100%

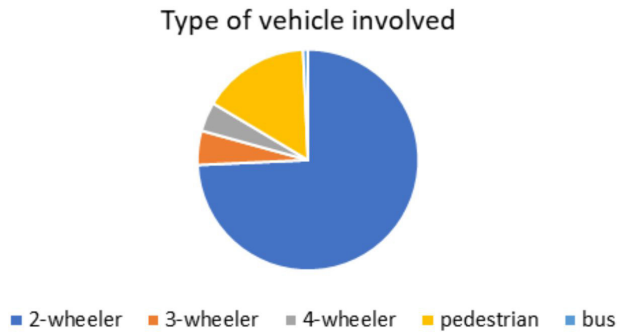

Figure No.1: Distribution of the type of vehicle

Type of victim involved

Most the victims were drivers, 74 cases (52.86%), followed by pillion riders in 35 cases (25%). 22 cases (15.72%) were pedestrians and 09 cases (6.42%) were occupants in 3 or 4 wheelers. It has been noticed that in all the cases involving two wheelers, helmets were not worn by the occupants.

Table No. 4: Type of victim involved

Victim	Number	Percentage
Driver	74	52.86%
Pedestrian	22	15.72%
Pillion rider	35	25%
Occupant	09	6.42%
Total	140	100%

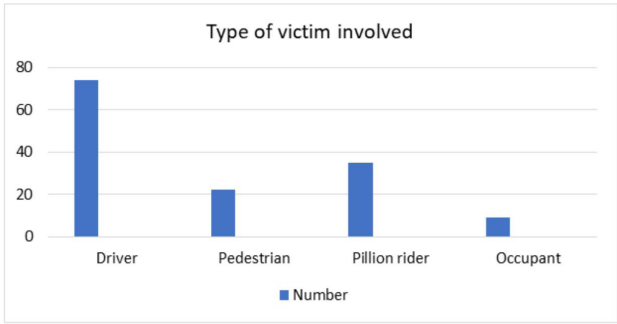

Figure No. 2: Distribution of the victims involved

Site of skull fractures

The commonest site of fracture was the vault, in 90 cases (64.28%), followed by the basal fracture seen in 16 cases (11.43%). Both vault and basal fractures were observed in 18 cases (12.86%).

Table No. 5: Site of skull fractures

Site	No.	Percentage
	90	64.28%
Base	16	11.43%
Facial bones	03	2.14%
Vault + base + facial	09	6.43%
Vault + facial	04	2.86%
Vault + base	18	12.86%
Total	140	100%

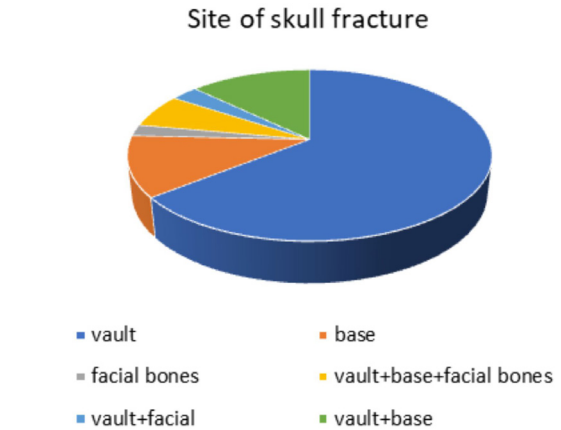

Figure No. 3: Distribution of site of skull fracture

Bone involved in cranial vault fractures

In fractures involving single bones of vault, Frontal bone fractures were seen in the highest number of cases, 29 cases (32.22%), followed by temporal bone in 15 cases (16.67%). The least number was seen in parietal bone, with 06 cases (6.67%).

Table No. 6: Bone involved in cranial vault fractures

Bone fractures in vault	No.	Percentage
Frontal	29	32.22%
Parietal	12	13.33%
Temporal	15	16.67%
Occipital	06	6.67%
Multiple bones	19	21.11%
All cranial vault bones	09	10%
Total	90	100%

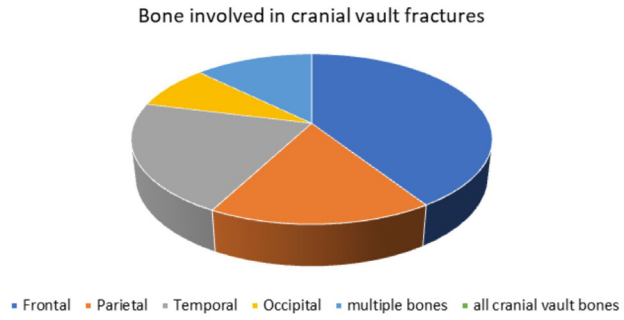

Figure No. 4: Distribution of cranial bones involved in fracture

Base of skull fracture

In fractures involving the base of the skull, the highest number of fractures were seen in MCF,10 cases (7.14%), followed by ACF, 03 cases (2.14%).

Table No. 7: Base of skull fractures

BOS fracture	No.	Percentage
ACF	03	18.75%
MCF	10	62.5%
PCF	00	0
Multiple	02	12.5%
All	01	6.25%
Total	16	100%

Types of skull fractures

The most common type of fracture noticed was linear fracture in 86 cases (63.23%), followed by comminuted fracture in 15 cases (11.02%). A combination of fractures was seen in 27 cases (19.86%).

Table No. 8:Types of skull fractures

Type of fracture	No.	Percentage
Linear	86	61.42%
Depressed	02	1.42%
Comminuted	19	13.59%
Elevated	01	0.73%
Hinge	01	0.73%
Crush	04	2.85%
Combination	27	19.28%
Total	140	100%

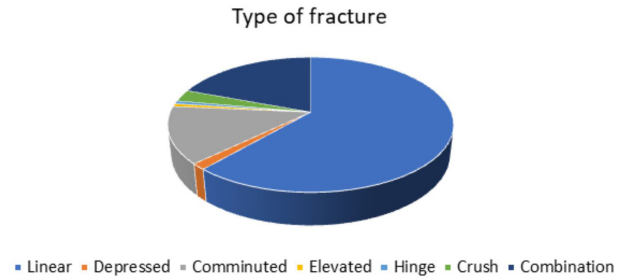

Figure No. 5: Distribution of type of fracture

Discussion

In our study, out of the 923 autopsy cases conducted during the study period, 342cases were of fatal RTA cases. Skull fracture was noted in 140 cases (58.57%), among 239 cases of head injuries. This is similar to the findings, in studies done by Shribhagwan et al[2] where in 150 RTA victims of death due to head injury, skull fracture was found in 59% of the cases. In a study conducted by Raza et al[6], skull fractures were present in 62% of the cases. The occurrence of skull fractures depends on a number of factors like speed of the vehicle involved, type of collision, use of safety features like helmets, seatbelts etc.

Majority of the victims were in the age group of 21-30 years,47 cases (33.58%), followed by 30 cases in the age group of 31-40 years (21.42%). These findings are consistent with the findings of many other studies. In the study conducted by Hashmi ZA et al[7], the majority of the cases were in the age group of 21 to 30 yrs with 119(25.2 %) cases and 31 to 40 yrs age group with 103(21%).Also, in studies conducted by Gopal B K et al[8] and by Shribhagwan et al[2] on victims with head injuries, the most affected age group was 21-30 years with 30% and 30.6% respectively. Inexperience, distracted driving, lack of safety precautions like use

of helmet, alcohol and drug use are some the factors contributing to the many causes. But in studies conducted by Nair SS et al[9] and by Shetty VB et al[10], the most commonly affected age group was between 30-40 years.

The incidence of skull fractures in males was 121 (86.42%) and 19 (13.58%) in females. The male: female ratio is 6.36:1. Similar finding was also observed in the study conducted by Hashmi ZA et al[7], wherethe incidence of skull fractures was 397 (84.3%) in males and 74 (15.7%)in females with a ratio of 5.36:1.Male preponderance is observed in almost all studies on fatal RTA deaths. Men tend to travel more frequently and widely for work or business, making them more likely to be involved in accidents. Additionally, factors such as higher risk-taking behaviour, alcohol consumption, aggression, and overconfidence contribute to the higher incidence of accidents among men compared to women.

Two wheelers were most commonly involved in the accidents, 102 cases (74.29%), followed by three wheelers in 07 cases(5%) and 4 wheelers in 06 cases (4.29%). In the study done by Pateria S et al[11], two-wheel riders accounted for 65.38%, followed by 4-wheeler in 14.46% of cases. Similar observation was also made in the study by Raza S et al[6], where two-wheeler accounted for 46% of the cases. Road accidents involving two-wheelers are a significant concern worldwide due to their high frequency and potential severity. Two wheelers have increased vulnerability in crashes as they lack safety features and protection offered by four wheelers. But in a study done by Malik Y et al[5], four wheelers were the most commonly involved vehicle, in 49.39% of the cases, followed by six wheelers (24.85%) and two wheelers in 23.03% of the cases.

Most the victims were drivers, involving 74 cases (52.86%), followed by pillion riders in 35 cases (25%). 22 cases (15.72%) were pedestrians. Also, in the study conducted by Pateria S et al[11] on fatal cases with head injuries, 48.31% of the victims were drivers. In contrast to our study, most of the victims involved in fatal RTAs were pedestrians in studies conducted by Gopal BK et al[8] (38%), Raza S et al[6] (37.3%), Shetty VB et al[10] (42.72%) etc.

In our study the commonest site of fracture was the vault, in 90 cases (64.28%), followed by the basal fracture seen in 16 cases (11.43%). Both vault and basal fractures were observed in 18 cases (12.86%). This is similar to the findings, observed by Hashmi ZA et al[7], in which fractures occurring in cranial vault alone was 71.3%, BOS alone was involved in 5.94% and both were involved in 65.43%. Also, in the study conducted by Das NK et al[12], fracture of the vault was seen in 56.5%, only base was fractured in 10% and both vault and base were fractured in 24.5% of the cases. However, vault with base fracture was seen in 42.85% of cases, in a study conducted by Devi M et al[13], followed by only vault fractures in 19.54% and only base fractures in 8.27%. Also, in study by Bharathi MO et al[14] combined vault and base fractures were seen in 48.23% of the cases.

Frontal bone fractures were seen in the highest number of cases, in 29 cases (32.22%), followed by temporal bone in 15 cases (16.67%). Shribagwan et al[2] too observed similar findings, frontal bone being involved in 44.32%, followed by temporal bone fractures in 30.68% of cases. Also, in a study by Soni SK et al[15], most of the fractures were present on frontal bone in 23% of the cases. Findings in contrast to our study was found in studies done by Hashmi ZA et al[7], Rajshekar V et al[16], in which temporal bone was the most commonly fractured bone seen in 21% and 53.3% of cases respectively.

In fractures involving the base of the skull, the highest number of fractures were seen in MCF,10 cases (7.14%), followed by ACF, 03 cases (2.14%). Our finding is in accordance with the study by Das NK et al[13], wherein MCF was most commonly fractured region involving the base, in 20% of the cases. Similar results were also noted in studies done by Bharathi MO et al[4], Hashmi ZA et al[7] and by Nair SS et al[9].

In our study the most common type of fracture noticed was linear fracture in 86 cases (63.23%), followed by comminuted fracture in 15 cases (11.02%). These findings are consistent with study conducted by Hashmi ZA et al[7], where linear fracture was observed in 59.8% of cases. It is also consistent with the studies done by Shribhagwan et al[2] and Nair SS et al[9], with 54.4% and 67.4% of cases respectively were observed with linear fractures. This was in contrast to the study conducted by Devi M et al[13], in which comminuted fracture was observed in maximum number of cases, constituting 31.5% of the cases.

Conclusion

In our study the majority of the victims were aged 21-30 years, comprising 47 cases (33.58%). Skull fractures were observed in 121 males (86.42%) and 19 females (13.58%), resulting in a male-to-female ratio of 6.36:1. Most of the victims were drivers, with 74 cases (52.86%), followed by pillion riders, who accounted for 35 cases (25%).A high number of fatalities due to road accidents occur in India every year. Its effect extends to the society at large. The financial burden produced on the family and healthcare system can be substantial. There can be adverse effect on the economic output of the country as well. Therefore, measures should be sought to reduce the road traffic accidents as a number of lives can be saved, as most of these are avoidable. For that, strict enforcement of traffic laws and regulations are crucial. Road infrastructures like road designs, signage, road markings should be enhanced. The public should be educated about road safety, responsible driving and about the consequences of violating traffic rules.

Ethical clearance: Ethical clearance was obtained from the institutional ethical committee prior to the commencement of the study. (ref no. GIMS/KLB/PHARMA/IEC/223/2024-25, dated:25-01-2024)

Source of funding: Nil

Conflict of interest: Nil

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Original Article

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Analysis of Fatal Blunt Force Head Injuries in Cases of Road Traffic Accidents: A study from Civil Hospital, Ahmedabad

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Abstract

Road traffic accidentsare a leading cause of death and disability worldwide, with significant implications in India due to its vast and diverse population. Post-mortem studies provide crucial insights into the epidemiology, causes and characteristics of fatal head injuries, informing prevention and management strategies in case of road traffic accidents. This study aims to analyse the epidemiological profile of head injury cases subjected to post mortem, identifying patterns in demographic factors, causes of injury and anatomical characteristics of blunt force head trauma. In this study, analysis was done for blunt force head injury in road traffic accident cases brought to the mortuary of Civil Hospital, B.J Medical College, Ahmedabad, over a one year period from January to December(2019). Among 1138 cases of road traffic accidents, 847 cases with head injury were selected. Data on age, gender, cause of injury, type and location of blunt force head trauma and associated injuries were collected, analysed and compared with other similar studies. Of 847 head injury cases, majority were males and age group of 21 – 40 Years. 43 % of study population died within 1 hour. Predominantly two wheeler's were involved in RTA and without safety measures. 43.5% of cases showed laceration as external injury and 53.4% of study population showed linear fracture of skull. This study on blunt head injury cases reveals critical epidemiological trends, emphasizing the need for enhanced road safety measures and public awareness. The findings underscore the importance of targeted prevention strategies and improved trauma care to reduce fatalities from head injuries in India.

Key Words: Road traffic accident, Fatal head injury, Survival period, Head on collision, blunt force injury, Skull fracture

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Introduction

Road traffic accidents continue to show an alarming rise in India. According to Ministry of Road Transport and Highways, more than 1.5 lakh people lose their lives every year, with reports showing an all-time high in road traffic accidents[1]. India universally has the highest number of road fatalities. Out of which head injury is the major contributor to deaths. The incidence of head injury is increasing with the rise in high velocity transport, traffic violations and failure to follow safety measures while driving. Accurate interpretation of head injuries in postmortem is very important for proper reconstruction.

Head injury is amorbid condition characterized by gross or subtle structural changes in scalp vault and /or the content of the skull. The application of blunt force may result in injury to the skull and its contents.[2]

The patterns of head injury observed during autopsy were analysed and evaluated meticulously because the factors responsible for it were multiple and variable. The nature and severity of head injury and circumstances surrounding it, not only speaks about the different manners of head injury but also underscore the need to reduce the high mortality rate in this group.

The present study aims to analyse the common place of occurrence, types of vehicles involved and whether safety measures like wearing helmet in two wheelershelp in preventing fatal injuries in road traffic accidents. Cases with definite head injuries irrespective of predisposing factors were selected for the purpose of scrutiny. From the head injury cases so scrutinized, fatal cases were isolated where the cranio-cerebral injury was the cause of death.

Material and Method

The present prospective study was conducted at the Department of Forensic Medicine and Toxicology at Civil Hospital, B. J. Medical College, Ahmedabad during the period from January 2019 to December 2019. The material for the present study consists of data collected from the autopsy reports and from police information forms 146 (i) and (ii) of all blunt force fatal head injuries cases of road traffic accident brought to mortuary of Civil Hospital, B.J Medical College, Ahmedabad.

A proforma was prepared to collect the data based on the deceased's particulars, including a complete external and internal examination of those involved in fatal head injury cases of road traffic accident.

The particulars of deceased selected for proforma were as follows.

1. Age
2. Sex
3. Time of sustaining injury
4. Hospitalization and survival
5. Details of Road Traffic Accidents
    - Type of Vehicle
    - Place of Incident
    - Type of Crash
    - Usage of safety measures (Seat belt, helmet)
6. Type of external Injury on Head along with skull fractures

The criteria used for selection of cases for this study were as follows:

Inclusion Criteria

- All autopsies of blunt force fatal head injury cases of road traffic accident at B.J Medical College, Civil Hospital, Ahmedabad during the period from January 2019 to December 2019.

Exclusion Criteria

- Decomposed cases with fatal head injuries, where the interpretation of injuries is not possible due to extensive decomposition.
- Unknown cases where the history and details are not available.
- Injuries as a result of causes other than road traffic accident.
- Extensive burns involving head, where there is difficulty in interpretation of injuries.

The data from all the proformas were compiled into a master chart and analysed by calculating sum, range, distribution and percentage. The data was also tabulated and appropriate inferences were drawn. These inferences were then compared with those from other similar studies. Merits and demerits with possible causes, reasons and solutions were deduced.

Results

A total of 3803 autopsies were conducted at the mortuary of Civil Hospital, Ahmedabad, from January 2019 to December 2019. Out of which, 1138 cases were Road traffic accident cases. Among the 1138 road traffic accident cases, 847 cases of blunt force head injury were selected for this study after applying exclusion criteria.

The relevant observations made during the study are as follows.

In the study, 593 were Male (70.1%) and 254 were Female (29.9%), showing a male dominance (Table 1). The maximum numbers of head injury fatalities was recorded in the age group of 21 – 40 years (57.4%), while the least number of deceased were below 10 years (1.6%) (Figure 1). The maximum number of victims, 369 (43.6%) died within 1 hour, which includes death occurred on the spot at the time of accident and could be the reason for the highest number within period (Table 2). Among the different vehicle user and pedestrian, maximum numbers of vehicles observed in case of RTAs were Two-Wheelers (554 cases, 65.4%) followed by Four-Wheelers 183 (21.7%) and least numbers observed among pedestrians(110 cases, 12.9%) (Figure 2).

Table 1: Sex Wise Distribution of Cases

Gender	Number of cases	Percentage (%)
Male	593	70.1
Female	254	29.9

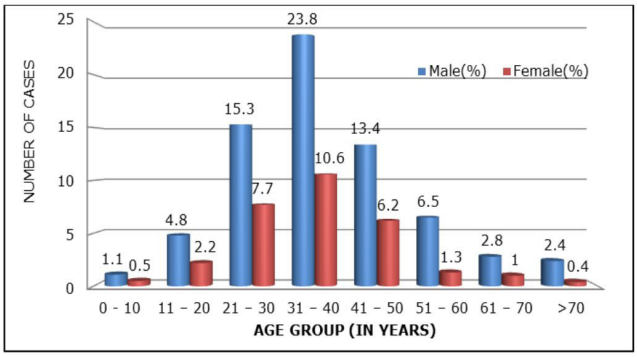

Figure 1: Age Wise Distribution of Cases

Table 2: Distribution of Case According to Survival Period

Survival Period	Number of cases	Percentage (%)
< 1 hour	369	43.6
1 to 12 hours	331	39
12 to 24 hours	58	6.8
>24 hours	89	10.5

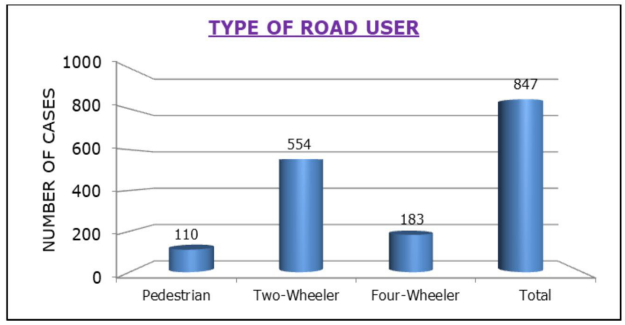

Figure 2: Distribution of Cases According to Type of User in Case of Rtas

Majority of RTAs occurred on district main roads(554 cases, 65.4%), followed by State and National High Ways (156 cases, 18.4%) (Table 3). Maximum number of deceased died due to head on collision (485 cases, 51.3%), while the minimum numbers died due to hit and run (94 cases, 11.1%) (Figure 3). The most common type of external injury noticed was laceration in (369 cases, 43.5%), followed by Contusion were seen in (160 cases, 18.9%), combination of multiple injuries in 145 (17.2%), Crush injuries were seen in 86 (10.2%) (Table 4). Extravasation of blood in the scalp region was found in temporal region 29.4%, whereas in frontal region 19%, in parietal region 18.7%, occipital region 16.6% and seen diffusely in 7.1%. Linear or Fissure fracture was the most common type of fracture of skull vault seen in (453 cases, 53.4%), while as (214 cases, 25.3%) showed no fractures. When considering the most common site of fractures in the skull vault, multiple bones were fractured in (66 cases, 26.9%). Temporal bone fractures was next common, seen in (60 cases, 17.5%), followed by frontal bone fractures in 54 cases (13.4%)(Figure4)

Table 3: Distribution of Cases According to Place of Rtas

Place of RTA	Number of cases	Percentage (%)
District main roads	554	65.4
National & State highways	156	18.4
Inner city/Village road	114	13.4
Others	23	2.8

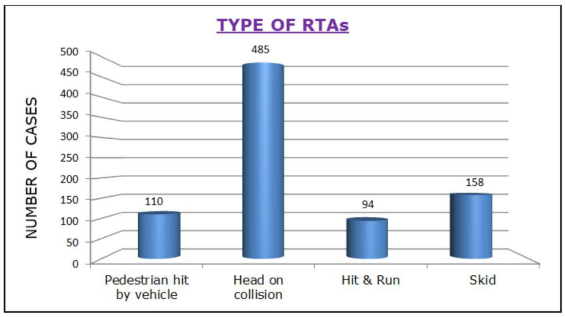

Figure 3: Distribution of Cases According to Type of Rtas

Table 4: Distribution of Cases According to Type of External Injury

Type of external Injury	Number of cases	Percentage (%)
Abrasion	87	10.3
Contusion	160	18.9
Laceration	369	43.6
Crush Injury	86	10.1
Multiple Injuries	145	17.1

Image 1: Abrasion
B. J Medical College, Ahmedabad (2019)

Image 2: Laceration
B. J Medical College, Ahmedabad (2019)

Image 3: Contusion
B. J Medical College, Ahmedabad (2019)

Image 4: Crush Injury
B. J Medical College, Ahmedabad (2019)

Figure 4: Distribution of Cases According to the Skull Fractures

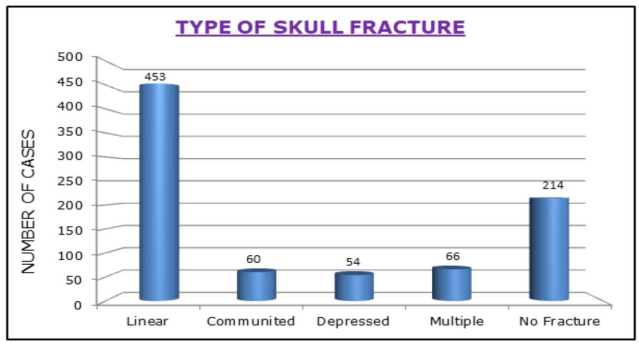

Image 5: Linear Fracture
B. J Medical College, Ahmedabad (2019)

Image 6: Communited Fracture
B. J Medical College, Ahmedabad (2019)

Image 7: Depressed Fracture
B. J Medical College, Ahmedabad (2019)

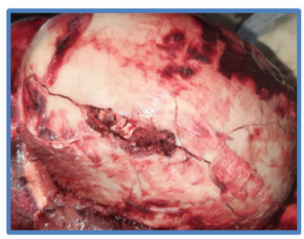

Image 8: Multiple
B. J Medical College, Ahmedabad (2019)

Discussion

The present study was compared with more than 10 significant studies related to Head Injury cases that were done in India. On comparison of present study with similar studies by Kamdar BA et al[3], Tripude BH et al[4], Khubchandani HT et al[5], Vaidehi Singh et al[6], Chavali KH et al[7], it is evident that all studies found a predominance of males among total cases of RTA similar with present study. Age group comparisons with studies by Vaidehi Singh et al [6], Gupta et al[8], Vaghela AC et al[9], Tandem RM et al[10] & Behra C et al[11], it is evident that age group of 21 to 30 years is the most common, followed by age group of 31 to 40 years, corresponding with present study. In comparison of survival period with studies by Kamdar BA et al[3], Khubchandani HT et al[5], Shivkumar

BC et al[12]and Vaghela AC et al[9], it is evident that in all studies, the majority of victims had a survival period of lessthan 1 hour, followed by survival period of 1-12 hours in most of the studies similar with the present study. Comparison of types of user in RTAs with studies done by Tandem RM et al[10], Pathak A et al[13], Vaghela AC et al[9], it was clear that studies done in last ten years show that maximum number of RTA cases were of two wheeler users. Whereas studies of Chandra J et al[14], Salgado MSL et al[15], Menon A et al[16] & Pruthi N et al[17], done before 15 years are showing maximum number of RTA cases in pedestrians.

Regarding the place of RTAs, studies by Vaghela AC et al[9] & Behra C et al[11] found that majority of RTAs occurred on district main roads, corresponding with the present study while study of Khubchandani et al[5] found maximum cases of RTAs occurred in inner city/village road. Comparison of type of RTAs with similar studies done by Pathak A et al[13], Vaghela AC et al[9] & Behra C et al[11], it was evident that maximum type of RTAs are head on collision similar with current study. It was evident that studies of Menon A et al[16], Oberoi SS et al[18] & Vaghela AC et al[9] showed laceration as the most common external injury in head injury cases of Road traffic accident which is similar with the current study. It was evident that in all the similar studies, maximum type of skull fractures were found to be linear. Comparison of use of safety measures with similar studies done by Pathak A et al[13], Shivkumar BC et al[12] & Surendra J et al[19], it was evident that maximum two wheeler user of RTA were found to be without helmet except studies of Ravikumar R et al[20] and Behera C et al[11]were it was found that maximum two wheeler user of RTA were with helmet.

Summary and Conclusion

The present study helped in drawing the following conclusions.

- The incidence was common among the age group of 20 to 40 years with 485 cases (57.4%).
- Male predominance was seen with 593 cases (70.1%) and Female incidence in remaining 254 cases (29.9%).
- A significant 82.7% deaths occurred within 12 hour following the incident of head injuries,while 17.3% had survived for more than 24 hours.
- Regarding the history of RTAs, 65.4% involved two wheeler motor vehicle occupants, 12.9% were those of pedestrians and 21.7% were those of four wheelers occupants.
- The most common place of occurrence of RTAs is Main Road which comprise 65.4% of cases of RTAs.
- Among RTAs cases, 57.3% cases involvedhead on Collusion, 13% cases involved Pedestrians being hit by the vehicles, 18.22% cases involved skidding incidents, and 11.1% cases were Hit and Run over.

Recommendation:

India tops the world in road crash deaths. It has 1% of the world's vehicles but accounts for 11% of all road crash deaths, witnessing 53 road crash every hour; killing 1 person every 4 minutes[21]. Therefore, the single most important thing a person can do to stay healthy and alive is to pay close attention to how they drive. Traffic safety education should be given in schools for production of skilled and responsible drivers in future. There are many causative factors involved in road traffic accidents, so a multidimensional approach involving road users, vehicles and the road environment is required.

Conflict of Interest: Nil

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Ethical Clearance: Ref No- 15/2020, IEC, B. J Medical College, Ahmedabad

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Original Article

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Prediction of Stature From Length of Distal Half of Upper Limb

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Abstract

Background: Establishment of identity is a real challenge when dead bodies are burnt, mutilated, or skeletonised. Stature is a very useful tool to establish the identity. Study of estimation of stature from the length of long bones are there in the literature, however the reliability of the formula is not consistent in many instances. The present study is an attempt to establish the relationship between stature and length of distal half of upper limb.

Materials and methods: This cross sectional study was conducted on 100 subjects, 50 males and 50 females aged between 21 and 60 years in the department of Forensic Medicine in Govt. Medical College, Thrissur.

Results: In males the mean length of distal half of upper limb is 47.64 ± 1.41 cm. and correlation coefficient (r) is 0.8125. In females the mean length of distal half of upper limb is 43.94 ± 2.19 cm. and correlation coefficient (r) is 0.7458. Thus stature is strongly correlated with length of distal half of upper limb.

Conclusion: There is significant difference between males and females with respect to both the parameters under study. The higher mean values obtained by males indicated that they have greater stature and length of distal half of upper limb measurements compared to females.

Key Words: Anthropometry, distal- half of upper-limb, stature, length.

Introduction

Dead bodies found in charred or putrefied state is a day to day affair in medicolegal practice. In the dead, identification may be necessary in fresh or in putrefied bodies in which features are not recognizable; in mutilated bodies; in buried remains and in bones which may comprise the whole or only a portion of skeleton.[1] Establishing the identity of the deceased is one of the main objective of any medico legal autopsy. Identity means the determination of individuality of a person.[2]Stature of an individual is an inherent characteristic, the estimate of which

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is considered to be important in the identification of unknown human remains. Many researchers have developed mathematical procedures for estimation of stature from skeletal remains.[3,4] Stature can be estimated using various anthropometric parameters like arm span, hand length,[5-9] finger length, foot length and foot breadth.

Study by Bharati, S., et al. states that stature can vary between ethnic groups within India.[20]Even though many regression equations and multiplication factors for estimation of stature are available for various ethnic groups of our country, the study for estimating the stature from length of distal half of upper limb has not been done in Kerala state. This study was done in live subjects so that accurate measurements could be taken due to the absence of practical difficulties like breaking of rigor. It could be conveniently applied in dead subjects especially unknown cadavers, so that it may be helpful in establishing the identity.

Objectives:

1. To find out the correlation between length of distal half of upper limb and stature of an individual.
2. To find out a regression formula to estimate stature from length of distal half of upper limb.

Materials and Methods:

This is a cross sectional study on 100 subjects, 50 males and 50 females aged between 21 and 60 years in the department of Forensic Medicine in Govt. Medical College, Thrissur.

Inclusion criteria: All Staff and post graduate students over age 21.

Exclusion criteria:

1. Subjects with apparent symptomatic diseases, deformities, fracture, amputation or history of any surgical procedures of fore arm and hand.
2. Who are not willing to participate in the study

Measurement of stature: The subjects were asked to stand erect with their heels together and backs as straight as possible so that the heels, buttocks, shoulders and the head touches the rod of stadiometer (in Frankfurt plane). The arms were hung freely by the sides. Reading was taken from the stadiometer scale at the vertex point (highest point on their head) with sensitivity 0.5 cm. Measurements were taken thrice and the mean value was taken to reduce error.

Measurement of length of distal half of upper limb: The right upper limb was semi flexed at the elbow which was placed in a vertical plane and the measurement was taken from the tip of olecranon process of ulna up to the tip of middle finger. Right upper limb was taken because of the prior similar study conducted by Kumar Amit, et al concluded that the role of right and left side measurements in stature estimation is statistically insignificant.[10] All the measurements were taken from left side as per the recommendation of International Agreement for the unification of Anthropometric measures on the living, in the case of paired measurement.[11] International biological programme procedures were also taken into consideration while taking the measurements.[12,13] Measurements were taken thrice and the mean value was taken to reduce error. It was measured using a measuring steel tape up to 5 mm accuracy.

Results

A total of 100 subjects were analysed which included 50 males and 50 females. This was a cross sectional study conducted during a period of 1 year. All the subjects were from Government Medical College, Thrissur.

Table 1. Total study population

Individuals analysed	
No. of males	50
No. of females	50
Total	100

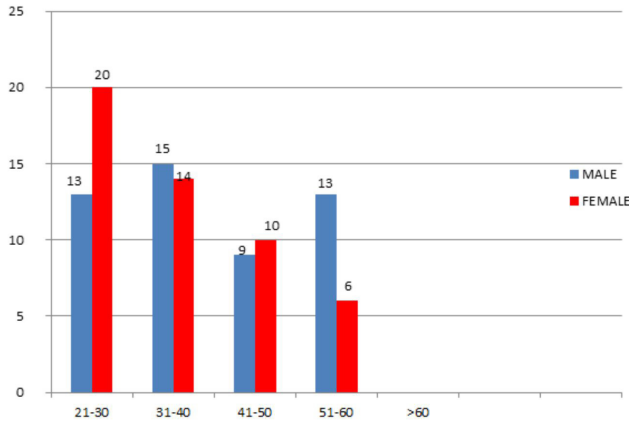

Figure 1. Age wise distribution of study population.

The age group of the female subjects ranges from 21 years to 60 years with the mean age of 35.54 ± 8.49 SD. The age group of male subjects ranges from 21 years to 60 years with the mean age of 37.39 ± 9.58 SD. Majority of the subjects belongs to the age group 21-30 years (33% of the total).

Height of males varied from 162 cm to 183 cm, the mean height was 170.85 ± 5.20 SD.

The height of females varied from 144 cm to 167 cm, the mean height was 157.44±4.93 SD. The height when the males and females combined varied from 144 cm to 183 cm and the mean height was 164.15 cm ± 8.42 cm.

The length of distal half of upper limb in males varied from 44.50 to 50.50 with mean of 47.64 ± 1.41 cm SD.

The length of distal half of upper limb in females varied from 36 cm to 49 cm with mean of 43.94±2.19.

The length of distal half of upper limb when the males and females combined varied from 36 cm to 50.50 cm with mean of 45.79±2.61 SD.

The correlation coefficient (r) in males was 0.8125.The correlation coefficient in females were 0.7458. The correlation coefficient when males and females combined was 0.8861.

Table 2. Mean of height and length of distal half of upper limb

	Males	Females	Males and females combined
Mean height	170.85±5.20 SD	157.44±4.93 SD	164.15±8.42 SD
Mean length of distal half of upper limb	47.64 ± 1.41 cm	43.94 ± 2.19 cm.	45.79 ± 2.61 SD.

Correlation between stature and length of distal half of upper limb

In males the mean length of distal half of upper limb is 47.64 ± 1.41 cm.

Correlation coefficient (r) is 0.8125.

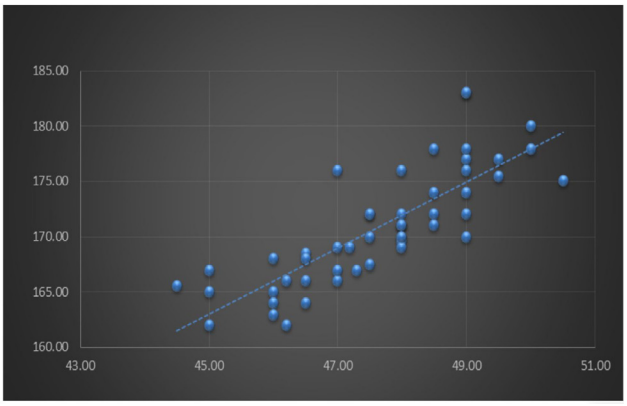

Figure 2. Correlation between stature and length of distal half of upper limb in males

- In females the mean length of distal half of upper limb is 43.94 ± 2.19 cm.
- Correlation coefficient (r) is 0.7458.

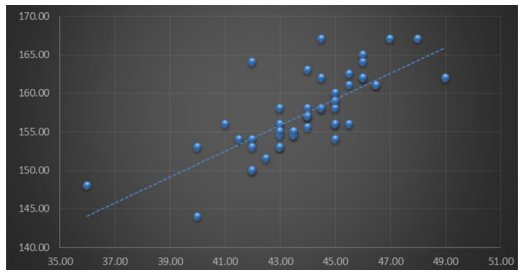

Figure 3. Correlation between stature and length of distal half of upper limb in females

In males and females combined, the mean length of distal half of upper limb is 45.79 ± 2.61 SD

Correlation coefficient (r) is 0.8861.

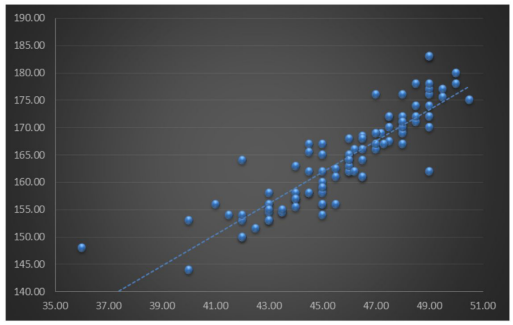

Figure 4. Correlation between stature and length of distal half of upper limb in males and females combined.

Correlation coefficient (r)

Table 3: correlation coefficient of males and females

Correlation coefficient (r) in males	0.8125
Correlation coefficient (r) in females	0.7458

Regression formula

The Regression equation is,

Height of individual (Y) =intercept(a) + slope(b) x X

Where, X = length of distal half of upper limb of the individual

Y= Height of individual

The regression equation for individuals independent of sex was found to be:

Height of individual = 33.285 + 2.858 x X

P values, P<0.001, SE for intercept (a) =6.925, SE for slope(b)=0.151

Regression equation for males is

Y = 28.562+2.987 X

Coefficient=2.987, SE=0.309, P value<0.001

Constant=28.562, SE=14.741, P>0.059

Regression equation for females is

Y = 83.497+1.683 X

Constant =83.497 SE=9.543, P<0.0001

Coefficient=1.683, SE=0.217, P< 0.0001

This equation is intended to be used in persons where the ossification centers are completely fused. The study population was so fixed to above 21 years. It should not be used in children.

Discussion

Determination of stature is an important part in identifying an individual, especially in cases of unidentified, mutilated or decomposed bodies. It is an important ingredient in calculating body mass index, used in nutrition assessment. Its measurements may not be practicable in old or debilitated persons who can't even stand or in the persons who may be having spinal abnormalities. The regression equation derived using the length of distal half of upper limb may at times provide an alternate method for predicting the stature.

Study by Trotter M et al., says that the height will increase by 2.5 cm after death.[14] This is an average increase seen in deceased bodies irrespective of age and gender. Hence this study in living definitely have advantage over cadavers. Studies by many experts indicates secular change and allometry between sexes. The sexual maturity attained in both sexes varies greatly during the course of development, so that gender specific equation is necessary to estimate the height of an individual.

The correlation coefficient between length of distal half of upper limb and stature was positive which indicates that there was strong relationship between the length of distal half of upper limb and human stature. The positive correlation reflects that, if the length of distal half of upper limb increases, the stature also increases and vice versa. The regression equation calculated was found to be nearer to actual height with a deviation of less than ± 4 cm in most of the cases. A variation of more than ± 5 was observed only in (5% of males and females).

This study was conducted among the staff and PG students of Government Medical College, Thrissur, Kerala. The measurements were taken by principal investigator himself in all subjects, with the help of a female doctor who was trained by the principal investigator so that the measurements were not read out by multiple persons and the error could be minimised.

Study conducted by Amit K et al. Calculated Regression equation for stature for males as 2.42 **X** + 54.64, where X is the length between tip of olecranon to the tip of middle finger. In the females the regression equation for stature is calculated as 2.31 X + 59.5.[15]In our study the regression equation for males was derived as Y = 28.562 + 2.987 X, and regression equation for females was derived as Y = 39.393 + 0.738 X. The difference in the values may be due to different ethnicities. This indicates that the specific regression equation used for prediction of stature is applicable only to the population in which the data was calculated.[16]

Telekka et al. (1950)[17] worked on the bones of

the limbs and was of the opinion that each racial group needs a separate formula for the estimation of stature. Inter geographical variations can also occur and the calculation and multiplications factors may be different in such settings.[18] Height is shown to decrease progressively as age advances due to spinal column shrinkage[19],it will be good if similar studies could be carried out on different age groups to complement the result of this study.

Conclusion

The relationship between stature and length of distal half of upper limb obtained in the present study was positive and significant. The regression equations were derived for males and females separately and also in combination for both sexes. This could be helpful in estimating the stature when distal half of upper limb is available for measurement. There is significant difference between males and females with respect to both the parameters under study. The higher mean values obtained in males indicates that they have greater stature and length of distal half of upper limb compared to females. The reliability testing of the regression formulae showed that almost all the equations are fairly accurate in predicting stature.

Ethical clearance: Taken from Medical college, Thrissur, Institutional Ethics committee, Order No: B6-155/2019/MCTCR(29) Date:20/12/2019, Govt. Medical college, Thrissur.

Source of funding: self

Conflict of interest: Nil

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Original Article

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Patterns of Head Injuries in Fatal Fall from Heights

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Abstract

Head injuries are most common in medico legal investigations. It is important to ascertain if the fatal head injuries is due to fall, road traffic incidents or other causes, especially in found-dead cases with isolated head injuries. Study of patterns of injuries can help differentiate the causative factors. This study is designed to study the patterns of head injury in different categories of fall. A prospective analytical study was conducted on 92 cases of fall presenting with head injuries over a period of one year. Statistical analysis was done using the Chi-square test using SPSS software and inference was made. This study showed younger males were predominant in falls with 12-60 feet being the most common height of fall. Age of victims showed strong correlation with period of survival. All the fall cases had scalp injuries, contusion being the commonest type. The skull base injuries were present in 32.6 % of fall cases with linear fracture being the commonest type. The skull vault injuries occurred in 68.47 % of fall cases. Brain injuries were present in all fall cases. The combination of subdural hemorrhage, subarachnoid hemorrhage and contusions was commonest type of brain injury among falls. The severity of scalp, skull base and skull vault injuries increased with the increase in height of falls. The causation of fatal head injuries in falls can be determined based on the patterns of injuries elicited during the autopsy examination, keeping in mind the various other factors that had come into play in the fall deaths.

Keywords: Falls, Head injuries, medico legal, fatal

Introduction or back ground

Falls account for the second highest number of unintentional deaths worldwide, resulting in an estimated 646,000 deaths globally every year.[1] The mechanism of head injury in a fall includes both the impact to the head upon landing and the impact sustained by head with other objects before landing.[2,3] The variables that primarily influence the distribution of injuries over the body are height of falls, the intervening objects or surfaces, the landing surfaces and the manner of death.[4] Of all the regional injuries, head injuries are the most common in medico legal investigations. During post-mortem examination of fall victim, height from which he or she has fallen gives an important information during medicolegal investigation.

Material and Methods

The present study was carried out at Department of Forensic Medicine, Maharajgunj Medical Campus,

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Institute of Medicine, Tribhuvan University, Nepal from September 9, 2020- September 9, 2021. The study comprised of 92 cases of fall with head injuries subjected to medico legal autopsy.

The deceased were divided into different groups according to their height of fall (less than 12 feet, 12 feet to 60 feet and more than 60 feet). Each group were correlated with the patterns of head injuries in the scalp (contusion, abrasion and laceration), skull (linear, depressed and comminuted) and brain (Subarachnoid hemorrhage, Epidural hemorrhage, Subdural hemorrhage, cortical contusion, cortical laceration, intracerebral haemorrhage). The variables were also correlated with age and sex. Pattern of injuries were also correlated with landing surface.

Data were collected from police documents, hospital records and communication with police personal, family and friends of deceased and post-mortem examination. The data obtained were recorded in proforma and chi square analysis was done by SPSS software.

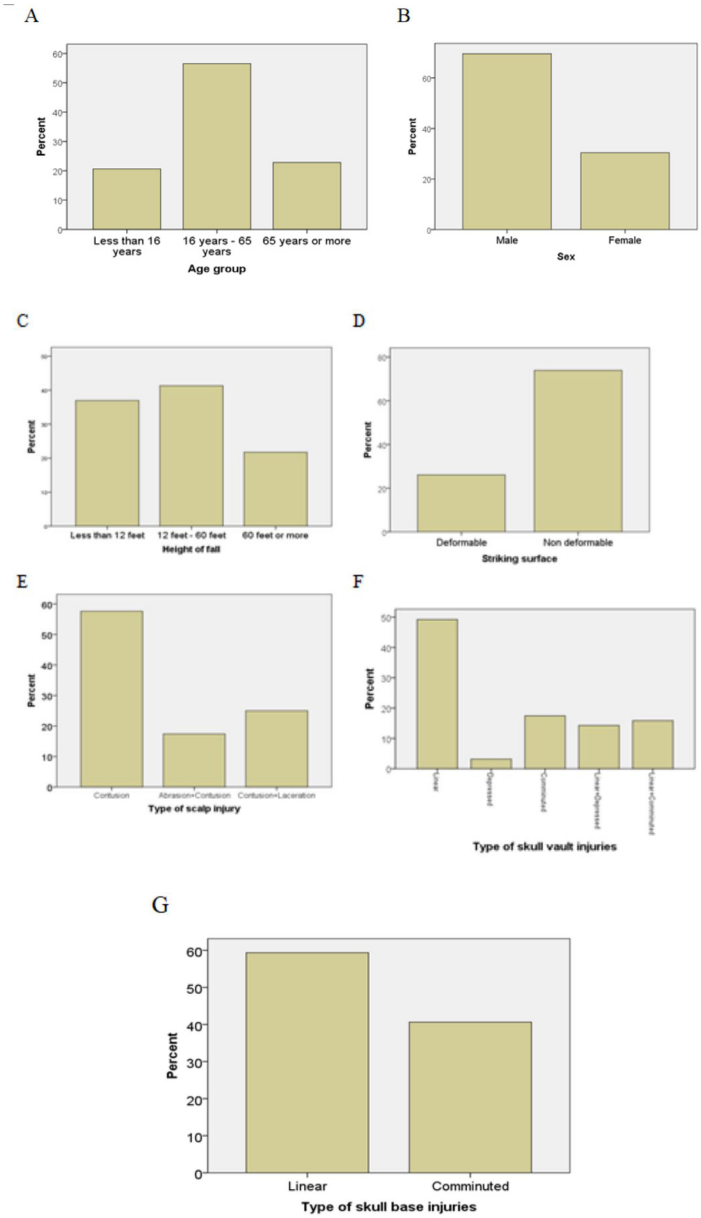
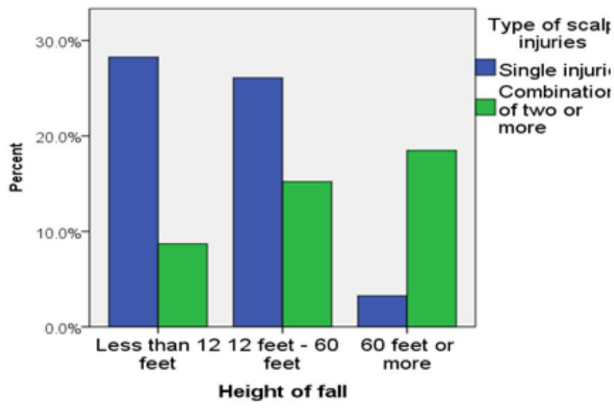


Figure 1: Bar Chart, the summary distribution of cases according to different categories. A (Age group) B (Sex) C (Height of fall) D (Striking surface) E (Type of scalp injuries) F (Type of skull vault injuries) G (Type of skull base injuries)

Table 1: Distribution of cases according to the type of brain injuries in Fall cases

Type of brain injuries			Frequency	Percent	Valid Percent	Cumulative Percent
Single injuries	Valid	Extradural hemorrhage	2	8.0	8.0	8.0
		Subdural hemorrhage	5	20.0	20.0	28.0
		Subarachnoid hemorrhage	18	72.0	72.0	100.0
		Total	25	100.0	100.0	
Combination of two injuries	Valid	EDH+SDH	3	8.3	8.3	8.3
		EDH+SAH	1	2.8	2.8	11.1
		SDH+SAH	9	25.0	25.0	36.1
		SDH+ICH	2	5.6	5.6	41.7
		SDH+CC	8	22.2	22.2	63.9
		SAH+ICH	2	5.6	5.6	69.4
		SAH+CC	8	22.2	22.2	91.7
		SAH+CL	3	8.3	8.3	100.0
		Total	36	100.0	100.0	
Combination of three or more injuries	Valid	EDH+SAH+ICH	1	3.2	3.2	3.2
		EDH+SAH+CC	1	3.2	3.2	6.5
		EDH+SAH+CL	1	3.2	3.2	9.7
		SDH+SAH+ICH	1	3.2	3.2	12.9
		SDH+SAH+CC	22	71.0	71.0	83.9
		SDH+SAH+CL	1	3.2	3.2	87.1
		EDH+SDH+SAH+CC	2	6.5	6.5	93.5
		SDH+SAH+ICH+CC	1	3.2	3.2	96.8
		SAH+ICH+CC+CL	1	3.2	3.2	100.0
		Total	31	100.0	100.0	

A



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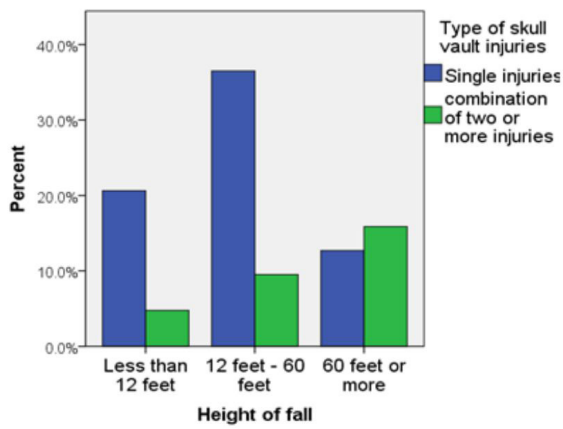

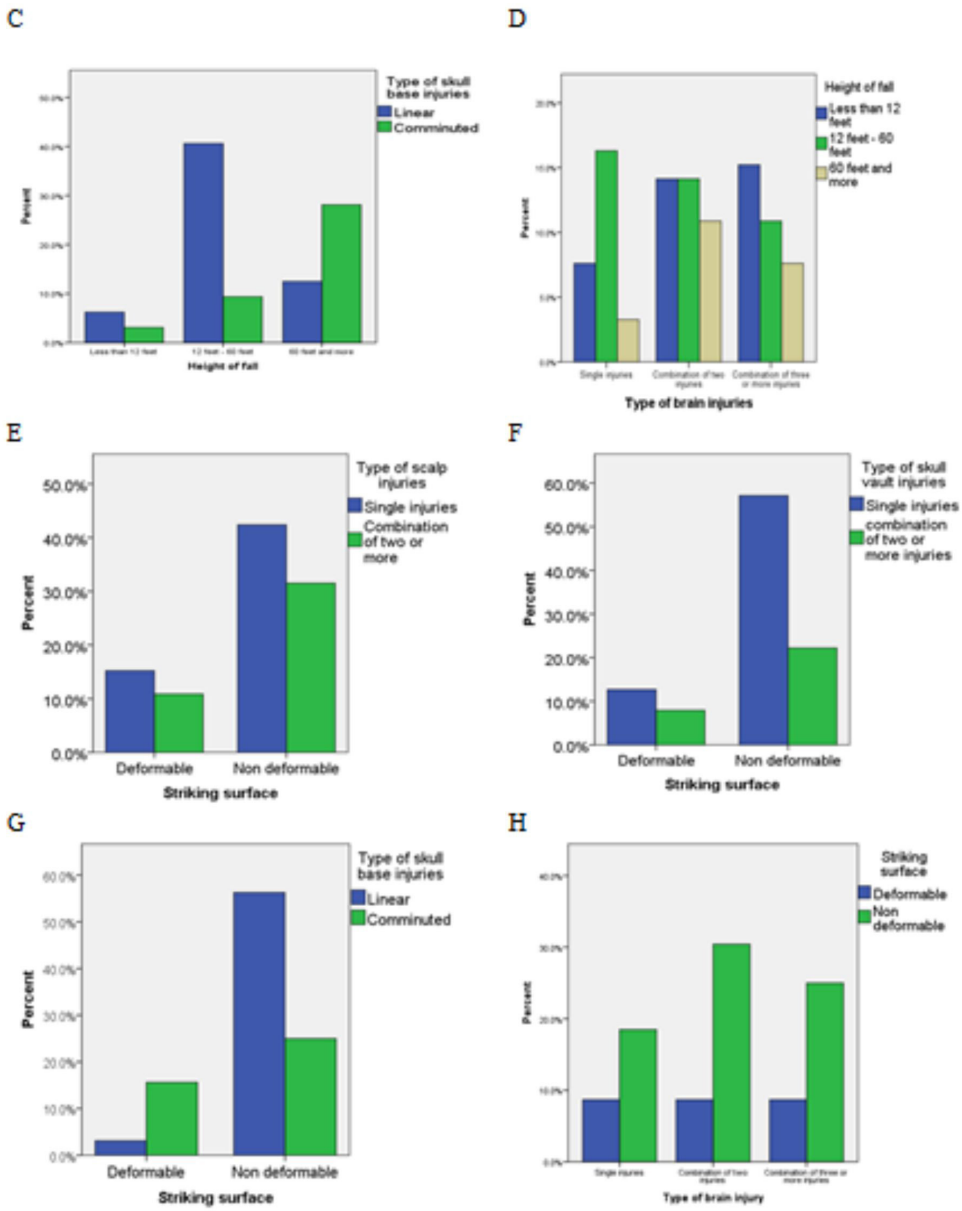

Figure 2 Correlations between A (Height of fall and type of scalp injuries) B (Height of fall and type of skull vault injuries) C (Height of fall and type of skull base injuries) D (Height of fall and type of brain injuries) E (Striking surfaces and type of scalp injuries) F (Striking surfaces and type of skull vault injuries) G (Striking surfaces and type of skull base injuries) H (Striking surfaces and type of brain injuries)

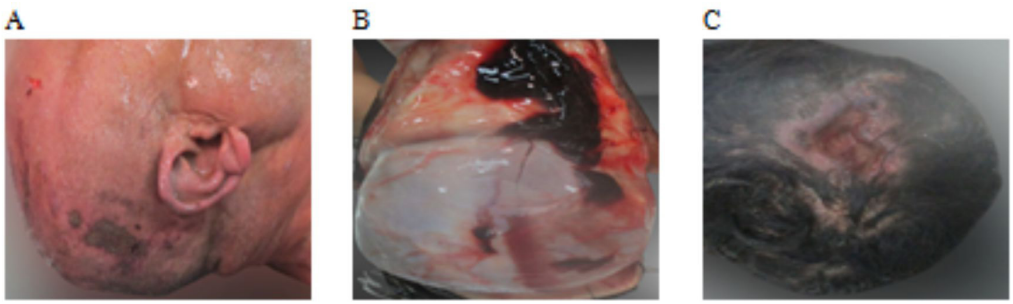

Figure 3: Type of scalp injuries. A (Abrasion) B (Contusion) C (Laceration)

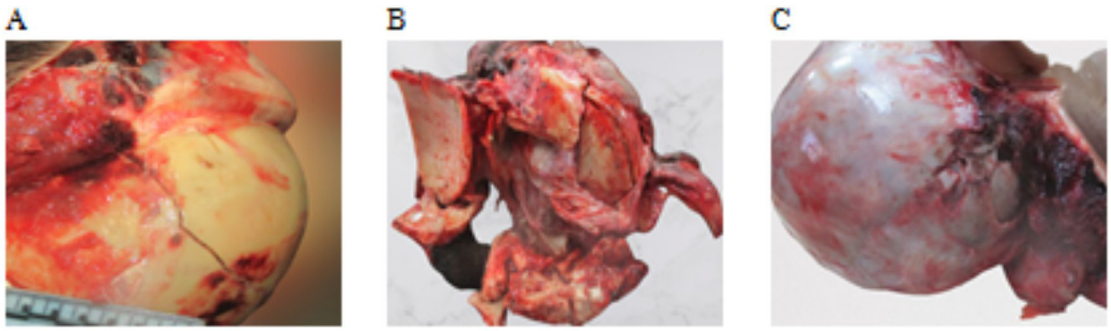

Figure 4: Type of skull injuries. A (Linear fracture) B (Communited fracture) C (Depressed fracture)

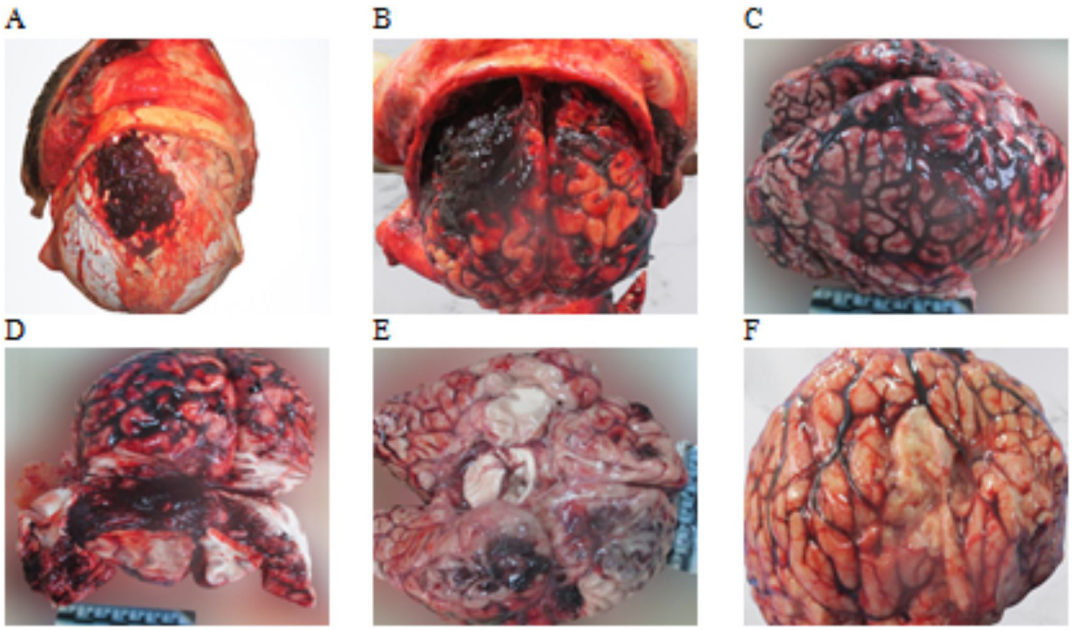

Figure 5: Type of brain injuries. A (Epidural hemorrhage) B (Subdural hemorrhage) C (Subarachnoid hemorrhage) D (Intra-cerebral hemorrhage) E (Cerebral contusion) F (Cerebral laceration)

Results and Discussion

Out of 92 cases of fall with head injuries, the most common age group was 16-65 years (56.5%) and least common less than 16 years (20.7%) which is similar to the study done by S Gupta (2015), in which the most common age group was 25-55 years (45.1%). As expected most of the deceased were from the working age group but vulnerity of children and elderly should not be ignored. Both the above findings were inconsistent with the findings of the WHO and S Goren (2003), where majority of victims were children and elderly. This could be due to geographical variation, influence by different lifestyles and social structures. Another reason for this discrepancy could be the better safety measures and awareness of workplace safety in countries more developed than Nepal. [1, 6, 7]

Male (69.6 %) outnumbered female (30.4%) by the ratio 16:7, as males are more involved in outdoor work. [5]

The most common group of height of fall was between 12 feet - 60 feet (41.3%) and the least common being more than 60 feet (21.7%). Most of the elderly population fell from the height less than 12 feet, similar to the findings as that of the study by Hartshorne (1997) and SK Rowbotham (2018). This can be explained by the presence of the underlying medical conditions in the elderly that predispose them to the standing-height fall. [8, 9]

All fall cases had scalp injuries. Contusions (57.6%) were the commonest scalp injuries in falls and the combination of abrasions and contusions (17.4%) the least common, whereas the scalp injuries were seen in only 43% of cases in the study by A

Kohli (2006).[10] This could be because of most of the deceased in this study fell into non-deformable surfaces.

Skull Vault injuries were seen in 68.5% of fall cases and skull base injuries seen in 34.78% of fall cases, which is similar to the study done by MD freeman (2014).[11] Linear fractures (49.2%) were the most common and the depressed fractures were the least common (3.2%) amongst the skull vault injuries. The study by M Ahmad (2014) showed that the linear fracture was the commonest (51.61 %) among the skull vault injuries and the most common site to get injured was the temporal bone, which is similar to that of the present study. The temporal bone is the thinnest area of the skull and most vulnerable to injures.[12]

Amongst the fall cases having skull base injuries, linear fracture was the commonest (59.4%) followed by communited fracture (40%). Polson and Gee found that fissured and comminuted fractures rather than localized or depressed fractures are the rules following fall, which is similar to this study.[13]

Forensic Medicine textbooks state that falls produce ring fractures around the Foramen Magnum. These fractures are rare, because the falling body landing on the flat feet or on the buttocks is a rare phenomenon. The study by Goonetilleke (1980) had only one case of ring fractures.[14] This study, with 92 fall cases, also did not present with any ring fractures.

Brain injuries were seen in all cases. The combination of subdural haemorrhage, subarachnoid haemorrhage and cerebral contusions were present in 23.9 % of falls followed by subarachnoid haemorrhage (19.6%). Whereas, study by L Li (1994) showed brain injuries in only 66.4% of cases, among which subarachnoid haemorrhage were present in 25.4 % of cases followed by the combination of subdural and subarachnoid haemorrhage (17.85%).[15] In cases of isolated brain injuries, subarachnoid haemorrhage was common similar to the study by A Kohli (2006) [10], which is different from subdural haemorrhage in the studies done by J Manavis (1991), Hartshorne (1997) and O paper (2014). [16, 8, 17]

Spot death increased with increase in height of fall. Spot death was highest in falls from the height of 60 feet or more (38.6%) as expected.[19]

Frequency of single injuries decreased and frequency of the combination of two or more injuries increased with the increase in height of falls. The frequency of combined skull vault injuries increased with the increase in height of falls similar to the study by S Gupta whereas the frequency of skull vault injuries were indirectly related to the height of falls in the study by MD Freeman (2014). [20, 11] Frequency of comminuted fracture of skull base injuries increased with the increase in height of fall. These findings were similar as in the study by TC Atanasijevic (2005).[19] Combination of three or more brain injuries was common in falls from height less than 12 feet (45.18%), single injuries were common in fall from height between 12-60 feet (60.47 %) and the combination of two injuries were common in fall from height less than 60 feet (72.22%).

Most of the falls were on non-deformable surfaces similar to the studies by CR Vasudeva (2012) and SK Rowbotham (2018). [9, 3] There was no significant correlation between types of scalps, skull and brain injuries injuries with striking surfaces, however non-deformable surface produced more injuries in fall from all heights. Types of injuries are more likely to depend upon the site of impact and the direction at which the body impact the surface.[21, 22]

In this study differences between accidental fall and incidental fall (suicidal and homicidal) were not studied, however it is likely to differ in pattern of injuries when compared between different parts of body.[23, 24] According to Tomsaz Cywka et al, suicidal fall victims are more likely to sustain pelvic and lower limb injuries in comparison to accidental fall victims. While studying the injury patterns, the role of intervening objects should be ruled out as this can be misinterpreted as a sign of assault. Therefore, well designed future studies should be conducted to differentiate between accidental, suicidal and homicidal falls.

Conclusion

This study showed there are variation in injury pattern according to different heights of fall, landing surface, age and sex. The detailed analysis of pattern of injuries in falls can give us tentative height of fall. According to various literatures, the coup and contre-coup injuries, ring fractures, fractures of feet bones and compression of vertebral fractures are more common in fall injuries. Therefore the correlation of these injuries with height of fall and other causes of head injuries like road traffic incidents, physical assaults etc are to be done in similar future studies. Safety measures are to be strictly followed at work

places to prevent falls in case of elderly and children. Due to the small number of samples, short study duration and the study site at only one institution, the study could not be representative of a larger population of the country. Some variables had to be merged to maintain the validity of statistical tests. Therefore similar studies in future should be designed with a larger sample so that the results can be more representative.

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Ethical Clearance: Ethical clearance given by Institutional Review Committee (IRC) of Institute of Medicine (IOM), Tribhuvan university on September 09, 2020 with the reference number-60 (6+11/E2 077 /078.

Declaration of conflicts of interest statement: Authors declare no conflict of interest

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Original Article

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Morphologic Variations in External Ear among Ethnic Meiteis: A Hospital-Based Cross-Sectional Study

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Abstract

The external ear is highly individualised in terms of its shape, size, and other morphological characteristics, making it a useful tool for forensic identification in determining sex and personal identification. These characteristics are believed to be controlled by multiple genes and shared among genetically related individuals. To describe the uniqueness and sexual differences in external ear morphology among the ethnic Meiteis, a cross-sectional study was conducted in the Clinical Section of the Department of Forensic Medicine and Toxicology from May 2022 to April 2024. The study included 422 ethnic Meiteis, and common characteristics observed in both sexes included an oval-shaped pinna in 35.38% of individuals, nodosity of Darwin's tubercle in 74.53%, medium-sized anti-tragus in 50.66%, arched shape of the lobule in 44.67%, and proportionate form of the concha in 74.10%. The tragus types were evenly distributed, with an average of 30% for each type. The shape of the helical fold differed between males and females, with 60.03% of males having a normally rolled shape and 62.16% of females having a wide covering scapha shape, with an average occurrence of 49.14%. There was no significant sexual difference in the external ear characteristics except for the helical fold. Regarding the uniqueness, most of the ethnic Meitei population exhibited the nodosity type of Darwin's tubercle, medium-sized anti-tragus, and proportionate form of the concha, accounting for more than half of the total study population.

Keywords: Ear morphology, ethnic Meitei, identification

Introduction

Identification is the establishment of a person's individuality based on specific physical characteristics unique to the individual. In forensic practice, establishing identity becomes challenging in mutilated remains, skeletal remains, and burnt bodies. Many entities, such as bones, teeth, hair, and external peculiarities, have been used for identification purposes. However, there is not enough data for identifying a person based on a single entity alone. Using various entities together provides a foolproof method for determining a person's identity.

The human external ear is considered unique in every individual in shape, size, and other

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morphological characteristics, making it suitable for forensic identification for sex determination and personal identification purposes. Further, various features of the external ear are under multiple genetic controls and are expected to behave similarly in genetically related persons.[1]

The external ear is made up of a single piece of fibrocartilaginous structure with an irregular surface with varying degrees of elevation and depression. It has the most visible external features on its surface compared to the other external features of the face. Further, according to some studies, ears are considered unique to every person to the extent that they are comparable to fingerprints.[2] The present study is being carried out with an objective to describe the morphologic variations in the external ear regarding its uniqueness and sexual dimorphism among ethnic Meiteis. The Meitei ethnic people are located in the state of Manipur. A Meitei individual whose three generations from both mother's and father's side are taken as ethnic Meiteis. No previous studies have been conducted on this ethnic group.

Materials and Methods

This cross-sectional study was conducted in a tertiary care teaching institute in North-East India. The data was collected from cases brought for examination in the Clinical Section of the Department of Forensic Medicine and Toxicology.

The sample size is calculated using the formula-

$$N=(Z_1-\alpha/2)^2pq/d^2,$$

$Z_1-\alpha/2=1.96$ (Critical value for the corresponding level of confidence of 95%)

p= By assuming 50% of the population have oval-shaped pinna[4]

(Based on a previous study by Singh and Purkait, 2009)

q= 1-p

d= 5% (Permissible margin of error with 95% confidence interval with 10% of non-response rate)

N=384+38(10% non-response rate)=422

The calculated sample size is 422

The study participants included the 422 subjects above ten years of age who were brought for medico-legal examination in the centre, as well as those who were brought for age determination for participation in sports and admission into sports academies/ schools during the period of May 2022- April 2024. Any person with ears with an anatomical defect or injury or previous surgery was excluded. The gender-wise variations in the shapes of the pinna, tragus, anti-tragus, lobule, anti-helix concha border, helical fold, and concha & forms of Darwin's tubercle, ear lobule attachment to cheek, and upper helix were studied.

After obtaining ethical clearance and written informed consent from the participants or parent/ LAR (legally authorized representative) along with oral/written assent in the case of child participants, the participants were seated in a pre-designed room with a camera (Canon Digital camera EOS 1500D Zoom lens EF-S 18-55mm, 24.1 Mega Pixels), Tripod stand (DigiTek DTR-495BH) & Digital Camera Flash) fixed on a tripod stand with adequate lighting. If the participant is wearing earring/s, s/he was requested to remove them wherever possible. The head of the subject was oriented in the Frankfort horizontal plane[3]. The camera's focal plane was kept parallel to the longitudinal plane of the external ear so that any protrusion could be negated to get a uniformly aligned image of the subjects. Images of both the ears of the subject were taken from 25 cm. The features of the external ears were categorized as per the classification, '*Somatoscopic characters describing the form of external ear*'[2]. The features of each subject were noted and compared, the findings were recorded & the data was entered using SPSS version 21(Armonk NY: IBM Corp) & the data were summarised in terms of percentage and frequency.

Results

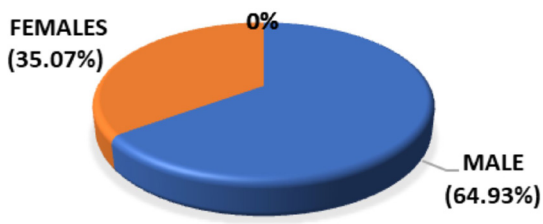

Figure 1: Gender distribution of the participants (N=422)

In this study, out of 422 subjects, 274 (64.93%) were males and 148 (35.07%) were females (Figure 1). The various characteristics of the external ears of both sexes are shown in Table 1. The oval shape (Figure 2a) of the pinna is found to be the most common in both males and females, with an overall percentage of 35.38% in ethnic Meiteis. The nodosity type of Darwin's tubercle (Figure 2b) is seen in both males and females (74.53% of the total study population).

The tragus of the external ear shows almost equal distribution of all three shapes in both males and females. A long type of tragus (Figure 2c) is commonly seen on the right ears of males, and a round tragus (Figure 2d) on the left ears. However, on average, the long types are frequent in males. Interestingly, in the female subjects, the round type of tragus is found to be the commonest.

The medium type of anti-tragus shape (Figure 2e)is the most common in both sexes, with an overall percentage of 50.66%. The distribution of anti-tragus types of the external ear also shows bilaterality in males. The arched-shaped lobule is the most common (Figure 2f) in both males and females with 44.67%. The partial form of lobule attachment to the cheek (Figure 2g) is seen in 44.30%. The shape of concha exhibits high percentages of proportionate type (Figure 2h) in both males and females, with 71.53% and 76.68%, respectively with an average of 74.10% in the ethnic Meitei subjects as shown in Table 1. The upper helix form of the external ear shows acute angle medial form (Figure 2i) in males with 37.22% and 50.67% in females, with an average of 43.94%. The most common anti-helix concha border present iscurved shape (Figure 2j) with 48.72% in males and 45.60% in females. The shape of the helical fold exhibited as normally rolled (Figure 2k) in males (60.03%) and wide-covering scapha (Figure 2l) in females (62.16%).

Table 1: Distribution of the external morphological characters of the ear

Feature	Classification	MALES			FEMALES			Overall
		RIGHT	LEFT	BOTH	RIGHT	LEFT	BOTH	
1. Shape of pinna	1.Oval	35.40%	36.50%	35.30%	35.81%	35.14%	35.47%	35.38%
	2.Round	29.56%	30.66%	29.56%	20.95%	28.38%	24.66%	27.11%
	3.Triangular	14.60%	16.42%	15.23%	17.57%	16.22%	16.89%	16.06%
	4.Rectangular	20.44%	16.42%	18.10%	25.68%	20.27%	22.97%	20.53%
2.Darwin's Tubercle	1.Absent	2.56%	3.65%	3.10%	1.35%	3.38%	2.36%	2.73%
	2.Nodosity	77%	79.93%	78.46%	5.35%	76.35%	70.60%	74.53%
	3.Enlargement	17.88%	13.50%	15.69%	30.42%	17.56%	23.98%	19.83%
	4.Projection	2.56%	2.92%	2.73%	3.38%	2.71%	3.04%	2.02%
3.Tragus	1.Long	42.70%	30.66%	36.67%	34.46%	18.92%	26.68%	31.67%
	2.Round	27.37%	37.96%	32.66%	33.11%	42.57%	37.83%	35.24%
	3.Knob	29.92%	31.39%	30.65%	32.43%	38.51%	35.47%	33.06%
4.Anti-tragus	1.Prominent	28.83%	28.83%	28.83%	33.78%	35.14%	34.45%	31.64%
	2.Medium	54.38%	54.38%	54.37%	45.27%	48.65%	46.95%	50.66%
	3.Flat	16.79%	16.79%	16.78%	20.95%	16.21%	18.58%	17.68%
5.Shape of lobule	1.Triangular	15.33%	14.23%	14.78%	16.22%	14.19%	15.20%	14.99%
	2.Rectangular	29.93%	22.26%	26.09%	30.41%	25%	27.70%	26.89%
	3.Tongue	5.84%	6.93%	6.38%	4.05%	4.73%	4.39%	5.38%
	4.Arched	41.97%	48.91%	45.43%	39.86%	47.96%	43.91%	44.67%
	5.Round	6.93%	7.67%	7.29%	9.46%	8.12%	8.78%	8.03%
6.Lobule attachment to cheek	1.Fully-attached	14.96%	14.60%	14.78%	19.60%	16.90%	18.24%	16.51%
	2.Partial	50.36%	43.07%	46.71%	45.95%	37.83%	41.89%	44.30%
	3.Free	34.68%	42.33%	38.50%	34.45%	45.27%	39.86%	39.18%

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7.Concha	1.Narrow	9.85%	9.12%	9.48%	12.84%	5.40%	9.12%	9.30%
	2.Proportionate	74.09%	68.98%	71.53%	72.97%	80.41%	76.68%	74.10%
	3.Broad	16.06%	21.90%	18.97%	14.19%	14.19%	14.18%	16.57%
8.Upper helix form	1.Acute angle medial	33.58%	40.88%	37.22%	47.30%	54.05%	50.67%	43.94%
	2.Angle upper directed	14.96%	10.95%	12.95%	12.84%	8.11%	10.47%	11.71%
	3.Obtuse angle medial	28.83%	30.66%	29.74%	16.90%	20.27%	18.58%	24.16%
	4.Angle laterally directed	13.87%	8.39%	11.13%	10.81%	4.73%	7.77%	9.45%
	5.Obtuse acute angle	5.11%	6.57%	5.83%	5.41%	5.41%	8.78%	7.30%
	6.Double right angle	3.65%	4.01%	3.10%	6.76%	7.43%	7.09%	5.09%
9.Anti-helix concha border	1.Straight	19.34%	18.98%	19.16%	16.22%	14.86%	15.54%	17.35%
	2.Curved	48.91%	48.54%	48.72%	47.97%	43.24%	45.60%	47.16%
	3.Round	24.82%	25.91%	25.36%	26.35%	31.76%	29.05%	27.20%
	4.Laterally protruding	6.94%	6.57%	6.75%	9.46%	10.14%	9.70%	8.22%
10.Helical fold shape	1.Normally rolled	58.76%	61.31%	60.03%	33.11%	35.81%	34.45%	47.24%
	2.Wide covering scapha	37.23%	35.04%	36.13%	62.84%	61.49%	62.16%	49.14%
	3.Flat	4.60%	2.92%	2.91%	3.38%	2.70%	3.04%	2.97%
	4.Concave marginal	1.09%	0.73%	0.91%	0.68%	0%	0.33%	0.62%

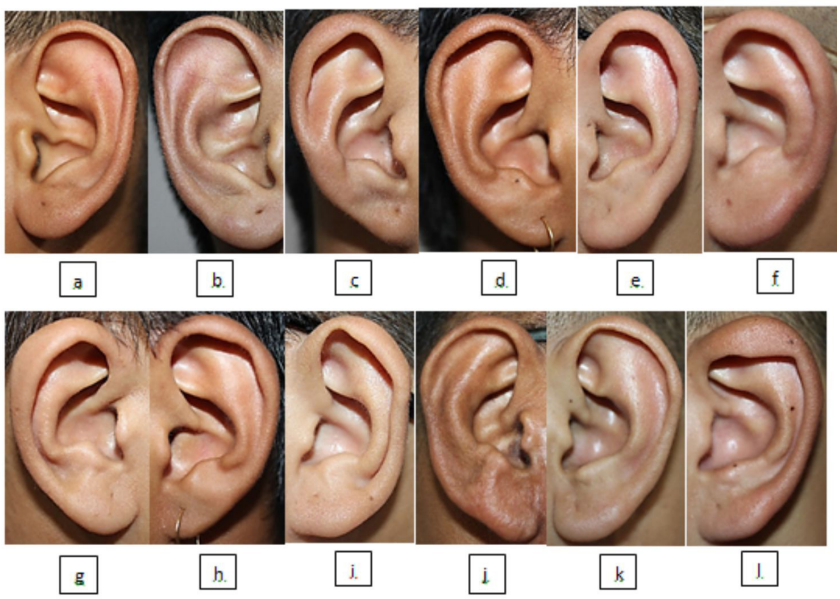

Figure 2: a) Oval shape of pinna b) Nodosity type of Darwin's tubercle c) Long tragus d)Round tragus e) Medium anti-tragus f) Arched lobule g) Partial-attachment of lobule h) Proportionate type of concha i) Acute angle medial form of helix j) Curved shape of anti-helix concha border k) Normally-rolled helix l) Wide-covering scapha

Discussion

In this study, the oval shape of the pinna was the most common in both males and females, while the other types were observed less frequently. Overall, Meitei's ethnicity showed an oval shape, which is the most common, with no sexual dimorphism. Similar findings were seen in a study of the external ear by Singh P et al.[4] in Central India, where oval-shaped pinnae were the most common. Interestingly, in a study by Farhan SS et al.[5] among Iraqi subjects, it was observed that the most common shape of the pinna in females was rectangular (78%). In males, it was oval (64%), and the shape of the pinna showed characteristic sexual dimorphism in the study population. On the other hand, Fakorede ST et al.[6]found a round shape of the pinna in Hausa ethnicity and an oval in Yoruba and Igbo which are in contrast to our study.

In our study, the Darwin's tubercle shows nodosity as the most common type in both males and females with no sexual dimorphism. In studies by Krishan K et al.[7]and Rani D et al.[8], the nodosity type of Darwin's tubercle was the most common in both males and females, which may be favourably compared with the findings of our study. According to a study by Ozioko O et al.[9], Darwin's tubercle was absent in Yoruba (87%) and Igbo (90%) ethnic groups.

In a study by Makaju S et al.[10], the most common type of tragus in females was round in both Indian and Nepali populations. Similar findings were observed in both sexes in a study by Swati M et al.[11]In the Meitei population, long-type tragus of the external ear was common in males, while it was round in females. Overall, for Meitei participants, the round type was the most common. However, the knob shape of the tragus was the most common type in both sexes on both sides in a study by Fakorede ST et al.[6]and Krishan K et al.[7] and in Hausa, Igbo and Yoruba tribes of Nigeria.

In the present study, the most common type of anti-tragus is medium, and it was prevalent in half of the ethnic Meitei study population. However, no sexual dimorphism could be ruled out. In a study by Kearney B[12], the most common type was round, with 80% in males and 68.6% in females. Gaya AA and Yahaya AI[13] found the flat type of anti-tragus to be the most common, with 68% in males and 57.4% in females.

The most common type of the shape of the lobule of the pinna was arched in both sexes in the present study. Rubio O et al.[14] observed that the most common type of lobule was the arched type in both sexes, which is similar to the findings of our study. Fakorede ST et al.[6] found the most common earlobe shape in Hausa ethnicity to be square and arched in Yoruba and Igbo. Triangular-shaped lobules were observed in 7.33% of males and 1.33% of females and the most common form in females was square and tongue in males in a study by Sezgin N et al.[15]

Lobule attachment to the cheek in the present study was found to be maximum, with the partially attached form in both the males and females with no sexual dimorphism. Meitei ethnicity showed that almost half of the study population had a partially attached lobule attachment to the cheek, with 44.30%. Similar findings were noted in a study by Rani D et al.[8], with partially attached earlobes as the most common in males (38.03%) and females (47.83%).

In our study of external ear morphology in ethnic Meiteis, the most common concha type is a proportionate type of concha in both sexes. No sexual dimorphism could be ruled out. However, the ethnic Meitei population shows a very high percentage of proportionate form of concha with 74.10%. According to a study by Gaya AA et al.[13], the shape of concha consisted of 13% narrow, 51% proportionate, and 36% broad in males, while 21.2% narrow, 59.6% proportionate, and 19.2% broad in females which is in agreement with the findings of our study.

In this study, the helical fold shape is maximum, with typically rolled helix in males and wide covering scapha in females. The Meitei study population showed an almost equal percentage of typically rolled and wide-covering scapha. A rolled helix was found in both sexes in a study by Singh P et al.[4], Krishan K et al.[7], and in another study by Swati M et al.[11]. However, in a study by Fakorede ST et al.[6], the most common form of the helix was found to be wide in all ethnicities of Hausa, Yoruba, and Igbo.

Conclusion

It may be concluded from the study's findings that no significant sexual dimorphism could be noted in the characters of the external ear in the Meitei

subjects except for the helical fold. A normally rolled helical fold in males and wide covering scapha in females were observed. As regards the uniqueness of the characters in ethnic Meiteis, it could be opined that the majority of the population manifested with the nodosity type of Darwin's tubercle, medium type of anti-tragus, and proportionate form of concha. Hence, a combination of external morphological characteristics observed in the study population may help determine the uniqueness of the pinna of the ethnic Meitei population and the establishment of its identity.

Ethical Clearance details: No.A/206/REB-Comm(SP)RIMS/2015/943/281/2022 from Research Ethics Board RIMS. Regional Institute of Medical sciences, Imphal, Manipur

Conflict of interest: Nil

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Original Article

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Study of Unknown Dead Bodies Brought for Post Mortem in Tertiary Hospital

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Abstract

Introduction: Medico legal autopsies are conducted in India in two circumstances: cases where a person has died because of unnatural circumstances and where the body of the deceased is unidentified. The present study relates to the latter of the two aforementioned circumstances, i.e. where the dead body is not identified.

Aims and material: In present descriptive prospective study the size and magnitude of problems regarding unidentified bodies. Also the profile of unidentified dead bodies such as age, cause of death, post-mortem interval, manner of death, seasonal trends, area (urban or rural), place from where the body was recovered was studied

Results: Total 1919 bodies were brought to us of which 169 cases were selected after exclusion criteria. The mean age of the patients was found to be 44.82±14.83 years with male predominance. Most of the cases were identified on the basis of the clothes belonging and 16.57% bodies were brought from the rural areas. Majority of the unidentified bodies were found in the autumn season (28.99 %). Maximum unidentified dead bodies were discovered at religious places (n= 64, 37.87 %). In the present study, most deaths were natural(n=114 (67.46 %) and the majority of autopsies were performed between 4 and 6 days (n= 73, 43.20%) .There were the most cases of illness/ diseased condition (n=55,32.5%).

Conclusion: Unknown/unclaimed should be presented for autopsy forthwith without any delay so that decomposition and other artifacts do not set in and obscure the findings of the postmortem examination can be avoided.

Keywords: Autopsy, Dead Bodies, Forensic, Post- Mortem, Unknown

Introduction

As the worldwide population and that of the developing Indian subcontinent are on the rise, a part of this growth is contributed by individuals migrating from different states seeking employment, among other reasons. Tragically, some of these individuals

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succumb to unfortunate circumstances, and their identification process begins under a police inquest, with an autopsy surgeon and a forensic scientist playing significant roles.[1]

In India, post-mortem examinations are often performed in government hospitals, by trained forensic medicine experts who work closely with law enforcement agencies to provide vital information for investigations.[2] Two main scenarios necessitate examination of unknown dead bodies in India: deaths resulting from unnatural circumstances and cases where the body is unidentified. The process of identifying these bodies involves examining physical characteristics and other identifying markers such as fingerprints, scars, tattoos, and dental records. DNA profiling and bone analysis are also employed, particularly when the body is decomposed or mutilated. In recent years, the use of more advanced techniques like facial reconstruction and isotopic analysis has also been reported in the literature.[3]

The medico-legal autopsies of unknown bodies not only help in criminal investigations, but they also provide valuable epidemiological data about accidental deaths, suicides, and homicides, which can guide public health policies and interventions.[4] While trying to establish the cause of death of an unknown body, the forensic experts also consider the geographical surroundings or circumstances in which the dead body was found.

The primary aim of this study is to assess the size and magnitude of the issue related to unidentified bodies, while providing a comprehensive profile of the unidentified dead bodies based on factors such as: determining if certain age groups are more vulnerable; common causes of death; time gap to discovery; manner of death; seasonal variation; any rural-urban divide; place where the bodies are most often recovered, etc. This study stands apart from others in the field due to its multi-faceted approach. While earlier research may have focused on singular aspects like the forensic identification process or geographic profiling, this study combines multiple variables to create a holistic profile of unidentified bodies. In this way, the study not only fills gaps in existing literature but also aims to provide data that can influence policy decisions and preventive measures.

Materials and Methods

The present descriptive cross sectional study was conducted for the period of 2 years at department of Forensic Medicine & Toxicology. Total 1919 bodies were brought for autopsy of which sample size of 169 cases of unknown bodies was selected.

The study included:

1. Cases of unknown bodies brought for post mortem

It excluded:

1. Dead bodies that were identified before or at the time of autopsy.

In this investigation, police inquest papers, panchnamas and, hospital records were closely examined. Photographs were taken to document findings, age, sex, cause and manner of death, area (urban or rural) from where the body was brought, seasonal trends were analyzed. External body examination included fingerprints, tattoos, anomalies, and scars. DNA samples and fingerprints were retained upon request.[5] After reviewing post-mortem, chemical, and histopathological data, the cause of death was determined. All case proformas were compiled. The data was statistically analyzed.

Results

During the two-year period of the study, a total of 169 cadavers with a dubious identity or unidentified have been autopsied in the department. These formed 8.80 % of total 1919 autopsies performed. Out of 169 unidentified cases, males comprised of 155 in number and 14 were females. The mean age of the patients was 44.82±14.83 years (Table 1).

Table 1: Table showing distribution of cases in reference to age and sex.

Age Group (Years)	Female		Male		Total	
	n	%	N	%	n	%
<1 Years	2	14.29%	2	1.29%	4	2.37%
1-10 Years	0	0%	2	1.29%	2	1.18%
11-20 Years	2	14.29%	0	0%	2	1.18%
21-30 Years	3	21.43%	13	8.39%	16	9.47%
31-40 Years	2	14.29%	41	26.45%	43	25.44%
41-50 Years	2	14.29%	47	30.32%	49	28.99%
51-60 Years	1	7.14%	33	21.29%	34	20.12%
≥61 Years	2	14.29%	17	10.97%	19	11.24%
Total	14	100%	155	100%	169	100%
Mean±SD	32.64±21.75		45.88±13.67		44.82±14.83	
Median	28.50		45.00		45.00	
Range	7 Months - 70 Years		7 Intra Uterine Month -75 Years		7 Intra Uterine Month -75 Years	
χ^2	37.547					
p value	0.001					

Most of the cases were identified on the basis of the clothes belonging to the cases, n= 158 (93.49 %). (Table 2) It was found out that 16.57% bodies were brought from the rural areas in which more were males (n=24).

Majority of the unidentified bodies were found in the autumn season (28.99 %) followed by the summer season (23.67 %) monsoon and winter season (15.38%). Maximum unidentified dead bodies were discovered at religious places (n= 64, 37.87 %) like temple or gurudwara, followed by 28 cases recovered from the water bodies/drowning (n= 28, 16.57). In the present study, most deaths were natural, n=114 (67.46 %) and the majority of autopsies were performed between 4 and 6 days (n= 73, 43.20%) (Table 2)Regarding the cause of death according to police records in the present study, it was determined that there were the most cases of illness/ diseased condition (n=55) (Table 2)

According to post-mortem multi-organ failure was the leading cause of death (n= 67, 39.64%), followed by injury (n= 29, 17.16%). In the majority of these 169 cases, photographs (49.11%) were used for identification, followed by scar impressions (20.71%) and tattoos (2.91%). In 1.18% of instances, moles were utilized. (Table 2).

Table 2: Shows various parameters studied in the present study

Variables		**Total (N=169)**	
		n	%
Extraneous Identification Materials	Clothes	158	93.49%
	Religious Symbols/ Locket/ Kara	4	2.37%
	Bangles / Watch	5	2.96%
	Red Color Kalawa(Religious Thread)	11	6.51%
	Wrapped in Plastic Sheet	8	4.73%
	Wrapped in Cloths Sheet	12	7.10%
	No Clothes on Dead Body	2	1.18%
Locality	Urban	141	83.43%
	Rural	28	16.57%

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Seasonal trends	Spring	28	16.57%
	Summer	40	23.67%
	Monsoon	26	15.38%
	Autumn	49	28.99%
	Winter	26	15.38%
Place	Near Religious places	64	37.87%
	Hospitals	22	13.02%
	Roadside	8	4.73%
	Railway and bus Stations	21	12.42%
	Bus Stand	9	5.33%
	Water Bodies/ Drowning	28	16.57%
	Other Area	26	15.38%
Manner of death	Natural	114	67.46%
	Accidental	33	19.53%
	Suicidal	16	9.47%
	Homicidal	6	3.55%
Duration since death	1-3 Days	63	37.28%
	4-6 Days	73	43.20%
	7-9 Days	23	13.61%
	> 9 Days	10	5.92%
Cause of death	Generalized diseased condition of multiple organs	55	32.54%
	Alcohol overdose	6	3.55%
	Burn Injury	2	1.18%
	Others	1	0.59%
	Infanticide	6	3.55%
	Sudden and Natural Death	26	15.38%
	Poison Ingestion	2	1.18%
	Drowning	13	7.69%
	Due to Injuries	5	2.96%
	Heart Attack	3	1.78%
	Railway Injury	1	0.59%
	RSA	22	13.02%
	Starvation	27	15.98%

Discussion

This study focuses on the critical role of forensic medicine specialists in identifying unidentified bodies and to ascertain there cause of death. The present study was in accordance with various studies conducted in India and around the globe in whom reported the predominant age group to be 21-50 and showed male predominance.[6-15] Only one study conducted in new Delhi reported female predominance.[16] The male predominance could be attributed to the patriarchal society of our country, where a female's main domain is her home; be it parental or in-laws, and her absence is usually enquired in to; while a male is free to go about where ever he wants.

It was found that more number of unidentified deaths were from metropolitan cities and as there the residing population is more and there is more

migratory population. The different regions have different number of unidentified bodies which might be due to different cultural aspects of the region and due to demographic variation.

In the present study, the majority of the cases were identified on the basis of the clothes belonging to the cases, n= 158 (93.49 %). The visible marks of identification are most common for identification. In the present study, it was found that 16.57 % of the unidentified bodies were brought from the rural areas while 83.43 % were brought from the urban areas. These findings are consistent with a similar study conducted in Mumbai.[17] Their research yielded comparable results, further emphasizing the apparent urban-rural disparity and the socio-economic imbalance persisting within urban zones. This consistency between studies strengthens the validity of our observations and signals a need for addressing these socio-economic imbalances in both settings.

In the present study, it was found that majority of the unidentified bodies were found in the autumn season (28.99 %) followed by the summer season (23.67 %). That is because of extreme heat experienced in the summer season and that may cause death due to dehydration or due to sun stroke mostly in the beggars. In the present study, most of the unidentified dead bodies were discovered near religious places (n= 64, 37.87 %) like temple or gurudwara the reason for this is that there are many migrated persons and beggars living around religious place in search of some donations or food, followed by 28 cases recovered from the water bodies/drowning (n= 28, 16.57 %), 26 cases from the other areas like open fields (n= 26, 15.38 %) and 22 cases from the hospitals (n= 22, 13.02 %). These findings were compared with the study done at France where cadavers were mainly discovered in public places (65.7%). [18]

The cause of the death was registered as natural and unnatural. In the present study, most deaths were natural, n=114 (67.46%), followed by accidental, n= 33 (19.53 %), suicidal; n=16 (9.47 %) and homicidal, n=6 (3.55 %).These results were more or less similar to the study done by Chattopadhyay[19] and Kumar[20] where majority of the cases were due to some diseases, pathological conditions or old age.

In the present study, in the majority of the cases the time period between the body brought to the mortuary and the when the autopsy was performed was 4 - 6 days (n= 73, 43.20 %). This was in accordance with the study done by Gitanjali et al where in majority post mortem was performed between 3 - 7 days (29.26 %).[12] The police take and preserve fingerprints, publish photos in newspapers and post pamphlets outside mortuaries, hospitals, police stations, and train stations to find unidentified bodies. This activity identifies more bodies, but it takes time, and the police normally request a postmortem after completing the foregoing requirements.

In the present study, regarding the cause of the death multi organ failure was the most common of the death on post mortem (n= 67, 39.64 %) followed by injury (n= 29, 17.16 %). The study from Italy found car accidents to be 21.6%, railway injuries (8%), assault (17.6%), poisoning (17.9%).[21] Head injuries was the principal cause of death in 75.86 % cases who died due to injuries. This result was similar to the study done in United States.[22]

Table 3: Comparison of the various study parameters in reference to unknown dead bodies.

Region	Year	No. Of cases	M:F	Age group (years)	Cause of death	Area of recovery	Manner of death
Punjab, India[8]	2008-10	156	6.8	21-40	Starvation 25 %	Near Holy places 28.8 %	Natural 46.1 %
Milan, Italy[21]	1995-2008	454	4.29	21-40	Car accidents 21.6 %	–	Accident 33.9 %

Continue.....

Garches, France[22]	2003-09	134	2.28	47.4 (avg)	Drowning 27.2 %	Public places 65.7 %	Suicidal 40.3 %
Denmark[23]	1992-96	89	3.68	19-39	Drowning 71 %	–	Suicidal 50%
USA[24]	1979-2004	413	4.15	18-37	Assault 31.8 %	–	Accident 41.8 %
Mumbai, India[25]	2013-15	109	11.1	41-50	TB 43.11 %	Footpath 72.27 %	–
Present study	2020-22	169	11.07	41-50	Multi organ failure 39.64 %	Near Religious places 37.87 %	Natural 67.46%

Conclusion

As regards the efforts for identification much more is needed to be done by the police personnel. Bodies that are unknown/unclaimed should be presented for autopsy forthwith without any delay so that decomposition and other artifacts do not set in and obscure the findings of the postmortem examination. The rule for preservation of an unknown body for 72 hours applies for its disposal and should not for its postmortem examination. Thus valuable data regarding the cause of death can be established. Active investigation and modern investigative and identification techniques should be used, workload of the police officers needs to be redistributed, and accountability of the police has to be fixed to get the body identified. More use of social medial and artificial intelligence should be promoted.

What is known about this topic

The unidentified dead bodies is big problem. Most of unidentified dead bodies remain unidentified even after efforts of police department which are old ways.

What this study adds

The cause of death among unidentified dead bodies, usual place of recovery of unidentified dead bodies, seasonal variation of unidentified dead bodies and new methods of identifications.

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Original Article

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Shedding Light on Forensic Science: Public Awareness and Understanding

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Abstract

Forensic science is the application of scientific disciplines that are directed to the recognition, identification, individualization, and evaluation of physical evidence by applying the principles, technology, and methods of natural sciences for the administration of criminal justice or to serve the law. Improved forensic investigation techniques rely heavily on raising public awareness of forensic science. This study aims to analyze the level of awareness among the community's various age groups by examining their knowledge and perception of forensic science. A survey-based study was conducted over 400 adults of different age groups ranging from 18 to 45 years or above, different professions, and genders. The survey questionnaire was made up in digital format using Google form tool, the questionnaire was designed into two sets of easy and moderate questions to ensure that participants of all age groups could effectively engage and contribute their insights. The study concluded that 92% of participants knew forensic science. The study, comprised of individuals aged 18 years or above, observed that those aged 18 to 30 responded more enthusiastically and efficiently to the survey than those aged 30 and above. Younger participants had more participation and efficiency in their responses. Additionally, sex had no impact on public awareness. However, substantial differences have been observed among age and profession. According to the survey, younger and employed people are more aware of forensic science. Nevertheless, it is too soon to make accurate predictions about awareness, knowledge, and engagement rates, as thorough nationwide surveys have yet to be undertaken. The preliminary research gives initial insights, but substantial data gathering is required to draw more definitive conclusions about public awareness and engagement levels. Launching awareness campaigns about the relevance of forensic Science is critical for creating a more informed community, lowering fears, and addressing knowledge gaps, ultimately helping the discipline and encouraging future participation.

Keywords: Awareness, Forensic Science, Justice system, Evidence

Introduction

Forensic science is a fascinating field that has received widespread attention in popular culture, ranging from television shows like CSI to best-selling crime novels. However, behind the flashy depictions is a complex and important discipline

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that plays a critical part in the criminal justice system. In recent years, there has been an increasing appreciation for the necessity of raising public awareness and comprehension of forensic science. This is not only for amusement or intrigue; it has far-reaching ramifications for the administration of justice, the preservation of individual rights, and the progress of scientific accuracy.[1] Forensic science is a wide range of scientific disciplines utilized for legal issues. From DNA analysis to ballistics, digital forensics to toxicology, it involves employing scientific concepts, techniques, and procedures to investigate crimes, identify criminals, and exonerate the innocent.[2][1] Despite its importance, forensic science is still a vaguely understood and frequently misrepresented topic in the eyes of the general public. One of the biggest causes of forensic science fallacies is the media's sensationalized presentation of the subject. Television shows and movies more often portray forensic professionals as invincible superheroes capable of solving difficult cases in a couple of hours. While these dramatizations provide engaging entertainment, they do little to effectively depict the complexities and limitations of real-world forensic investigation.[3]

Furthermore, a lack of public understanding of forensic science has major implications for the criminal justice system. Media coverage complicates the understanding of forensic science, as laypeople and media professionals with limited scientific knowledge often misinterpret evidence presented in court. Without a solid grasp of forensic methods, they struggle to assess the reliability and relevance of findings. This misunderstanding can mislead public perception and compromise the integrity of the justice process, risking unfair outcomes.[1] Another important feature of public knowledge of forensic science is its role in encouraging confidence and accountability in the criminal justice system. In recent years, famous cases in which forensic evidence was discovered to be wrong or forensic practitioners participated in misconduct have eroded the public's belief in the integrity of forensic science.[5] Building transparency and knowledge of the procedures and practices used in forensic investigations is critical for restoring trust and safeguarding the integrity of criminal proceedings.[6]

Another reason for increasing awareness is to encourage young people to consider forensic science as a viable career option. With greater visibility of the field's diverse applications and its crucial role in the justice system, more students may be inspired to pursue careers in forensic science, recognizing its potential for meaningful and impactful work. Enhanced awareness can also lead to increased enrollment in forensic science programs, fostering a new generation of skilled professionals who are passionate about contributing to the legal and investigative processes.[7] In recent years, attempts to raise public awareness and comprehension of forensic science have gained traction. Educational activities, such as forensic science classes in schools and public outreach programs, are intended to explain the profession and foster scientific literacy.[8] Furthermore, advances in communication technology have made forensic science information more accessible, allowing specialists to interact directly with the public via social media, podcasts, and other digital platforms.[9]

Despite these advances, there is still more work to be done in bridging the gap between forensic science and the general population. Continued investment in educational outreach, collaboration between forensic practitioners and communication professionals, and a dedication to transparency and accountability are critical for fostering a more educated and involved public.[10]

Methodology

Participants: The active participants residing in Uttar Pradesh represented a diverse range of age groups, educational backgrounds, and professions. Demographic information, including gender, age, occupation, and educational level, was collected through a Google Form.

Survey Instrument: The research employed a questionnaire created in English using the Simple Binary Questionnaire Model, designed for easy understanding and response. This digital questionnaire was developed using Google Forms and included 23 questions. These questions were crafted to evaluate participants' knowledge, awareness, and perceptions of forensic science and its advancements, covering various aspects of the field, including its application in criminal investigations.

Data Collection: The digital questionnaire was distributed through various social media platforms, accompanied by a clear explanation of the study's aim, objectives, and significance. This approach ensured the inclusion of a diverse range of participants from different age groups, educational backgrounds, and professions.

Data Analysis: The responses were collected and analyzed to evaluate the awareness and knowledge levels regarding forensic science among the Indian population. The data provided insights into the participants' understanding of forensic science and its role in the justice system.

Results

"During a 1-month internship, a Google form survey was disseminated, yielding responses from 400 active participants. This sample size was calculated to ensure a confidence level of 95% and a margin of error of 4.80 % for the target population. The data collected is statistically robust, providing sufficient power for subsequent inferential analyses and ensuring reliable generalizations within the context of the study." while the information about the residence of people surveyed is anonymous, we received a reasonable amount of data from various places to carry out our research. The individuals involved in this research were of varied genders and various age groups ranging from 18- 45 years and above. The data obtained had men comprising 44% and females 55.5% and 0.5% individuals who prefer not to say about their gender. Regarding their age, the majority of the participants were in their 18-25 year age group that was 69% followed by 19% in the age group between 25-35, and the least number of individuals were from the 35-45 age group with 4.5%(8) in rate, and the second least recorded results were from above 45 age group of individuals with 7.5% rate. While dealing with profession majority were from graduate and postgraduate individuals with 40% and 34% rates respectively, whereas 15.5% of participants were from higher secondary education (12^{th}) and 10.3% of participants were from other professions like employed, unemployed, businessmen, etc. Table 1 represents the participant's detailed characteristics.

Table 1. The participants' detailed demographic data

Characteristics	Participants characteristics	%
Sex	Male	176 (44%)
	Female	222 (55.5)
	Prefer not to say	2 (0.5%)
Age	18-25	276 (69%)
	25-35	76 (19%)
	35-45	18 (4.5%)
	45 above	30 (7.5%)
Profession	Higher secondary education (12^{th})	62 (15.5%)
	Graduate	160 (40%)
	Postgraduate	136 (34%)
	Other (employed, unemployed, etc.)	42 (10.5%)

Table 2 Simple Binary Questionnaire Model for Ease-of-Understanding Questions and its Response.

Questionnaire responses	Yes	No	Maybe
Are you aware of forensic science?	91.4%	8.65	-
Do you think forensic science is accurately portrayed in TV shows & movies?	24.7%	31.1%	44.2%
Are you aware of forensic science and its application in the court of law?	61.7%	17.9%	20.4%
Do you think forensic science can provide justice in the court of law?	85.9%	2.5%	11.6%
Do you think increased awareness of forensic science could benefit society?	91.9%	1.8%	6.3%

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Are you aware of any recent advancements in forensic science?	38.5%	50.4%	11.1%
Do you think technological advancement will positively impact the future of forensic science?	87.1%	2.3%	10.6%
Are you aware of the forensic science institutes and the courses under them?	46.8%	36.9%	16.3%
Are you aware of the state and central forensic labs?	44.4%	42.6%	12.9%
Do you think the used techniques for forensic science examination are accurate?	53.6%	7.7%	38.8%
Do you think the results of the forensic examination are reliable?	71.9%	4.3%	23.7%
Do you think the chain of custody is important in forensic evidence?	65%	5.7%	29.3%
Forensic science is a combination of multi-disciplinary branches, do you agree?	76.6%	4.4%	19%
Do you think forensic science will be helpful to the public in solving Cybercrime at present?	67.9%	14.4%	17.7%
Do you think the Government runs a campaign to spread awareness about forensic science?	51.2%	27.4%	21.4%
Do you think that the government should run a campaign to spread awareness about forensic science and its role in the judicial system?	89.2%	2.1%	8.7%

Studies show that the source of knowing about forensic science, 22.9% of the participants got to know from TV, 19.8% of them learned about forensic science from social media, 32.7% of them knew about forensic science from the internet and 24.6% of them knew about forensic science from other offline sources like science magazines, newspaper, etc.

This study revealed that 92.7% of participants know about the definition of forensic science and marked "the application of science to criminal and civil law" as an option, while 3.5% of the participants marked "study of plant" as an option, whereas 1.5% and 2.3% of participants marked "study of animal" and "study of bones" as an option respectively.

Most of the participants believed that improving public understanding of the criminal justice system, promoting trust in the accuracy and reliability of forensic evidence, by empowering individuals to make informed decisions about their rights and responsibilities could help benefit society,77.4% marked all of the above as an option while 22.6%came up with their particular solutions.

The study revealed that most of the participants were aware of the types of evidence analysed in forensic investigation, 81.4% marked all of the above as an option while 18.6% came up with their particular solutions (hair & fiber, handwriting analysis, soil samples).

Participants were also aware of the personnel involved in the investigation of the crime scene 80.9% marked forensic scientist as their answer, while 14.2% marked police, 2.5% marked doctor as an option, and 2.3% participants believed that they were someone else, and marked other as an option.

The observation of research revealed that participants are aware of the contribution of forensic

science in criminal investigation, majority of the participants 63.7% marked "by conducting laboratory analysis of evidence" as an option, while 10.2% believed that forensic science contributes to criminal investigation by solving crime by using intuition, 23% of the participants marked "by providing evidence-based conclusion" and 3.1% think by relying solely on witness testimony contribute in criminal investigation.

The majority of the participants know about the role of forensic scientists in criminal trials, 81.1% of the participants marked "to provide expert testimony based on forensic evidence", while 4.6% believed acting as a judge is the role of forensic scientists in criminal trials, 6.8% believed that they represent the defendant in the court, whereas 7.7% marked none of the above as the answer.

Mostly majority of the participants who were aware of forensic science were the individuals from age group of 18-35, whereas those 45 years or above were less willing to respond still according to the successful responses by this age group we came to know that they were aware, but not that much about the forensic science and the age group of 35-45 was least in number in results as they were not much aware or were not willing to give the responses, in India there is great need of awareness campaigns and programs that should target the specific age group for the awareness among them.

Discussion

In 2019, Bell S. et al. found that public awareness of forensic science was often shaped by media portrayals, leading to misconceptions about its capabilities. Many believed forensic techniques to be infallible and instantaneous. In reality, forensic science has limitations, such as human error, contamination, and time constraints, which the public often overlooks, creating a gap between perception and practice.[11] In a 2021 study, Brewer PR et al. explored how media portrayals impact public perception of forensic science. They found that TV shows, movies, and news reports significantly shape public expectations, often leading to misconceptions. These portrayals tend to oversimplify forensic procedures and exaggerate their accuracy, contributing to unrealistic beliefs about the capabilities and limitations of forensic science.[12]In 2021, Rousseau L. et al. conducted a study exploring educational interventions aimed at improving public understanding of forensic science. They found that various strategies, such as hands-on workshops and media campaigns, effectively enhanced knowledge while dispelling common myths. Notably, specific programs integrating real-world forensic case studies demonstrated the most success in increasing public awareness and correcting misconceptions.[13] In a 2021 study, Edmond G. et al. examined how misconceptions about forensic science impact the legal system. They found that misinterpretations of forensic evidence can lead to biased judicial outcomes, undermining fairness in trials. Overestimating forensic evidence may result in wrongful convictions, while misinterpretation can cast doubt on valid findings, ultimately distorting the pursuit of justice.[14] In a 2019 study, Canela C. et al. highlighted key challenges forensic professionals face when explaining complex scientific concepts to the public and legal professionals. These obstacles include technical jargon, differing levels of understanding, and the oversimplification of findings. To improve, forensic experts can adopt clearer language, use visual aids, and seek interdisciplinary collaboration to bridge communication gaps effectively.[15] In 2023, Chin JM et al. emphasized the critical role of transparency in fostering public trust in forensic science. They argued that openly communicating forensic methods, limitations, and uncertainties is essential for maintaining confidence in forensic evidence. Best practices for ensuring this transparency include clear documentation, rigorous peer review, and public accessibility to forensic reports. By acknowledging uncertainties and potential errors, forensic experts can build a more informed and trusting relationship with the legal system and the public, ultimately improving the credibility of forensic science.[16]

Conclusion

The objective of this research was to assess the comprehension and awareness of forensic science among the Indian population. Although younger, more educated people had a greater awareness of forensic science, there is an urgent need to improve the general public's understanding of legal regulation, basic used technology, and advancements in forensic science. To raise public awareness, this study makes

a few recommendations, including increasing the availability of forensic science in universities, some specialized education programs at schools, improved media participation, and well-organized visits to specific forensic laboratories. However, this survey had various limitations, such as low participation from elderly persons because the questionnaire was in digital form and they might not have been able to grasp it effectively, and because the form was sent to over 800 individuals, only 400 replies were received. Since it is too early for predictions of the amount of awareness and participation rates, nationwide surveys must be conducted. To summarize, massive efforts to raise public knowledge of forensic science in the Indian community are crucial.

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IEC Approval: This research does not involve any human participants, human biological samples, or identifiable personal data. Consequently, this study does not require approval from the Institutional Ethics Committee (IEC). All work has been conducted by relevant guidelines and regulations governing non-human studies.

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Original Article

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Autopsy-Based Study of Suicidal Deaths Among the Elderly Conducted at Victoria Hospital Mortuary

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Abstract

Background: Suicide is the act of deliberately killing oneself and it is a significant cause of death in all age groups. When comparing the number of attempted and completed suicides, older people have a more significant number of successful suicide than any other age group worldwide. 'National Policy on Older Persons'- 1999 defines 'elderly' or 'senior citizen' as a person of age 60 years or above. NCRB 2020 reported that around 13,126 older people per 100,000 population committed suicide in India.

Objectives: This study aims to investigate the demographic characteristics, psychological, and etiological factors associated with elderly suicides, and evaluate the methods used by individuals in this age group to end their lives.

Methods: A cross-sectional study was conducted at Victoria Hospital Mortuary over 18 months (February 2021 to July 2022). Out of 397 autopsies in the study age group, 67 cases of suicide were included based on the inclusion criteria. Information was collected from police reports, family members, and suicide notes, followed by a detailed analysis of autopsy findings.

Results: The study revealed that 77.6% of the victims were male, with the majority falling within the 60-64 age group (40.3%). Hanging was the most common method of suicide (50.7%), followed by poisoning (34.3%). Key contributing factors included psychiatric disorders, predominantly depression (53.73%), chronic physical illness (46.27%), and social isolation or loneliness (32.84%).

Conclusion: Elderly suicide is a multifactorial issue, with psychological distress, chronic illness, and social isolation being the primary contributors. Effective prevention strategies should include early mental health interventions and social support systems tailored to the needs of the elderly.

Keywords: Elderly suicide, psychiatric disorder, social isolation, chronic illness, autopsy.

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Introduction

Suicide, the intentional act of taking one's own life, is a major cause of death across all age groups [1]. Globally, older adults have a higher rate of completed suicides compared to other age groups when considering the ratio of attempted to successful suicides[2].Suicide is a significant public health issue globally, with elderly individuals being one of the most vulnerable groups. The World Health Organization (WHO) estimates that every 40 seconds, someone dies by suicide, and the elderly population is particularly at risk due to various social, psychological, and physical stressors [5]. The term suicide, derived from Latin suicidium ("self-killing"), is defined as the deliberate act of ending one's life [6].

The National Policy on Older Persons, established in January 1999, defines the elderly as individuals aged 60 years or above [3]. According to the Population Census 2011, India has nearly 104 million elderly persons, with 53 million females and 51 million males [4]. In 2015, those above 60 accounted for 7.77% of the total suicide deaths in India [5]. A person reaches his or her old age after witnessing and withstanding all storms of life; thus, they can provide us with a 360-degree perspective on life. The traditional joint family system in Indian society has helped safeguard the social and economic security of older people. However, rapid changes leading to the emergence of nuclear families and the migration of younger generations abroad have exposed older individuals to emotional, physical, and financial insecurity [6, 7].

Despite the pressing nature of this issue, the problems faced by the elderly population in India have not received adequate attention. With the majority of the population aged less than 30, the issues confronting the elderly, or "grey population," have not been given serious consideration. It should not be forgotten that this demographic has contributed significantly to the growth of the country and individual families in their prime, and they can serve as mentors to today's younger generation for a better tomorrow. Factors such as co-morbid physical illness, mental health issues, lower socioeconomic status, unemployment, and loneliness have been identified as significant predictors of suicide attempts among the geriatric population [8,9]. While much attention has recently shifted towards adolescent suicides, the issue of suicide among the elderly remains critically underexplored. Given their higher rate of completed suicides, it is essential to focus on this vulnerable group. This research aims to fill the existing gap by identifying common risk factors and methods of suicide among the elderly, ultimately contributing to more effective prevention strategies. By highlighting the profound impact of elderly suicide, this study underscores the importance of addressing this often-overlooked demographic.

Methodology

1. **Study Design**

A cross-sectional study was conducted at Victoria Hospital Mortuary, Bengaluru, over 18 months (February 2021 to July 2022). The aim was to analyze the demographic, psychological, and etiological factors of suicide among elderly individuals aged 60 years and above.

2. **Study Population**

Out of 397 autopsies conducted on individuals aged 60 years and above, 67 suicide cases were selected based on the inclusion criteria.

Inclusion Criteria

- Elderly individuals (60+ years) with confirmed suicidal deaths.
- Availability of police reports, family interviews, or suicide notes.

Exclusion Criteria

- Inconclusive cause of death or insufficient information.

3. **Data Collection**

Data was gathered from:

- Autopsy reports: Determining the method of suicide and pre-existing conditions.
- Police reports & Family interviews: Information on circumstances and psychological history.
- Suicide notes: Insights into the mental state of the deceased.

4. **Data Analysis**

Data was summarized using descriptive statistics, focusing on demographic characteristics, psychological conditions, and suicide methods.

5. **Ethical Considerations**

Ethical approval was obtained (NO. BMCRI/PG/131/2020-21 dated 10-02-2021), and confidentiality was maintained throughout the study.

This streamlined approach provides a concise understanding of the methodology used in this study.

Results

A total of 397 autopsies were conducted on individuals aged 60 years and above during the study period, out of which 67 cases were identified as suicides.

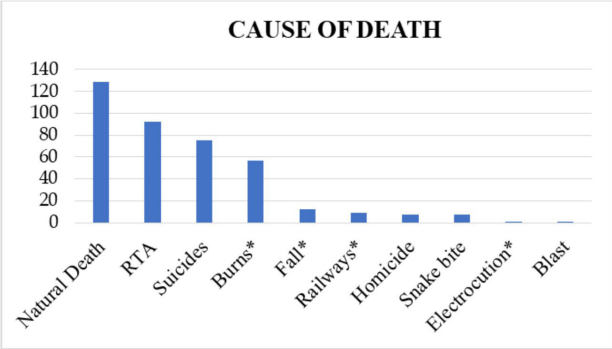

Fig. 1. Distribution of total number of unnatural deaths in the study age group between February 2021 to July 2022

Out of 390 cases in the study age group majority of the cases ie, 33.07% (129 cases) were natural death; 92% (92 cases) were road traffic accidents; 19.23% (75 cases) were suicides; 14.62% (57 cases) were accidental burns; 3.08% (12 cases) were accidental fall; 2.31% (9 cases) were accidental railway deaths; 1.79% (7 cases) were homicides; 1.79% (7 cases) were snake bite cases; 0.26% (1 case) was accidental electrocution and 0.26 % (1 case) was as a result of blast injury.

Table No: 1. Age wise distribution of suicides during study period.

Age	Frequency	%
60- 64 years	27	40.3
65- 69 years	16	23.9
70- 74 years	13	19.4
75- 80 years	5	7.46
More than 80 years.	6	8.96
Total	67	100

Table No: 1 shows age wise distribution of suicides among elderly. It has been observed that 40.3% (27 cases) of suicides occurred among the people aged 60-64 years, followed by 23.9% (16 cases), 19.4% (13 cases), 19.4% (13 cases), 7.46% (5 cases) and 8.96% (6 cases) among people aged 65-69 years, 70-74 years, 75- 80 years and >80 years respectively.

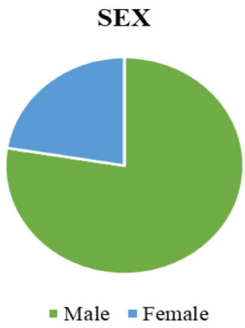

Fig. No: 2. Sex wise distribution of elderly suicides

Fig. No: 2 indicates that elderly males commit suicide (73%) more often than their counter parts (27%).

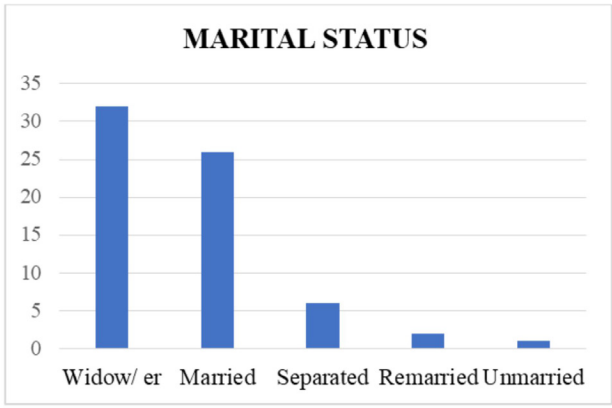

Fig. No: 3. Marital status of elderly suicide victims

In this study it has been found that married and widow/er were the majority group. 6 cases were separated from their spouse, 2 cases were remarried and 1 was unmarried.

Table No: 2. Socioeconomic status of elderly suicide victims

Socioeconomic class	**Frequency**	%
Upper	6	8.96
Upper middle	4	5.97
Lower middle	18	26.86
Upper lower	25	37.31
Lower	14	20.9
Total	67	100

Table No: 2 depict socioeconomic status of study group. Upper lower class includes 37.31% and lower middle class includes 26.86%, followed by lower class 20.9%, upper class 8.96% and upper middle class5.97%.

Table No: 3. Distribution of Suicidal methods

Method of suicide	Frequency	%
Hanging	34	50.7
Poisoning	23	34.3
Railway	4	5.97
Burns	2	2.99
Cut throat	2	2.99
Drowning	1	1.49
Fall	1	1.49
Total	67	100

Table 2 shows that the most common method of suicide was hanging, reported in 50.7% of cases (34 cases). This was followed by poisoning, which accounted for 34.3% (23 cases). Other methods included self-inflicted injuries and drowning, although these were less common.

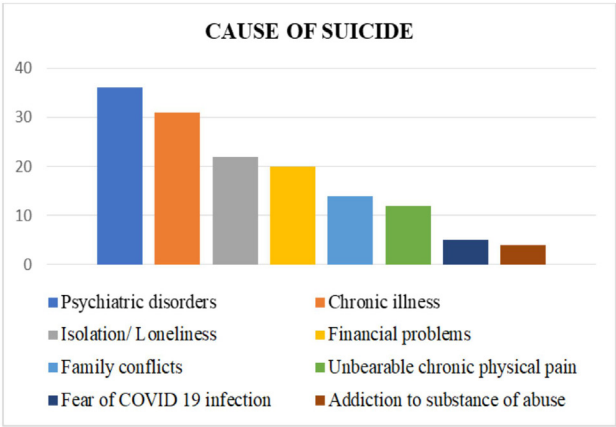

Fig. No: 4. Distribution of causative factors for suicide.

Fig. No: shows elderly suicide is having multifactorial causes. Majority of study population had psychiatric disorder in 53.73%-majority had depression secondary to their illness, chronic physical illness (46.27%), isolation/ loneliness (32.84%). Others factors include financial problem (29.85%), family conflicts (20.9%), chronic physical pain which is some time unbearable (17.91%), fear of COVID 19 infection and addiction to substance of abuse was found in 5.97% of study population.

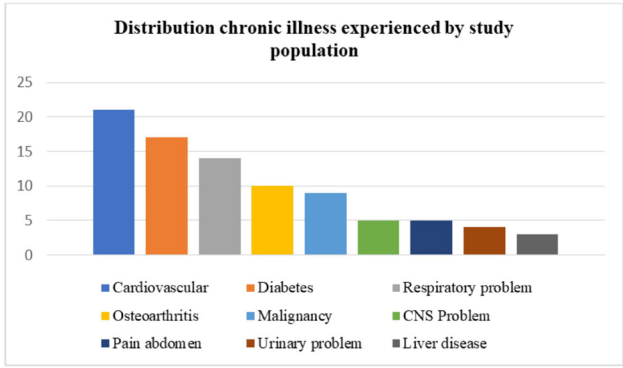

Fig. No: 5. Distribution chronic illness experienced by study population

Figure No: 5 highlights that among the study population 31.34% had cardiovascular disease, which included hypertension and IHD. Diabetes mellitus was present in 25.37%, respiratory problems in 20.89%, osteoarthritis 14.92%, malignancies (13.43%), neurological problems in 7.46% of chronic illnesses, pain abdomen 7.46%, urinary problems (5.97%) - only in males secondary to BPH, and liver disease constitute 4.48% of - cirrhosis and had liver abscess in oneeach.

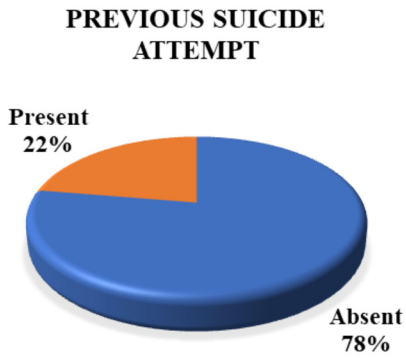

Fig. No: 6. Distribution of previous suicidal attempts in elderly suicide victims

Observations from Figure No: 6, indicates that previous suicidal attempt was present in 22.4% of the study population. It is absent in rest of the study population. This suggests that recurrent mental health issues and unresolved psychosocial problems were prevalent among those who completed suicide.

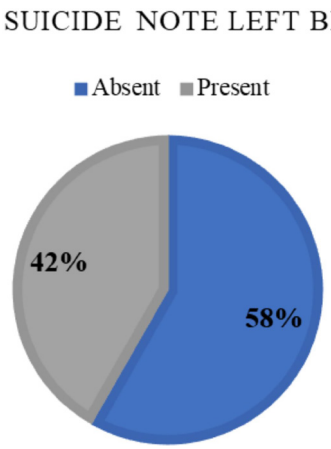

Fig. No: 7. Distribution of Suicide note written

Fig. No: 7 represents distribution of suicide notes written showing 28 cases (41.8%) had written suicide notes before death providing valuable insight into the psychological state of the victims. The notes often revealed feelings of hopelessness, despair, and a sense of being a burden on family members. Majority of the cases 39 cases (58.2%) did not write any suicide note.

Image No: 1. Image showing a case of death by partial hanging from a tree in the backyard with a kerchief used as padding to neck.

Image No: 2. Shows atypical hanging inside the bed room with obliquely upwards and backwards directed ligature mark.

Image No: 3. Suicidal hanging in a hospital due to COVID – 19 positive status.

Note the insitu intravenous canula

Image No: 4. A case of complex suicide. In-situ ligature material present around the neck with an intact knot over left side of the neck with hesitation cuts over the front of left forearm.

Image No: 5. Image a showing inflamed blackish discoloured friable stomach mucosa in a case of caustic poisoning.

Image b showing haemorrhagic stomach mucosa with prominent rughae in a case of aluminium phosphide poisoning.

Image No: 6. A case of death by railway suicide with open skull injury.

Image No: 7. A case of death by self-immolation.

Also note the presence of soot particles in the larynx and trachea.

Image No: 8. A case of death by hanging with intact ligature material.

The deceased also had an infected callous ulcer of the right foot.

Image No: 9. Shows features of chronic liver disease in a case. The diseased was an alcoholic who lived separately and didn't had enough money to undergo treatment.

a) Icterus in the sclera.
b) Cirrhotic liver.
c) Pus in the peritoneal cavity possibly due to bacterial peritonitis.

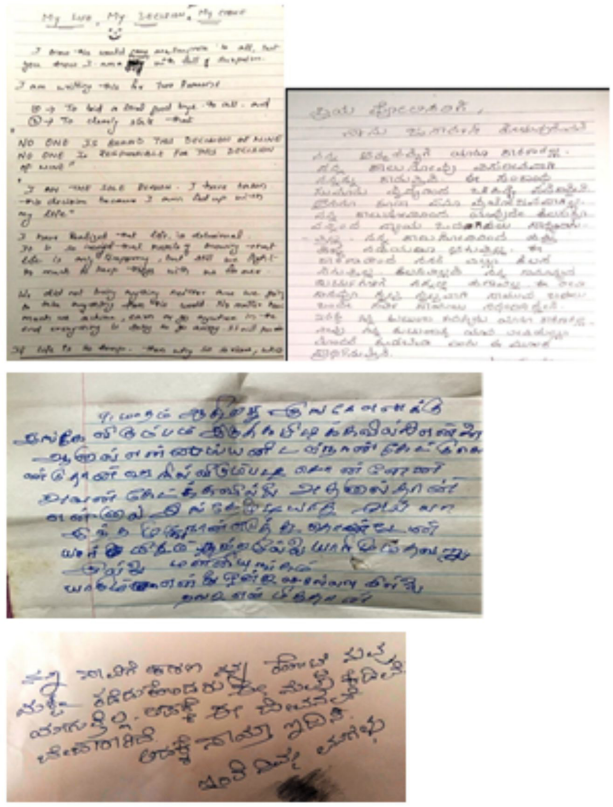

Image No: 10. Suicide notes. The collage above presents suicide notes collected in Kannada, Tamil, and English. The notes reflect the deceased individuals' struggles with chronic pain, inability to lead normal lives, financial hardships, psychological issues such as loneliness, and, in one case, the distress of being unable to return home to Tamil Nadu due to the COVID-19 lockdown, which left the individual stranded in Karnataka. These personal accounts provide valuable insight into the circumstances leading to their tragic decisions.

Discussion

This autopsy-based study on elderly suicides provides insights into demographic, etiological factors, and methods of suicide. During the 18-month study, out of 3962 autopsies, 10.02% (398 cases) were individuals over 60 years old, with 19.23% (75 cases) attributed to suicides. However, 67 cases were analyzed after excluding cases that didn't meet the inclusion criteria. Natural deaths (33.07%) and road traffic accidents (23.58%) were the most common causes of death, with suicides ranking third. This is in line with studies like that of Ozge Timur et al., which found suicides to account for 9.3% of unnatural deaths

in Turkey[10], and Dr. Aadamali Nadaf, who reported suicide as the third leading cause of unnatural deaths in India[11].

The highest suicide rates were observed in the 60-64 age group (40.3%), followed by 65-69 years (23.9%) and 70-74 years (19.4%). The mean age was 73 years, consistent with findings by Salib et al. [12] and Dr. Nadaf[11]. Similarly, a study by Avanish Bhai Patel also found the 60-69 age group most prone to suicide[13].

The current study revealed that men (77.6%) were more likely to commit. The suicide rate is higher among men (22.4%) than women (22.4%), with a ratio of 2.7:1. Avanish Bhai Patel (61.66%)[13], Dr. Aadamali Nadaf (73%)[11], Abraham V. J. (60.31%)[14], and K. Thulasiram et al. (68.3%)[15] have reported similarly high rates of suicide among males.

Marital status played a role, with nearly half of the cases being widowed. Studies by Nadaf[11] and others echoed similar findings, showing widows and widowers as a significant demographic in elderly suicides. The high suicide risk among widows and widowers in the current study may result from spouse loss, loneliness, and a demanding lifestyle. The socioeconomic analysis using the Modified Kuppuswamy Scale[16] revealed that most suicides occurred in the upper-lower and lower-middle classes, highlighting the link between economic strain and suicide. Dr. Nadaf's study reported similar findings, indicating that the increased suicide incidence among lower-class individuals may be attributed to a higher prevalence of health and financial issues[11].

Hanging (50.7%) emerged as the most common method of suicide, followed by poisoning (34.3%). Other methods included throwing oneself under a vehicle, cut-throat, and drowning. Similarly hanging was the common method adopted for committing suicide in the studies done by Braham et al. (62.5%) [17] and Ozge Timur et al. (60%)[10].While some studies from other regions cite poisoning as more common, the preference for hanging could be due to its perceived quickness and certainty. Contrary to the current study, Salib et al. [12] and Dr.Aadamali Nadaf [11] reported that self-poisoning is the most common method used for suicide, followed by hanging. NCRB (2009) reported in their research that the most popular methods of suicide in India were poison eating (33.6%), hanging (31.5%), self-immolation (9.2%), and drowning (6.1%) [18].

The current study demonstrates that elderly suicide is multifactorial, with psychiatric disorders (53.73%), chronic physical illness (46.27%), and isolation/loneliness (32.84%) being the primary contributors. Other factors include financial difficulties (29.85%), family conflicts (20.9%), chronic physical pain (17.91%), and a smaller proportion affected by fear of COVID-19 and substance abuse (5.97%). Salib et al. [12] found psychiatric conditions in nearly half (49.5%) of elderly suicides, consistent with findings by Harwood et al. (2001) [19] and Barraclough (1971)[20], which indicated depression in 77% and 90% of cases, respectively. These studies suggest that depression in older adults often manifests as physical complaints, such as exhaustion and memory loss, making it harder to detect.

Physical illness is another significant factor, with 63.5% of elderly suicides having a co-existing medical condition. Conditions like cardiovascular disease (31.34%) and diabetes mellitus (25.37%) are particularly prevalent, alongside respiratory issues and cancer. Cattell and Jolley (1995) also emphasize that physical illnesses often increase suicide risk through associated mood disorders. The COVID-19 pandemic further exacerbated elderly mental health, with over 300 suicides during the lockdown linked to fear of infection and loneliness[21].

Cardiovascular issues were the most prevalent chronic ailment in the study population (31.34%), followed by diabetes mellitus (25.37%), respiratory problems (20.89%), osteoarthritis (14.92%), cancer (13.43%), abdominal pain (7.46%), urinary issues (5.97%), and liver problems (4.48%). Similar findings were reported by Dr.Aadamali Nadaf[11]and H. R. Cattell[22]. Haakon H. Eilertsen[23] also found a high prevalence of cancer among older individuals who committed suicide. This suggests that cardiovascular disease and diabetes contribute significantly to rising suicide rates among the elderly, especially in lower and middle-class groups.

In this study, 22.4% of the elderly suicide victims had previously attempted suicide, which contrasts with Dr.Aadamali Nadaf's [11] findings of 11%.

Research suggests that older adults with strong suicidal intent are more likely to succeed in their attempts. Additionally, 53.7% of the study population had poor health before death, supporting Howard Cattell's [22] findings that deteriorating health often precipitates suicidal behaviour. In contrast, other studies reported that most victims were in good health prior to their suicides.

In this study, 41.8% of the elderly suicide cases left suicide notes, while 58.2% did not. This aligns with findings by Salib et al. (38%) and Cattell and Jolley (43%). Note-leaving is not random and may depend on factors like education, physical ability, and access to writing materials. Many older adults may live alone or lack someone to write to, which can explain the low occurrence of suicide notes[12, 21].

Conclusion

Elderly suicides are driven by a mix of social, psychological, economic, and health-related factors. This study emphasizes the urgent need for comprehensive prevention strategies that address mental health, enhance social support, and ensure economic security for the elderly. The elderly possess a wealth of life experience, offering valuable perspectives that can benefit younger generations. However, the shift from traditional joint families to nuclear families, coupled with the migration of younger generations, has left many elderly individuals vulnerable to emotional, physical, and financial insecurities.

Although their contributions to society have been significant, the issues facing the elderly have not received adequate attention, especially in a country where the focus is often on the younger population. It is crucial to recognize the value the elderly bring to society and the potential they have to mentor and guide the next generation.

To reduce the incidence of suicide among the elderly, early detection and treatment of depression, strengthening social networks, and ensuring access to healthcare are essential. Additionally, culturally sensitive prevention strategies, such as restricting access to common means of suicide and providing targeted mental health support, are necessary. By addressing these unique challenges, society can ensure that the elderly continue to contribute meaningfully, while also reducing the risk of suicide in this vulnerable group.

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Conflict of Interest: No

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Original Article

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Study of Characteristics of Victims and Alleged Accused in Cases of Deaths Due to Homicide

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Abstract

Aims and Objectives: Homicide is a cruel act of mankind. It reveals one of the darkest sides of the society. Homicidal crimes represent a reasonable proxy for all different kinds of violent crimes in general. The study aimed to find out the different characteristics of victims and perpetrators i.e. alleged accused in homicidal deaths

Materials and Methods: The present prospective study was carried out on 179 homicidal deaths at the Department of Forensic Medicine and Toxicology of Indira Gandhi Government Medical College, Nagpur from January 2013 to October 2014.

Observation and Results: Male victims were most commonly attacked by acquaintances in 33 (18.44%) cases whereas females were by their husbands or In-laws in 13 (7.26%) cases. Maximum homicidal attacks54 (30.17%) occurred at or near the victim's house. Males were common victims due to quarrels whereas females due to illicit sexual relationships. Sharp and pointed weapons were most commonly used. Maximum victims 125 (69.83%) died at the place of homicidal attack.

Conclusions: Males outnumbered females in all aspects of Homicidal deaths. A specific pattern was observed which could help police investigating authorities in tracing out characteristics of victims and assailants in homicidal deaths reported shortly.

Keywords: Homicide, Acquaintances, Motive, Place of incidence, Weapons.

Introduction

Homicidal deaths can be considered the **"TIP OF THE VIOLENCE ICEBERG"** as the Majority of violent crimes are not recorded or notified. As per the Judicial system in India, Homicide is classified into: 1) Lawful; (i) Justifiable, (ii) Excusable. 2)

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Unlawful; (i) Murder (S. 300 IPC), (ii) Culpable homicide (S. 299 IPC); (a) Amounting to murder, (b) Not amounting to murder (S. 304 IPC). 3) Rash and negligent homicide (S. 304 A IPC) [1]. In 2023older versions of the Indian Penal Code IPC have been replaced by the Bhartiya Nyaya Samhita (BNS Act). Accordingly, cases of Homicidal deaths are included under Section 101 of Bhartiya Nyaya Sanhita, 2023 (BNS)[2].

Homicidal crime rate data is the most representative and comparable crime indicator[3]. Death can be caused violently by mechanical injuries by weapons, violent asphyxia, thermal injuries, firearm injuries, etc as reported in Forensic literature[4,5,6,7].

It is a cruel act of mankind and reveals one of the darkest sides of society. Therefore, Homicidal crimes represent a reasonable proxy for all different kinds of violent crimes in general.

Studies done in India and Globally[8,9,10,11,12,13,14] have revealed factors associated with assaults ultimately resulting in the death of an individual. Also, the easy availability of lethal weapons has increased incidences of homicide nowadays. Hence, the present study has been done to explore different epidemiologic profiles of victims and alleged accused to help law enforcement agencies investigate the cause and manner of death for the proper administration of justice in the court of law.

Aim and Objectives:

- To study the Victim-Assailant relationship.
- To study the number of perpetrators per incident.
- To study the motive and places of incidence selected by assailants in executing their homicidal attacks on victims.
- To study the alleged type of weapon used for assaults.
- To study the survival period and presence of alcohol or drugs on post-mortem.

Material and Methods

Prospective research was conducted at the Department of Forensic Medicine in central India from January 2013 to October 2014. The Institutional and Maharashtra University of Health Sciences, Nashik ethical committees [Letter No MUHS/PG-T/E 1/FL.42/2706/2013 dated 21-09-13] approved the study protocol.

During the study period, 179 cases of homicide were reported. In every case, detailed information was gathered from the police Inquest and the treatment records. Factors like age, sex, place of occurrence, motive, alleged weapon used, and victim-assailant relationship were taken into consideration. Relevant information was also collected from the relatives of the deceased.

Detailed post-mortem examination of the body was done to know the alleged type and kind of weapons used for assault and emphasis was given on evidence of alcohol consumption or drug intoxication. Detailed information indicative of the alleged place of occurrence was obtained and a crime scene visit was organized in suspicious cases. Proper follow-up of these cases was done later on to rule out cases in which the alleged manner of death was not due to homicide. Also, reports of Forensic science laboratory (FSL) chemical analysis, Queries put forward regarding injury patterns, weapons brought for examination by police investigating authorities, and final opinion as to the cause of death were taken into consideration.

Statistical Analysis:

Statistical analysis was done using descriptive and inferential statistics using the Chi-square test. The software used was SPSS 17.0 version and GraphPad Prism 5.0 version; $p < 0.05$ is considered a significance level.

Observations and Results

A total of 3412 autopsies were conducted during the study period, out of which 179 (5.24%) cases were of alleged homicide.

Table 1: Victim-Assailant relationship

Assailant relationship with the victim	Number of victims		Total no. of incidents (%)	א2-Value
	Males	Females		
Acquaintances	33(18.44%)	3(1.68%)	36(20.11%)	32.98 p=0.000,S
Friends	28(15.64%)	2(1.12%)	30(16.76%)	
Spouse /In-laws	9(5.03%)	13(7.26%)	22(12.29%)	
Siblings	7(3.91%)	4(2.23%)	11(6.15%)	
Neighbours	5(2.79%)	1(0.56%)	6(3.35%)	
Others/unknown	65(36.31%)	9(5.02%)	73(40.78%)	
Total	146(81.56%)	32(17.87%)	179(100%)	

In 73 (40.78%) cases, no victim-assailant relationship existed, the relationship could not be traced properly, or the relationship was not known, which included 65 (36.31%) males and 9 (5.02%) females.

Table 2: Number of perpetrators (alleged accused) per incident

Sr no	No of assailants	No of incidents	The victim	
			Male	Female
1	One	64(35.75%)	47(26.26%)	17(9.50%)
2	Two	21(11.73%)	16(8.94%)	5(2.79%)
3	Three	14(7.82%)	13(7.26%)	1(0.56%)
4	Four	2(1.12%)	2(1.12%)	0(0%)
5	Five	3(1.68%)	2(1.12%)	1(0.56%)
6	≥ five	7(3.91%)	7(3.91%)	0(0%)
7	Unknown	68(37.99%)	59(32.96%)	9(5.03%)
א2-Value	8.10,p-value=0.23,NS,p>0.05			

Table 3: Place of incidence in cases of homicide

Place of incidence	Male	Female	Total (%)
Inside or nearthe victim's house	32(17.88%)	22(12.29%)	54(30.17%)
Inside or nearthe assailant's house	7(3.91%)	2(1.12%)	9(5.03%)
Combined victim's and assailant's house	6(3.35%)	1(0.56%)	7(3.91%)
Outdoor (Road/Street side)	45(25.14%)	3(1.68%)	48(26.82%)
On or around the railway track	8(4.47%)	1(0.56%)	9(5.03%)
Workplace	11(6.15%)	2(1.12%)	13(7.26%)
Remote area	11(6.15%)	1(0.56%)	12(6.70%)
Forest area	8(4.47%)	0(0%)	9(5.03%)
In water source (river, lake or drainage)	6(3.35%)	0(0%)	6(3.35%)
Others	12(6.70%)	0(0%)	12(6.70%)
Total	147(82.12%)	32(17.88%)	179(100%)

Bodies of 06 males were found in and around a water source, three on the banks of the river, two inside a well, and one in the drainage area. In such cases, cause of death was stab injuries, head injuries, and strangulation.

Four female bodies after the possible sexual assault were found two at the victim's residence, one in the outskirt farmhouse area, and one around the railway track. Bodies of two female infants were found in a forest area and one female infant was strangulated and thrown in a garbage area.

Table 4: Motive behind homicidal attacks by the assailants

Motive of Accused	No of Victims	Percentage (%)
Quarrel	47	26.26
Enmity	46	25.70
Elicit relationships	22	12.29
Familial disputes	8	4.47
Property disputes	13	7.26
Robbery	7	3.91
Financial problems	11	6.15
Unknown	61	34.08

Males were common victims due to quarrels whereas sexual assault or illicit sexual relationships were the principal motive behind homicidal attacks on females.

Table 5: Type of weapons used by assailants

Weapon/object	Number of cases	Percentage (%)
Blunt and hard	51	28.49
Sharp and pointed	56	31.28
Sharp and heavy	32	17.87
Combined blunt and sharp	11	6.14
Ligature material	19	10.61
Firearm	3	1.67

Sharp and pointed weapons were most commonly used in 56 (31.28%) cases followed by hard and blunt in 51(28.49%) cases. Sharp weapons commonly used were knife 37 (20.67%), gupti 18 (10.05%) and axe in 9 (5.02%) cases. Hard and blunt weapons commonly used in this area were stones 29 (16.20%), bricks 15 (8.37%), bamboo sticks 12 (6.70%), iron rods 11 (6.14%), etc.

Table 6: Survival period of victims

Moment of death		Number of cases		Total
		Males	Females	
Death on the spot / on the way to hospital		97(54.19%)	28(15.64%)	125(69.83%)
Hospitalized Victims	0-6 hours	7(3.91%)	2(1.12%)	9(5.03%)
	6-24 hours	34(18.99%)	1(0.56%)	35(19.55%)
	1-7 days	5(2.79%)	1(0.56%)	6(3.35%)
	>7 days	4(2.23%)	0(0%)	4(2.23%)
Total		147(82.12%)	32(17.88%)	179(100%)

Blunt weapon injuries were common in spot-dead victims and sharp weaponsin admitted cases.

In all such cases, stomach contents, blood, and other routine viscera were sent to the forensic science laboratory for chemical analysis.

A detailed history of incidence was recorded to know about the associated use of alcohol or drug abuse in these cases. Victims' postmortem findings suggestive of the presence of the smell of alcohol and its chemical analysis reports obtained later on and in cases of known accused related to homicidal attacks depending on the information provided by the police officials about alcohol consumption at or before the incidence was taken into consideration.

Acute alcoholism or drug abuse was seen in 39.67 % of cases of accused (based on information provided in police Inquest)and 16.20 % of cases of victims (based on post-mortem findings and chemical analysis reports) of homicide.

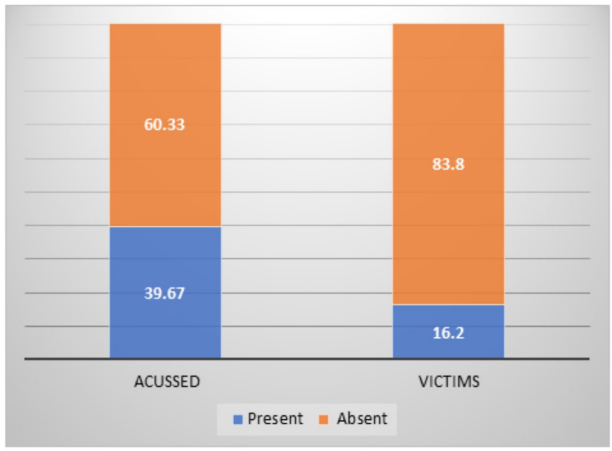

Figure 1: Percentage wise distribution of cases according to detection of Alcohol or drugs.

Figure 2 (a): Weapon of offense and body of a victim at the crime scene.

Figure 2 (b): A close-up view of a chop wound caused by a spade as shown in photograph number (2).

Discussion

Sudden provocation or momentary rage due to conflicts between the victim and the assailant was responsible for a maximum number of deaths. Victims were assaulted by one or two assailants mainly due to old rivalry, quarrels, or sudden provocation.

Similar findings were reported in studies of Huggar BS et al [8], in the Western world (strangers) Henderson JP et al[9], (close family members) in the study of Scott KW et al[10], Drawdy SM et al[11], Ambade VN et al[12], Bahera C et al[13], Shivkumar BC et al[14](family member), Mada P et al [15], Viz et al[16] and by Cros J et al[17].

Inmost cases of homicide outdoors, sharp weapons were commonly used whereas at victims' homes as a result of quarrels hard and blunt objects were preferably used. This corroborates the police history of premeditated assault or assault at the spur of the moment resulting from a quarrel.

Huggar BS et al[8] (33.25%), Shivkumar BC et al[14] 50%, Chaurasiya N et al[18],Viz A et al[16] 49.4%, Kidd SH et al[19] (kitchen knives), Butt WHK et al[20] (57.14%), Au Ki et al[21] (141 cases) He M et al[22] 36.7%, Karn A et al[23] 36% reported similar findings of injuries by sharp cutting weapons for assault in homicidal deaths as seen in our study.

Observations in our study were inconsistent with Gupta S et al[24] 82 cases (42.49%), Kominato Y et al[25] 38.1% in Japan, Patel DJ et al[26] 30 (37.97%), Buchade D et al[27] 138(37.2%), Singh OG et al[28] and Bhupinder S et al[29] 46% and Ambade VN et al[30] wherein blunt weapons more commonly used than sharp weapons in homicidal deaths.

Firearms injury deaths were most common in studies done by Drawdy SM et al[11], Preti A et al[31] in Italy, Patowary AJ et al[32], and Meel BL et al[33], Cros J et al[17] 37%, Obiorah CC et al[34], Catanessi R et al[35] 33.8 %, Kohli A and Aggarwal NK[36] and Fine PR et al[37]. Observations in the present study were inconsistent with the above studies because in this metropolitical city, firearm-related laws are strict, and firearm weapons are not easily available.

It may be that a male assailant tends to choose a blunt weapon in preference to a sharp one while assaulting a woman because he believes that he doesn't need a weapon in a conflict with a woman. After all, she is less strong. Alternatively in assaults involving men sharp weapons may be used to gain an advantage over an opponent of roughly equal strength thereby producing more open and penetrating wounds.

In the present study, 125 (69.83%) victims died on the spot. The survival period of victims depended on severity, site, and type of injuries. Where the number of assailants was more, multiple injuries were present and the survival period was shorter and vice versa. Similar results were obtained in studies done by Mishra PK et al[38] (76.1%), Huggar BS et al[8] (82.5%), and Shah JP et al[39] (74%).

Acute alcoholism or drug abuse was seen in 39.67 % of cases of accused and 16.20 % of cases of victims.Chemical analysis reports were found to be positive for alcohol in studies done by Mohite PM et al.[40] in 17.6% of cases, Mohanty S et al[41] 30.23 % and CrosJ et al[17] 48.5 %.

The risk of homicidal attack by the assailant on the victims increases for both genders with alcohol consumption and it depends on the number of alcohol units consumed in a drinking session.

Summary and Conclusions

- Most assailants were males who executed their homicidal attack at the victim's home.
- Most victims died on the spot of a homicidal attack.
- Maximum incidences were at the victim's house and attacks on males were common outdoors whereas on females indoors.
- Quarrel, enmity, and marital conflicts were the main motives.
- Acute alcoholism played a major role in interpersonal violence.

Suggestions:

The present research work was confined to areas with the majority of slums and lower socio-economic strata of the population. Hence results derived can be applied in any region throughout India or Globally. Forensic Science Laboratory experts and Police authorities can be guided properly in searching for accused persons if they collaborate with an Autopsy surgeon and Psychiatrist.

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