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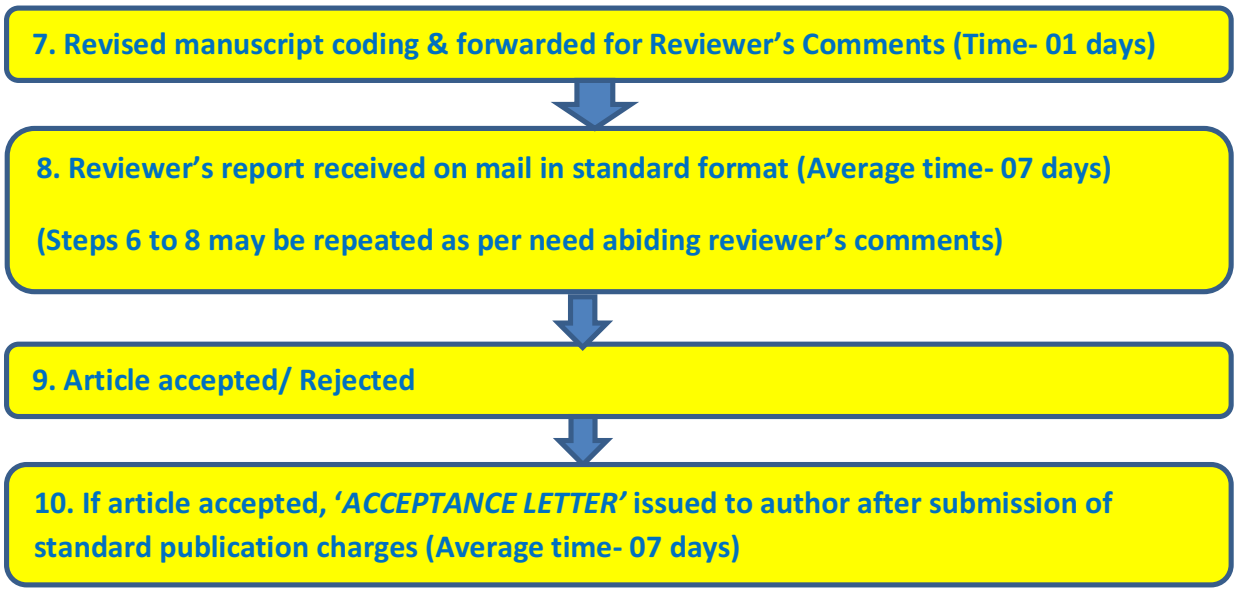

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Editorial

Violence Against Doctors: Prevention, Administrative and Legal Recourse

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1. Introduction

Violence against doctors and healthcare professionals/ hospitals is a great concerning issue. Workplace violence (WPV) against general practitioners, doctors and healthcare providers is an important global issue.[1,2]

'No physician, however conscientious or careful, can tell what day or hour he may not be the object of some undeserved attack, malicious accusation, black mail or suit for damages....'[3]

It refers to physical, verbal, or psychological aggression targeted at medical practitioners, nurses, and other healthcare staff. This violence can occur in hospitals, clinics, and other healthcare settings. Recently, reports of violence against doctors, including grievous hurt or murder, are making headlines across the world.[2]

Majority of these violence cases (60-70%) are violence took in the form of either verbal abuse or aggressive gesture. Very often, abusers of a medical person were patients themselves. They were mostly under the influence of alcohol or drug. It happened mostly in psychiatry ward or at casualties. There is increased risk of violence when a general physician is on call, particularly at night.[2,3,4]

There are various important factors that may be contribute to such incidents. Amongst these commonest factors are emotional stress, long wait times and frustration, disagreements over treatment, lack of communication, cultural and language barriers, resource limitations, mental health issues, lack of security measures, lack of training and de-escalation techniques.[5]

2. Global Perspectives:

The World Health Organization (WHO) has recognized violence against doctors and healthcare providers as a global issue. WHO estimate suggest that about 8-38% of healthcare providers suffer from physical violence at some point in their professional careers. Study of violence against healthcare providers from the USA in the 1980s showed that 57% of emergency care workers have been threatened with a weapon, whereas in the UK, studies showed that 52% of doctors reported some kind of violence.[2-5]

In Asia, violence against medical professionals has been reported from China, Pakistan, Israel, and Bangladesh. Prevalence rates of violence against doctors have been higher in Asia as compared to those of Western countries.[6] Study by Liu et al in 2019, aimed to quantify the prevalence rates of workplace violence (WPV) by patients and relatives against healthcare providers. The prevalence is high, especially in Asian and North American countries. Psychiatric wards and casualty departments were most common settings.

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Mostly nurses and on call physicians were victims of such violence. There is a need of collaborative efforts by policymakers, governments and health institutions to take actions to address issue of violence towards healthcare professionals.[2]

3. Indian perspective:

According to the study by Indian Medical Association (IMA) in 2017, over 75% of doctors across the country had faced some form of violence at their workplace. The study also reported that over 50% of doctors had experienced physical violence.[7]

Violence against doctors in India:

Healthcare professionals, including doctors, nurses, and other medical staff, have been subjected to various forms of violence, including physical assaults, verbal abuse, and intimidation. This phenomenon has led to protests, strikes, and calls for better protection and security for medical practitioners.[8] Violence seen in various forms such as telephonic threats, verbal abuse, intimidation, physical but non-injurious assault, physical assault causing simple or grievous injury, murder, vandalism, and arson. Violence leads to develop psychological issues in doctors such as depression, fear, and anxiety, insomnia, posttraumatic stress leading to absenteeism. Many doctors have injured themselves, lost lives, lost their clinics, and also tarnished their reputation as a professional.

Some key factors contributing to violence against doctors in India

a. Policy factors: India's health-care spending is close to 2% of the total budget. This is dismal when compared to other countries.
b. Social factors: Impression of profit making profession in the mind of general public and patient, there are unrealistic expectation that paying more money should save one's life.
c. Professional factors: Ineffective patient–doctor communication, unempathetic approach by healthcare providers.
d. Local Factors: Mob mentality, politician's interference.

Various Issues:

a. Lack of Communication: Poor communication between doctors and patients, especially in cases where there are language or cultural barriers, can exacerbate misunderstandings and conflict.
b. Media Influence: Negative portrayals of medical professionals in the media can contribute to a negative perception of doctors, which may indirectly contribute to violence.
c. Legal and Ethical Issues: Legal and ethical concerns related to medical practices can sometimes lead to confrontations between doctors and patients or their families. Even though there is act passed by the Government of India to prohibit violence against Medicare service persons and damage or loss to property of Medicare service institutions in year 2008 and in Maharashtra, there is similar act "The Maharashtra Medicare Service Persons and Medicare Service Institutions (Prevention of Violence and Damage or Loss to Property) Act, 2010" was Implemented in year 2010 but there is improper implementation of these laws have made them ineffective in curbing the violence against the healthcare professionals. Other sections like sec 425,427 IPC were not properly implemented against the accused person.[9]

4. Prevention:

It is need of the hour. In general necessary things are as follows-

a. **Communication Improvement and improved Doctor-Patient Relationship**: Efforts to improve the doctor-patient relationship, promote transparency, and enhance patient education have been made to reduce misunderstandings and distrust.
b. **Training Programs**: Training programs for doctors and healthcare staff in communication skills, conflict resolution, and de-escalation techniques have been introduced to better handle challenging situations.
c. Mental Health Support.
d. **Public Awareness Campaigns** and **increased Public Engagement**: Engaging with the public and addressing concerns through open dialogue can help build trust and improve relationships between healthcare professionals and patients. **Awareness Campaigns** helps to educate the public about the importance of respecting healthcare professionals and the consequences of violence.
e. **Security Measures**: Such as installing surveillance cameras, increasing the presence of security personnel, and improving access control.
f. **Police Protection at hospitals**: It is needed especially in situations where there was a risk of violence.

g. **Legal Measures:** Stringent law and strict implementation.
h. **Fast-Track Courts**: It will help to expedite the legal proceedings for cases related to violence against doctors.
i. **Collaborative efforts:** between healthcare institutions, government bodies, law enforcement, medical associations, and the general public. A multifaceted approach involving healthcare institutions, governments, communities, and the public to address the issues.

Doctor's role:

1. Effective doctor-patient communication:
   a. Improve relationship, use anxiety alleviation techniques,
   b. Better training to tackle these situations
   c. Optimize and reduce the long waiting periods for the needy patients.
2. Security Measures:
   a. Installing surveillance cameras,
   b. Increasing the presence of security personnel, and
   c. Improving access control.

Hospital administration Role:

a. Improvement of services in a global fashion.
b. Employ sufficient number of doctors.
c. Undertake steps to tackle the patients rush and address long waiting hours issue.
d. Use of computer and internet technology,
e. Strengthen hospital security and easy interlocking with the local police.
f. Arms/ammunition should not allowed to patient or their relatives in the hospital.
g. Bring transparency on rates of different consultation charges, investigations rate, rents and other hospital related expenses.
h. Install proper complaint redressal system in the healthcare instituion.
i. Indian Penal Code (IPC) contains several provisions that can be invoked in cases of violence against doctors and healthcare professionals.

5. Conclusion:

Although violence against health care providers is common, the incidence of severe forms of violence in India is increasing. Many remedies have been used to tackle this situation. There is need of collaborative efforts between healthcare institutions, government bodies, law enforcement agencies, doctors associations, and the general public.

A multifaceted collaborative approach involving governments, healthcare institutions, medical associations, media, communities, and the public is needed to address the issues. It result to improve health care delivery to needy and minimise violence against doctors.

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Original Research Article

Postmortem Study of Sudden Death with Special Reference to Cardiovascular Causes

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Abstract

Introduction: The present study is carried out on cases died due to sudden natural causes which were brought for medico-legal autopsy to our institute. The study was aimed at analyzing the medico-legal and epidemiological aspects in cases of sudden natural deaths with special reference to cardiac causes. **Material & methods:** Total 2088 autopsies were conducted, out of which, 221 cases (10.58%) were of sudden natural death. Various factors like age, sex, time of incident, survival period, occupation, marital status, month wise distribution, seasonal variations, locality, religion, nourishment, habits, injuries, system wise affection, disease and sex wise distribution, cases of MI, distribution of coronary artery block, location of coronary artery block, cut section of ventricular wall, multisystem involvement to the body were studied. **Results:** Amongst these 221 cases, 195 cases (88.23%) were male and 26 (11.76%) were female. The male to female ratio was 7.5:1. It was observed that cardiovascular system was the most vulnerable to sudden death contributing to 114 (51.59%) deaths. **Conclusion:** Among cardiovascular causes, maximum deaths (96.49%) were due to coronary artery disease followed by mitral stenosis 2 cases, cardiac tamponade and Ventricular heart disease 1 case each. Most commonly affected age group was 41-50.

1. Introduction

Death is defined as complete and irreversible stoppage of the circulation, respiration and brain functions. The definition holds that life is sustained on three interlinked vital systems namely - the nervous, of entry.[1] Forensic pathologists deal not only with criminal, accidental and suicidal deaths, but also with circulatory and respiratory system – so called as "Tripod of life". It is obvious that all systems would fail if any one of the vital systems fails and that is why these systems are known as "atria mortis" i.e. the death's portals a wide range of deaths from natural causes. Many of these deaths are sudden, unexpected, clinically unexplained or obscure, even though there need be no criminal element in their causation. It is quite possible for a person to be in apparently

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perfect health but at the same time suffering from a serious disease of which he may not be aware. Sudden deaths are important from a medico legal standpoint as they raise suspicion of foul play. The incidence of sudden death is 10% of all deaths. Among these, those due to pathology in cardiovascular system are predominant (45%), followed by those due to pathology in respiratory system (20%). About 15% are due to central nervous system pathology, 6% due to alimentary causes, about 4% due to genitourinary causes and the rest (10%) are due to miscellaneous causes.[2] A sudden cardiac death occurs when the heart stops beating or is not beating sufficiently to maintain perfusion and life. Despite advances in the screening and the diagnosis of cardiovascular disease, sudden cardiac death is often the first manifestation of an underlying heart problem in apparently healthy individuals. The incidence of sudden natural deaths are not uniform and it depends on many factors such as sex, age, ethnic group, chronological criteria and methodology of diagnosis.[3] The present study had been conducted in the Department of Forensic Medicine and Toxicology with aim to determine the exact cause of sudden natural death with special reference to cardiac causes. The objectives were:

1. To study the incidence of heart related sudden death in various age groups and their sex
2. To study the incidence of heart related sudden death in different gender.
3. To study the incidence of heart related sudden death and its relation to location of coronary artery block.
4. To study the relation of cut section of ventricular wall and CVS causes

2. Materials and methods:

All cases, irrespective of age groups and sex, who died suddenly and/or unexpectedly and brought to our institute for post-mortem examination, were studied.

Criteria for selection of cases were as follows.

Inclusion criteria:

1. The cases, which were admitted in our or other private hospitals, died within 24 hours of onset of terminal symptoms of natural disease and then brought to our hospital, for post-mortem examination, were included in this study.
2. The cases which were brought in casualty of our hospital, or the cases where the death was unobserved/unattended, and were brought to institution for post-mortem examination with the manner of death either natural or not known and the cause of which subsequently on post-mortem examination, turned out to be sudden natural were included.

Exclusion criteria:

1. The cases, where the unnatural means such as trauma, violent, asphyxia or poisoning had caused the death were not included in this study.
2. The cases where cause of death turned out to be unnatural were not included in this study.
3. The cases where cause of death remained obscure even after detailed post-mortem examination were not included.

In case of hospitalized patients, medical reports were studied and the provisional causes of death written in it were noted. Before starting the post-mortem examination, history about the onset of symptoms, their duration and habits was obtained from the relatives whenever available. In cases, where the death was unobserved / unattended and the dead body was brought directly from site of death to our institute by police for post-mortem examination and/or where the relatives were not available, help of police inquest was taken regarding the manner and cause of death.

AUTOPSY TECHNIQUES: Routine autopsy techniques were followed. Cavities opened and organs were examined in-situ before removal. The organs were then dissected out by routine dissection technique. Weight of all organs was taken before dissection. Gross examination of the organs was performed and each individual organ was dissected as per the standard autopsy technique. Heart is opened in the direction of the flow of blood. The enterotome is introduced first through inferior vena cava and extends into the opening of the superior vena cava and right atrium is cut between the openings of these two veins. In opening the right ventricle, the enterotome is introduced into the atrium, cuts through the tricuspid orifice and opens the right ventricle along the right lateral wall (Margo acutus). In opening the pulmonary valve, the enterotome is introduced into the right ventricle close to apex and conus pulmonalis and the valve are cut along the interventricular septum.The left atrium is opened by cutting the line connecting the opening of the pulmonary veins. The left atrium is incised along its

left lateral wall, the incision extends through the mitral orifice and continuing along left lateral wall of heart (Margo obtusus), opens left ventricle. Next the line of incision extends from apex along the interventricular septum into the aorta, opening the aortic valve. The coronary arteries are examined for their consistency & then by making serial parallel cross sections along the entire course of the major vessels about 2 mm apart, using a scalpel. This method demonstrates narrowing of the vessel, and any ante mortem thrombus in its lumen.[4]

3. Results:

The present study was carried out in the Department of Forensic Medicine and Toxicology from 1st January 2009 to 31st December 2009. During this period, 2088 autopsies were conducted, out of which, 221 cases (10.58%) were of sudden natural death. Amongst these 221 cases, 195 cases (88.23%) were male and 26 (11.76%) were female. The male to female ratio was 7.5:1. It was observed that cardiovascular system was the most vulnerable to sudden death contributing to 114 (51.59%) deaths. **Table no. 1 to 5** shows detailed results of the present study.

Table no. 1: Showing Cardiovascular diseases and sex-wise distribution of cases

System & diseases	Male deaths	Female deaths	Total deaths
CAD	72	05	77
CAD + AMI	29	--	29
AMI	04	--	04
Mitral stenosis (MS)	01	01	02
VSD	--	01	01
CT	01	--	01

CAD: Coronary artery disease, AMI: Acute Myocardial Infarction. **VSD:** Ventricular septal defect, **CT:** Cardiac Tamponade.

Table No. 2: Showing cases of myocardial infarction (MI)

Myocardial Infarction (MI)	No. of Cases	M/F	Percentage
Old	37	36/01	86.05
Recent	06	06/--	13.95
Total	43	42/01	100

Table No. 3: Distribution of block in coronary artery disease.

Site of block	Within 2 cm of its origin	More than 2 cm	Total
Number of cases	110	18	128
Percentage	85.94	14.06	100

Table No. 4: CVS – Disease-wise affection in different age group

Age (Yrs.)	CAD M/F	CAD + AMI	AMI M/F	MS M/F	CT M/F	VSD M/F	TOTAL M/F
0-10	--	--	--	--	--	--/01	--/01
11-20	--	--	--	--/01	--	--	--/01
21-30	04/--	03/--	--	--	--	--	07/--
31-40	22/--	04/--	01/-	01/--	--	--	28/--
41-50	**23/01**	**09/--**	**--**	**--**	**01/-**	**--**	**33/01**
51-60	14/02	07/--	01/-	--	--	--	22/02
61-70	08/02	04/--	02/-	--	--	--	14/02
> 70	01/--	02/--	--	--	--	--	03/--
Total	72/05	29/--	04/-	01/01	01/-	--/01	107/07

Table no. 5: Location of coronary artery block

Single vessel				Double vessel		Triple vessel	Total
LAD	LCM	RC	LC	LAD+ LCM	LAD+ RC	LAD+LC+R C	
63	2	7	2	23	11	19	127

4. Discussion:

The definition of a sudden death varies according to authority and convention. The definition of sudden death used in the present study is “A death which is not known to have been caused by any trauma, poisoning or violent asphyxia, and where death occurs all of a sudden or within 24 hours of the onset of the terminal symptoms”.[5]

The duration of the death process has ranged from minutes to hours, but it is difficult to determine how long the fatal symptoms have been present, as death often occurs before the victim reaches hospital, in situation in which no data on the symptoms are available for want of eye witnesses. The incidence of sudden unexpected deaths varies greatly because of the aforementioned interpretative difficulties and differences in postmortem legislation from one country to another. This study deals only with material from postmortem examinations, and the cases were selected during the study period, with lack of proper registration of deaths, therefore statistical incidence of sudden death is not attempted.

In the present study, it has been observed that incidence of sudden natural death was 221 cases out of 2088 total deaths (10.58%) amongst the

medico legal autopsies conducted during the study period.

It was observed that maximum deaths were related to cardiovascular system 114 (51.59%) cases, followed by Respiratory system 55 (24.89%) cases. In this study maximum deaths were due to coronary artery disease 110 cases (96.49% of CVS deaths), followed by pulmonary tuberculosis 37 cases. Preponderance to cardiovascular diseases is due to various risk factors, physical and mental stress and food habits, addictions and lack of exercise which affect the mostly cardiovascular system.

Luke et al studied 275 cases of sudden unexpected death from natural causes. There were 105 deaths (38%) related to circulatory system.[6] The study of Penttila A shows that cardiovascular diseases comprised the major proportion of all sudden natural deaths, whereas respiratory cause were the leading category in the remaining cases.[7] Durigonet al out of 77 cases of sudden death, 72.7% of cases died from cardiovascular disease.[8] Nandy A stated that, most of the deaths were due to cardiovascular causes accounting about 45% among all the cases of sudden deaths.[2] Reddy Narayan KS states that major causes are cardiovascular system (45-50%) followed by respiratory (15 to 23%).[9] The study of Zanjadet al shows that cardiovascular causes 111 (49.55%) cases were the leading causes of death followed by respiratory system 61 (27.23%) cases.[10] The study of Derya shows that the most common cause of sudden natural death was related to the cardiovascular system i.e. 153 cases (55%) and second most common cause was related to the respiratory system (19.1%).[11] In the study by Rao et al, about 66.67% of cases were due to cardiovascular pathology, 27.45% were due to pulmonary pathology.[12]

The present study coincides with studies of Luke et al, Penttila Anti, Durigon et al, Nandy A, Reddy Narayan K.S., Zanjad et al, Derya AA and Rao et al.[2,6-12]

Cardiovascular causes are the principle cause among sudden death in the present study. Out of 221 cases of sudden natural death, 114 cases (51.59%) were due to cardiovascular causes, of which 107 (93.86%) were male and 7 (6.14%) were female.

The study of Sarkioja et al shows that out of 77 cases of sudden deaths, 47 cases (61%) were due to cardiovascular causes, of which 43 (91.48%) were male and 4 (8.51%) were female.[13] Nordrumet al studied 428 cases of explained natural death by autopsy findings, which shows 296 cases (69.15%) died of cardiovascular diseases.[14] Out of 296 cases, 256 (96.48%) were male and 42 cases (14.18%) were female. The study of Thomas et al shows that out of 322 cases of sudden death, 224 (69.5%) cases were due to cardiovascular causes, of which 179 (79.91%) were male and 45 (20.08%) were female.[15] Zanjadet al cardiovascular cause 111 (49.55%) cases were the leading cause of death in which male: female ratio 1:0.178.[10] Derya in his study 153 (55%) of cases of sudden death was related to cardiovascular system in which 133 (86.93%) were male and 20 (13.07%) were female.[11] Rao et al in his study 66.67% of cases were due to cardiovascular pathology. In cardiovascular deaths male to female ratio was 7.5:1.[12]

Thus from all above studies, it is seen that cardiovascular cause was the principle cause of death among sudden death and more common in males than females which is consistent with the present study.

Cardiovascular System (CVS) Diseases – Disease-wise affection in different age group

In present study, it has been observed that out of 114 cases died of cardiovascular causes, 110 (96.49%) were due to coronary artery disease. Thus coronary artery disease was not only principle cause among cardiovascular causes but also important cause among sudden natural death amounting to 49.77%. Out of 114 cases, 107 (93.86%) were male and 7 (6.14%) were female.

The study of Sarkiojaet al shows that the most common single cause was coronary artery disease which accounted for 38 cases (80.85%) of 47 cases of cardiovascular deaths and 49.35% of 77 cases of sudden death.[13] Out of 38 cases of coronary artery disease, 35 cases (92.1%) were male and 3 cases (7.89%) were female. The study of Nordrumet al shows that out of 296 cases died of cardiovascular causes, 268 cases (90.54%) were due to coronary atherosclerosis.[14] Out of 428 cases of explained natural death, coronary atherosclerosis accounted for 62.61%. The study of Thomas et al shows that out of 224 cases died of cardiovascular causes, 189 cases (84.37%) were due to ischemic heart disease. Out of 322 sudden natural deaths, ischemic heart disease accounted for 58.7%.[15]

The study of Forneset al of sudden death out of hospital coronary deaths with no previous cardiac history, shows that 230 cases (73.5%) of sudden cardiac deaths are coronary in origin. The study of

Luke et al[6] shows that out of 105 cases of circulatory system, maximum deaths were due to coronary artery disease (28%).[16] The study of Di Maio et al shows that out of 609 deaths due to cardiovascular disease, 451 (74%) were attributed to coronary artery disease.[17] The study of DurigonM shows that 72.7% cases died from cardiovascular cause mainly coronary atherosclerosis.[8] The study of Zanjadet al Death due to coronary artery disease amounts to almost half of all sudden deaths (42.85%).[10] Derya shows that out of 278 cases of sudden death, 55% of cases related to cardiovascular causes, principally ischemic heart disease.[11]

Thus from all above studies, it is seen that coronary artery disease was the most important cause not only among deaths due to cardiovascular causes but also among sudden deaths and this finding is consistent with the present study.

In the present study, non-ischemic heart disease cases were 4 (3.51%) of all cardiovascular deaths, which include two cases of mitral stenosis, one case each of ventricular septal defect and cardiac tamponade.

In this material, deaths caused by complication to coronary atherosclerosis comprised the majority of the cases with an explained cause of death. Half of the coronary deaths had no morphological signs of recent events in the vessels or in the myocardium. Stenosis in the coronary arteries of more than 75% has been stated to have significant hemodynamic effects. Subjective assessment of the degree of coronary artery stenosis is probably difficult. If the stenosis was evaluated as significant and there was no other obvious cause of death, then the case was classified as a coronary death.

Cases of myocardial infarction (MI)

In the present study, it has been observed that recent myocardial infarction was seen in 6 (5.26%) cases of coronary artery disease (114) of which all male. Recent myocardial infarction was confirmed by histopathological examination. In 37 cases (32.46%) old myocardial infarction were seen on gross examination, of which 36 were male and 1 case of female.

Di Maio et al shows that out of 451 coronary artery disease cases, 157 (34.8%) showed gross scarring of the myocardium, with 38 cases (8.4%) giving evidence of an acute myocardial infarction grossly.[17] This finding does not match with the present study as histopathological examination was not conducted in all cases in Di Maio et al.

Farbet al 90 hearts were examined. Acute myocardial infarction present in 19 (21%) and healed myocardial infarction only in 37 (41%) and no myocardial infarction in 34 (38%).[18] This finding was not consistent with the present study.

Distribution of block in coronary artery disease

Maximum numbers of coronary arteries were blocked within 2 cm of origin of artery. It coincides with findings quoted in textbooks of Robbin and Dikshit.[19]

Location of coronary artery block

A death due to single vessel (58.27%) was common and left anterior descending artery (49.60%) was most commonly involved artery.

In the study of Luke et al shows twenty cases demonstrated recent complete coronary artery occlusion, 15 of the left anterior descending coronary.[6] In the study of Sarkiojaet al severe stenosis was located in the left descending artery in 58%, and in 52 % the disease was only in one vessel.13 In the study of Burke et al shows that 72% of hypertensive's with one vessel disease versus 17% of normotensives with one vessel disease.[20]

This coincides with studies of Luke et al, Sarkioja et al and Burke et al.[6,13,20]

Relation of cut section of ventricular wall and CVS causes of death

In present study it was observed that out of 114 cases solitary left ventricular hypertrophy in 67 cases (58.78%), biventricular hypertrophy present in 20 cases (17.54%), and solitary RVH in 3 cases (2.63%)cases.

The present study is consistent with the study done by Burke et al where in 71 hearts with CAD, LVH was present in 64% of hypertensive's versus 33% of normotensives.[20]

5. Conclusion:

The following conclusions are derived from the present study about the sudden death with special reference to cardiovascular system involvement.

- Among cardiovascular causes, maximum deaths (96.49%) were due to coronary artery disease followed by mitral stenosis 2 cases, cardiac tamponade and Ventricular heart disease 1 case each.
- Male to female ratio in cardiovascular disease was 15.29:1.

- Maximum CVS related deaths were observed in 41-50 years.
- Death due to coronary artery disease was maximum in age group 41-50 years.
- Out of cases 43 cases, 6 cases show changes suggestive of recent MI. In 37 cases, old healed scar of MI seen.
- Coronary arteries (89.55%) were frequently blocked within 2 cm of origin.
- Single vessel was blocked in 58.27% and LAD (49.60%) was frequently involved.
- Out of 114 cases, Solitary LVH observed in 58.78% cases followed by Biventricular hypertrophy 17.54% and solitary RVH in 2.63% cases.

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Original Research Article

Socio-Demographics at no par in Culling Out Hanging as the Mode for Self- Killing.

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Key words
Self-Killing,
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Abstract

Introduction: The quantitative study focused on the meta-analysis performed in order to examine the relation of socio-demographic variables to understand the difference for choosing different suicidal methods. **Materials & methods**: The data of 441 cases of Asphyxial deaths were taken into consideration which were then compiled and analyzed for the present treatise. The variables taken into consideration for said socio-demographics were age, sex, socioeconomic status, marital status, and literacy. **Discussion & conclusion**: Marginal insignificant differences were found between the 441 autopsies resulting into asphyxia death, studied, of which 342 deceased chosen hanging for self-killing. For all socio-demographic characteristics, the distribution of correlations was insignificantly homogeneous, and statistical contrasts revealed the operation of several moderating variables. The pattern of overall variables studied rendering homogeneity in results and their relation to earlier reviews is thereby discussed.

1. Introduction

In early 18th century, the term 'asphyxia' by modern Latin (in the sense 'stopping of the pulse') came into being from Greek term 'asphuxia' [from a- 'without' + sphuxis 'pulse']. According to the Definition of asphyxia as noun from the Oxford Advanced Learner's Dictionary, it is *"the state of being unable to breathe, causing death or loss of consciousness".*

Thereby, an asphyxia death is the death resultant due to asphyxiation. There are various forms of asphyxiation such as caused by hanging, throttling, strangulation, smothering, choking, drowning and also those caused by trauma.[1-3] The aim of present study is to throw light that the socio-demographic characteristics do not add up in the choosing the method to commit self-killing. No matter the literacy or the socioeconomic status or the driving motive force behind such grotesque decision, it all comesto the understanding to achieve it instantaneously with least possible means at hand. Thereby,hanging oneself proves out to be the most convenient and most chosen form of self-killing. Mostly the common understanding rules in the favor of typical form of hanging rather than the

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atypical hanging. Hanging is suspending oneself through a ligature material constricting around the neck which compresses the airway externally. The weight of the suspending body provides the constricting force in the typical form of hanging. In case of atypical form of hanging, the body is not completely suspended in free gravity wherein, the body is in adherent to some of the external body surface or ground, and the neck is constricted with the ligature material wherethe compression is due to the weight of the head suspending outwardly in order to provide the force.

Among the arrays of asphyxial death, drowning oneself is volition for self-killing. The incidences of self-killing via drowning are also considered in the present treatise but the phenomenon has been proven to be more accidental in manner than the suicidal in occurrence. The focused group of deceased encountered in the present meta-analysis showed the rarest percentage towards suicidal drowning. Apart from hanging and drowning, other assortment of asphyxia were predominantly homicidal in manner and least, accidental. The purview of the current exposition is laid over the pattern of analysis of socio-demographic sort through the meticulous analysis of numerous autopsies occurred in the Kanpur district.

2. Material and Methods

Present study was conducted in the department of forensic medicine of a medical college and tertiary care hospital in Kanpur district during the period of one year from January 2018 to December 2018. During that time stretch, 3667 bodies were brought in for medico-legal autopsy in the mortuary of tertiary care hospital, Kanpur district, Uttar Pradesh. The data of 441 cases of Asphyxial deaths were taken into consideration which were then compiled and analyzed for the present treatise.

The criteria for such bracket were inclusive of all ages reported during the said span ascertainedto affirmative of asphyxial causation of death, irrespective of the gender. The bracket excluded those deceased whose bodies were in advanced decomposed state to wither off any possibilityother than that of asphyxia.

Method of data collection:

Socio-demographic variables taken into account were age, sex, socioeconomic status, marital status and literacy. The summation of tally of said attributes were jot down from the detailed history appropriated from the police & the relatives along with the pretested questionnaire with traits mentioned. The questionnaire was prepared in simple English language with Hindi language translated version also included in it. The interview was done in local dialect.

3. Observation and Results

In the study, total 3667 cases were included out of which in 441 cases (12.02%), cause of death was asphyxia while 3226 cases (87.98%), cause of death was other than asphyxia. Among asphyxia, maximum cases (78.00%) were of hanging followed by strangulation (12.01%) (**table no. 1**).

Table 1: Description of autopsies conducted during study period

S. No.	Cause of death	No. of Cases	% of Cases
1	Asphyxia	441	12.02%
1a	Hanging	344	78.00%
1b	Drowning	22	4.98%
1c	Throttling	13	2.94%
1d	Smothering	09	2.04%
1e	Strangulation	53	12.01%
2	Other than asphyxia	3226	87.98%
Total		3667	100.00%

Table No. 2: Demographic Profile of Cases included in Study

Criteria	Demographic Profile	No. of Cases	% of Cases
Gender	Male	283	64.17%
	Female	158	35.83%
Religion	Hindu	364	82.53%
	Muslim	63	14.28%
	Other	14	3.17%
Marital Status	Married	287	65.07%
	Unmarried	141	31.98%
	Unknown	13	2.94%
Residence	Rural	175	39.68%
	Urban	253	57.36%
	Unknown	13	2.94%
Socio-economic status	Upper SES	10	2.26%
	Middle SES	207	46.94%
	Lower SES	146	33.1%
	BPL Status	65	14.8%
	Unknown	13	2.94%

Table 2 shows demographic profile of cases in present study. Male (64.17%) outnumbered female (35.83%) cases. In present study, maximum cases (82.53%) belong to Hindu community and majority cases (65.07%) were married. In this study,

maximum cases (57.36%) were residence of urban area. About half of the cases (46.94%) belong to the middle socio-economic status followed by lower socio-economic status (33.1% cases).

Table No. 3: Age wise Distribution of Asphyxial Death Cases

S. No.	Age group (Yrs)	Asphyxial Deaths			Total
		Hanging	Drowning	Other deaths	
1	**1-10**	0	0	01	01 (0.22%)
2	**11-20**	85	01	03	89 (20.18%)
3	**21-30**	130	07	16	153 (34.69%)
4	**31-40**	77	02	39	118 (26.75%)
5	**41-50**	39	04	04	47 (10.65%)
6	**51-60**	04	01	00	05 (1.13%)
7	**>60**	09	07	12	28 (6.34%)
Total		**344**	**22**	**75**	**441 (100.00%)**

Table No. 4: Literacy wise Distribution of Asphyxial Death Cases

S. No.	Literacy Status	Asphyxial Deaths			Total
		Hanging	Drowning	Other deaths	
1	Illiterate	46	01	02	49 (11.1%)
2	Primary	32	00	03	35 (7.93%)
3	High School	76	03	11	90 (20.4%)
4	Intermediate	52	08	26	86 (19.5%)
5	Graduate	105	05	14	124 (28.11%)
6	Postgraduate	21	01	09	31 (7.02%)
7	Well employed	12	04	10	26 (5.89%)
Total		**344**	**22**	**75**	**441**

Table 3 shows age wise distribution of asphyxial death cases. Maximum number of cases (153 cases, 34.69%) belongs to age group 21-30 years followed by age group 31-40 years (26.75%) and 11-20 years (20.18%). Maximum hanging cases (130 cases) was reported in 21-30 years age group while maximum number of drowning cases (7 cases each) was reported in age group 21-30 years and > 60 years age cases. **Table 4** shows literacy wise distribution of asphyxial death cases. Maximum number of cases (124 cases, 28.11%) belongs to Graduate class followed by high school (90 cases, 20.4%). Maximum cases of hanging (105) have graduate literacy status while in drowning; it was seen in intermediate class.

4. Discussion

Self-killing is considered a final destination to a pathway of severe antecedent incidences which may be in addition to unclear mechanism of some mental illness. Self – killing ideation is mostly considered and understood generally on a basis of having thoughts to terminate one's own life. Traditionally reviewing medical practitioners follow the ideation of self-killing to be along a continuum, which may either range between ideating alone or with a plan. Later of which is considered to be more significant risk factors. Self-killing attempts leading to not completion signifies the ideation of self-killing and in the spur of moment, mostly the hanging with the ligature material most common as the Dupatta or Saree has been found in several casesstudied. Those occurring according to the ideation with the plan were mostly apart from hanging and resulted in mostly drowning or more heinous form such as Road Traffic Accidents or falling from a high sourced heightened building. Though most cases demonstrated the groupof ideation and completion within spur of the moment and were chosen hanging in a very largestudied group of cases. Thereby, Socio-demographic variables taken into account have extensively showed no significant impact over culling out hanging as the most preferred method for asphyxial self-killing. Hanging is considered as suicidal manner of death in almost99.9% of the cases without any doubt; hence, manner of death was exclusively self-killing.

Speaking of socio-demographics, the data has been taken from the yearlong autopsies done enumerative of 3667 cases, of which our essentiality

was chased down to 441 asphyxial deaths. Out of 441 asphyxial deaths categorized for asphyxial deaths, 283 deceased were males and 158 were females. Thereby, it can be easily fractionalized to ratio rendering insignificant value dependency upon the desired result of the treatise which is to check whether differentcharacteristics taken into account, reflects in culling out hanging as the prime factor of self- killing. Here, gender distinction does not play any role in such reflection, that is to say, whethermale or female, the decision to prime hanging for self-killing remains unaffected by the said variable. Studies done by Bhagora LR et al.[4], Patel AP et al.[5] and Singh A.[6] also observed similar results.

Off the list, next variable amounted to the deceased age which would have made a deep impact while in the moment of such plight, wherein adult brain function with maturity in personality may have hit off differently than those of young mind with hot boiling blood. But as the traitswere analyzed within the purview of the study, this yet again proved insignificant as in othersto have been reflecting any significance. Results of present study coincides with the study done by Singh A.[6] and Rawat V et al.[7]

Since the aim of the treatise is to focus on the manner of death which concluded to be suicidalin manner, those cases which were culpable to suicide are only fixated for the purpose, whichare inclusive of hanging and drowning as the other are exclusive to be the suicidal manner andare rather homicidal or accidental, thus not pertaining to the purview of this meta-analysis.

Stepping forward we determined with careful evaluation based on police information and the proforma survey about the socio-economic status of all the deceased who died by hanging or drowning in completed attempts towards self-killing. The data interpretation showed that most of the deceased in majority belonged to middle class followed by lower class. Of the whole aimed group of deceased, 13 deceased were unknown with no police information and thereby their socio-demographics could not be studied. The marital status and literacy of these group were also the part pertaining to the discussion, whereby the statistics showed us that majority were married as a large group irrespective of gender was married because the local tradition dictates the early marriage of female as soon as they attain majority and males were too not spared of this tradition where they are supposed to get married as soon as they start earning their bread and is capable to pursue married life in the district of Kanpur. Thereby, onecan say that the unmarried group were mostly either in due of education in case of females or were not the bread-earners in case of females. Similar results were observed by studies done by Singh TK et al.[8], Waghmare PB et al.[9] and Vadgama DK et al.[10]

Majorly deceased were among the age group of 21 – 30 years which represents the class of educational group who attains graduation and either leans towards self-employment or employment in multinational companies as per the statistical records of Kanpur districts. A fewget their majors after their grads. The literacy status representing the category of well-employedimplies to those who were in a well-pay off business or employment with self-turnover of nearly lacs per month. Biddle L et al.[11] and Vijaynath V et al.[12] coincides with the present study.

Conclusively, we can summarize here that the effect of socio-demographic variable did not playany significant adherence to the self-killing method. The knowledge and the severity of pain infliction on self were beyond the understanding of the deceased when one came across the suicidal ideation and attempted such ideation into action which rendered the desired result. Asthe present treatise of work is majorly inclined towards the meta-analysis, it did not produce any observation out of the bloom as the earlier literary review produce. Divergent literature review inclined towards convergence of our observation were of Rawat V et al[7], Bhosle S H et al,[2] Patel A P et al[5], Vadgama D K et al[10], Waghmare P B et al.[9]

5. Conclusion:

In the vicious cycle of life, many comes across the hindrance to an extent which pushes one over the edges to determine that the life isn't worthwhile and they couldn't handle the pressure anymore and have had the mean mode of self-killing ideation which spurs into their mind fromtime to time on repetitive occurrence of such prime causation force. Many a do, those causationfactors summarize to categorize itself into poverty, property, career failures, defamation, extortion, dowry traditions, ill-treatment by in-laws, rash and negative behavior from husband, extramarital affairs, intoxicating behavior, infertility. Upon the comprehensive meta-analysis of the gathered data, the motive behind such self-killing distributed among thesecausation factors

as mentioned.

When these behavioral patterns came to express itself in the tormentors moments, the deceased felt disparate urges towards self-killing and the ideation took the actionable form leading to completion of such ideal attempts and as the focal point of the study determined the major ideation led to one self-terminating their life by hanging themselves from the point of suspension causing the typical hanging establishing suicidal manner of death. Thereby, no matter what age group one belongs to, what marital status caused the prime factor to be motive, literal status of one, do not define one's understanding to be different from other in the characteristic traits while culling out hanging to be mode for self-killing, it all comes to means,most accessible one!

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Original Research Article

Study of Victims of Child Sexual Assault at a Tertiary Health Care Center in Western Maharashtra

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Child Sexual Abuse, Threatening, Pornography, Genital Manipulation.

Abstract

Background: Reporting of child sexual assault cases is increasing day by day since the inception of the Protection of Children from Sexual Offences Act 2012. Child sexual assault not only includes penetrative assault but also various other modes of assault like showing pornographic content, manipulation of genitals or making to do so, fingering, threatening, etc. This study aims to study these various modes of sexual assault in children and Genito anal injuries in relation to age and gender. **Materials and Methods:** A cross-sectional descriptive study among 176 victims of the <18 years of age group with a history of sexual assault (natural and unnatural) was conducted. **Results:** Out of 176 victims, 148 (84.1%) were females, and the majority of victims 101 (57.4%) were between 13-18 years of age. In this study, we found various modes of assaults, fingering in 74 (42%), history of showing porn in 37(21%), oral stimulation in 55 (31.3%), history of threatening to life or serious injuries in 55.1% of cases. In 6–12-year, age group, most of the cases reported with history of threatening, history of force for touching the accused genitals and showing porn to the victims. **Conclusion:** Girls and boys are equally affected psycho-socially and physically by child sexual assault. The age group of 6-12 years is more vulnerable to child sexual assault/abuse as these are more approachable and easier to manipulate.

1. Introduction

The prevalence of child sexual abuse (CSA) in India and all over the world is known to be high as children are soft targets because they do not realize that they are being abused. India has the world's largest number of CSA cases: For every 155th minute a child, less than 16 years is raped, for every 13th-hour child under 10, and one in every 10 children is sexually abused at any point in time. [1] The World Health Organisation (WHO) defines CSA as "the involvement of a child in sexual activity that he or she does not fully comprehend and is unable to give informed consent to, or for which the child is

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not developmentally prepared, or else that violate the laws or social taboos of society.[2] The term CSA includes a range of activities like "intercourse, attempted intercourse, oral-genital contact, fondling of genitals directly or through clothing, exhibitionism or exposing children to adult sexual activity or pornography, and the use of the child for prostitution or pornography.[3]

In India, the Protection of Children from Sexual Offences (POCSO) Act, 2012 (that regards any sexual activity with a child below 18 years of a crime) describes various forms of sexual offenses.[4] Government of India, Ministry of Women and Child Development (MWCD) study in 2007 which interviewed 125,000 children in 13 Indian states revealed that the prevalence of all forms of child abuse is extremely high (physical abuse [66%], sexual abuse [50%], and emotional abuse [50%]). This major state-sponsored survey in India reported the prevalence of CSA as 53%. Boys were equally affected and more than 20% were subjected to severe forms of sexual abuse that included: sexual assault, making the child fondle private parts, making the child exhibit private body parts, and being photographed in the nude.[5] The National Crime Records Bureau (NCRB) revealed that crimes against children increased by 4.5% in 2019 as compared to 2018. In its report, NCRB stated that as many as 148,185 crimes against children were reported in 2019 in the country. In this, 31.2% of cases of crimes against children were registered under the POCSO Act, 2012. Maharashtra is the state where the maximum number of 8,503 cases under the POSCO Act, 2012 were registered in the country during 2017–2019.[6] Experiencing child sexual abuse is an adverse childhood experience (ACE) that can affect how a person thinks, acts, and feels over a lifetime, resulting in short- and long-term physical and mental/emotional health consequences. This study analyses types of injuries and various modes of sexual abuse in a child and its relation with age and gender. This will help create awareness and take preventive measures for child sexual abuse in various sectors like law and order, NGO, and the judiciary system.

2. Materials And Methods-

A cross-sectional descriptive study was conducted at the Department of Forensic Medicine and Toxicology, at tertiary care institution between 1st November 2018 and 31st October 2020 after approval of the institutional ethics committee. 176 cases with a history of sexual assault (natural and unnatural) including male and female victims less than 18 years of age were included which fall under sections of IPC 376, 377, & POCSO acts. Each case was examined after taking informed consent from the victim. If the victim was less than 12 years of age, consent from a parent/guardian was obtained. A thorough history without interpretation was noted, and clinical examinations were carried out in Department & Gynaecology ward. All data were entered in MS Excel sheet and statistical analysis was done by using SPSS software. Chi-square & Fisher exact test applied & p-value <0.05 considered as statistically significant finding.

3. Results:

In our study, the victims 101 (57.4%) were observed in the 13-18 years age group followed by 57 (32.4%) in the 6-12 age group (**Table- 1**).

Table no. 1: Distribution of Study Subjects according to the Age and Gender

Age (in Years)	Male (%)	Female (%)	Total (%)
1-5	2 (16.7)	10 (83.3)	12 (6.8%)
6-12	22 (38.6)	35 (61.4)	57 (32.2%)
13-18	4 (4.0)	97 (96.0)	101 (57%)
>18	0.0 (0.0)	6 (100.0)	6 (4%)
Total	**28 (16%)**	**148 (84%)**	**176 (100)**

Note: In the above table, victims which are mentioned above 18 years were having history of assault when they were below 18 years but complained later on.

Table no 2: Gender-wise distribution of history of physical assault and other Parameters

History of Physical Assault and Other Parameters	Gender		P Value
	Female	Male	
History of Physical Assault	58 (39.5)	14 (50.0)	0.544
History of threatening	69 (46.6)	27 (96.4)	<0.001*
Force for touching the accused's genitals	45 (30.4)	20 (71.4)	0.001*
History of showing porn	22 (14.9)	15 (53.6)	<0.001*
Anal injuries	1 (0.7)	6 (21.4)	<0.001*

The gender distribution abiding history of assault shown in **table no. 2**.

Genitals injuries:

In 118 (79.8%) cases hymen was torn and in 30 (20.2%) cases hymen was intact. Amongst all torn hymen cases, 100 (84.74%) cases showed old hymenal injury, and 18(15.26%) cases showed fresh hymenal injury. Circumferential tears with tags were seen in 73 (61.86%) cases. Hymenal tears are between 6-9 o'clock position seen in 30 (26.27%)

cases, in between 3-6 O' clock position in 18 (15.28%) cases, the tear was seen between 12-3' clock position in 8(6.7%) cases. The tear was seen in between 9-12' clock position in 5 (4.23%) cases. In 103 (85.12%) cases showed smooth edges, 12 (9.91%) cases showed erythematous edges and 6 (4.95%) cases showed erythematous and swollen edges both at a time.

Table no. 3: Age-wise Distribution of various modes of sexual assaults

S. No.	Modes of sexual assaults	Age in (Years)				Total	P Value
		1-5	6-12	13-18	>18		
1	**Manipulations**						
	Rubbing over genitals	1 (8.3)	2 (3.5)	1 (1.0)	0	4 (2.2%)	0.204
	Touching genitals	4 (33.3)	13 (22.8)	11 (11.0)	0	28 (16.2%)	
	Both	7 (58.3)	42 (73.7)	87 (87.0)	6 (100.0)	142(80.6%)	
	No history	0	0	1 (1.0)	0	1 (0.5%)	
2	**History of Physical Assault**	3 (25.0)	29 (50.9)	37 (37.4)	3 (50.0)	72(42%)	0.553
3	**History of Threatening**	6 (50.0)	48 (84.2)	40 (40.0)	2 (33.3)	97(55%)	<0.001*
4	**History of Force for touching the accused's genitals**	4 (33.3)	38 (66.7)	23 (23.0)	0	65(36.9%)	0.001*
5	**History of Showing porn**	3 (25.0)	24 (42.1)	10 (10.0)	0	37(21%)	<0.001*
6	**Oral sex**	3 (25.0)	32 (56.1)	20 (20.2)	0	55(31.3%)	<0.001*
7	**Anal Injuries**						
	Abrasion	0	2 (1.8)	0	0	2 (1.2%)	0.030*
	Oedema & Redness	0	0	1 (1.0)	0	1 (0.6%)	
	Lax anal tone	0	3 (5.3)	0	0	1 (0.6%)	
	Tenderness	0	4	0	0	4 (2.3%)	
	No Injuries	11 (91.7)	53 (93.0)	99 (99.0)	6 (100.0)	169 (96%)	

4. Discussions

In our study, the maximum number of victims 101 (57.4%) were observed in the 13-18 years age group followed by 57 (32.4%) in the 6-12 age group (**Table- 1**). Similarly, Sarkar et al[7] reported the most affected (68.9%) age group between 11-20 years followed by (11.2%) were from the 0-10 years of age group & Al-Azad MAS et al[8] also found the most affected age group was victims between 11-20 years (69.57 %). Easy availability of mobile phones with high-speed internet services and rampant use of social media increases interaction with known and unknown persons is responsible for the increase in incidences as previously there was no such mode of mass interaction with other unknown people.

The majority of the cases were females i.e., 148 (84.1%) (**Table - 1 & 2**). Such female preponderance in victims was also noted by Sarkar et al[7] that out of 90 victims 88.9% were females & 11% were males. M. Maqsood et al[9] also found out of 27 victims of sexual assault, 22(81.4%) were females and 5 (18.5%) were males. In the 6-12 age group, 40% were males and 60 % were females in contrast to another age group where the maximum cases were only females. Female victims in the age group between 14-18 years are particularly more vulnerable as due to hormonal changes, they get easily attracted to the opposite sex and can get manipulated easily into love relationships. According to the RAINN foundation statistical study from the US department of justice, females aged 16-18 are 4 times more likely than the general population to be victims of rape, attempted rape, or sexual assault, and observed that 82% of all victims under 18 are female and 1 out of every 10 rape victims are male.[10]

A history of manipulation with the victim's genitals was seen in 103 cases (58.4%). Force for oral stimulation was seen in 31.3% of cases & history of fingering was reported in 74 (42%) cases. Riggs et al[11] found oral assault in 25% of cases. Z Lackew et al[12] found genital fingering cases accounting for 1.8%. Maximum incidences of forceful oral intercourse(fellatio), threatening, showing porn to the victim before the act, and force for touching the accused genitals were seen in the 6-12 age group. (**Table-3**)

The most common act in male rape is anal penetration, followed by fellatio.[13] Out of 8 victims with anal injuries, 80 % were males followed by

tenderness (4 cases), abrasion (2 cases), lax anal tone (1 case), and edema (1 case). Similar observations of anal injuries were also made by M. Maqsood et al[9] (11.11%) and Seree Teerapong et al[14] (21% cases). Bhowmik K et al[15] reported 50% of males had injuries to anal margins. However, Tamuli R P et al[16] found anal injuries in only 2% of cases, all of which were males. (**Table 3**).

Most of the hymenal tears were old i.e in 104 cases (59.1%), and only 18 (10.2%) cases were reported with a fresh tear. Maximum cases with old healed hymenal tears showed circumferential tears followed by tears at the 6-9 clock position in 17.6% of cases. A similar observation was also noted by Haridas et al[17] that old hymen tears in 91.44% of cases and at multiple positions. Other authors Sarkar SC et al[8], Bhowmik K et al[15], and Arpana S et al[18] found that maximum cases presented with an old healed tear of the hymen. Al-Azad MAS et al[8] found hymen injury in 36.91% of cases and the majority of them at 6'o clock position. Iain McLean et al[19] reported the most common location for hymenal tears between the 3 and 9 o'clock position. A majority of the victims (83.5%) in the present study reported after 24 hours of incidence, the chances of finding fresh injuries became less. Moreover in 31.1% of cases as the act was consensual old hymen tears were more commonly found.

Boys as a victim involved in this study mostly belong to age group of 6-12 years. In the same age group, there was a high rate of threatening, a force for observing porn, and a force for touching accused genitals in both sexes. 80% of sodomy cases were males. This signifies the equal need to protect boys as we do girls. Male victims of sexual assault experienced a high level of psychological trauma necessitating those sexual assaults should be considered as equally as severe female sexual assault.[20]

Force of oral stimulation and manipulation of the victim's genitals was also common in the 6-12 age group. This happens because this age group comprises of children who are innocent, unaware of the accused intention and so easily get into the hands of the older accused. It is seen that 44% of cases were between 16-18 years. Only 10% of cases with recent injuries in this study may be attributed to the delay in reporting the incidence or seeking legal help in the event of violence. Before 2012, the age of consent was 16 years for girls as provided under the Indian Penal Code, section 375, and has been so since the year 1940. POCSO law, 2012 is a special law that raised the age of consent to 18 years, for both boys and girls, followed by an amendment to the Indian Penal Code through the CLA Act, 2013, which did the same.[21] Now is the time when statutory rape should not be charged under the POCSO Act and so it is important to evaluate the existing laws and reconsider and again minimize the age of consent from 18 to 16 so as to protect adult independency.

5. Conclusion

Incidences of Child sexual assault are increasing day by day in spite of stringent legislation enacted for safeguarding the interest of children. The main culprit is poverty, illiteracy, lack of awareness, rage, compounded by the easy availability of high-speed internet services, and social media. Explicit social media content is very influential nowadays for all types of people ranging from low socioeconomic to higher class people. This study was conducted at a tertiary center in Mumbai to study genital injuries and various modes of child sexual abuse and its relation to age and gender. With growing cases of child sexual assault, it is very important that we need to try to understand the intention of people with whom we are leaving our children.

Understanding the anogenital injury patterns, including frequency and prevalence, that occur with consensual sexual intercourse will help to identify the difference between injury related to consensual vs. non-consensual sexual intercourse. Our study mainly concludes that girls and boys are equally affected psycho-socially and physically in child sexual assault and the age group of 6-12 years is more vulnerable to child sexual assault/abuse as these are more approachable and easier to manipulate necessitating the need for continuous supervision by parents to avoid any kind of child abuse.

There is an urgent need for the government to aggressively awareness drive regarding the legal consequences of sexual intercourse below 18 years of age to the vulnerable group and parent education coupled with strengthening legal aid services are the need of the hour.

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Original Research Article

Evaluation of Fatal Craniocerebral Injuries: An Autopsy Based Study in Rural Medical College in Central India

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Key words
Head Injury,
Fatal,
Fracture of Skull,
Intracranial
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Abstract

Background: 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. Trauma is one of the leading preventable causes of death in developing countries, and is a major health and social problem. **Material and Methods:** The study has been conducted during the period 1st August 2013 to 31st August 2015. During this period, total 146 cases of fatal head injuries with intracranial traumas were studied. **Results:** In the present study, out of 146 cases of fatal head injury, 118 were male and 28 were female. Male, female sex ratio is 4.21:1. Of which 100 cases were of RTA (68.49%), followed by Railway accidents 26 cases (17.80%). **Conclusion:** Fracture of vault of skull (n= 83; 56.84%); was maximum as compared to base of skull in 36 (24.65%) cases. Subgaleal Haemorrhage was observed in 131 (89.73%) cases. Subarachnoid Haemorrhage in 115 cases (78.77%) was most commonly intracranial Haemorrhage. **Recommendations:** Fatal head injuries can be prevented by implementing sufficient road safety measures, working at heights while wearing safety equipment. Using safety gates and childproofing your home will prevent children from accessing dangerous areas like stairs.

1. 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. The application of blunt trauma to the head may result in injury to the contents of the skull, either alone or with fracture of skull.[1] Trauma is one of the leading preventable causes of death in developing countries, and is a major health and social problem. Since prehistoric times, head had been looked upon as one of the most vulnerable regions of the body and injuries involving it have always been considered very serious.

In low- and middle-income countries trauma related mortality before 70 years of age is more frequent than higher income countries.[2]

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Present study is being carried out in Central India, to study the pattern of craniocerebral injuries caused due to various etiology.

2. Materials and Methods:

This study was undertaken in the Department of Forensic Medicine and Toxicology of Mahatma Gandhi Institute of Medical Sciences, Sevagram. The study has been conducted during the period 1st August 2013 to 31st August 2015. During this period, total 146 cases of fatal head injuries with intracranial traumas (on gross autopsy) were studied. Information was collected, compiled, tabulated and analysed from the police, inquest report, hospital records, and information provided by the relatives and post-mortem findings. The cases without any findings of intracranial trauma and the cases with findings of intracranial disease pathology on gross autopsy were excluded from the study.

3. Observations and Results:

Out of 146 fatal head injury cases 24 cases were brought directly to mortuary and 3 head injury cases were died immediately in casualty which are also involved in study. Victims from age group of 21-30 years were maximum (53.42%), out of which (n=67; 45.89%) were male and (n=11; 7.53%) were female followed by 31-40 age group (19.86%) out of which (n=25; 17.12%) were male and (n=04; 2.74%) were female .The victims of age group more than 71 are least affected by head injuries (01.37%) (**Table no. 1**).

Out of 146 fatal cases, 100 (68.49%) were of RTA, in which 79 (54.11%) were male and 21 (14.38%) were female, followed by Train or Railway accidents 26 (17.80%) cases out of which 20 (6.14%) were male and 6 (4.10%) were female, followed by assault or homicide were 10 (6.85%) cases reported and all of them were male (**Graph no. 1**).

Table No. 1: Age Wise and Gender Wise Distribution Of Fatal Cases (N=146)

Age Group (Yrs)	Male	Female	Total	p value
0-10	1(0.68%)	3(2.05%)	4(2.74%)	0.062
11-20	10(6.85%)	5(3.42%)	15(10.27%)	
21-30	67(45.89%)	11(7.53%)	78(53.42%)	
31-40	25(17.12%)	4(2.74 %)	29(19.86%)	
41-50	7(4.79%)	3(2.05%)	10(6.85 %)	
51-60	4(2.74%)	1(0.68 %)	5(3.42%)	
61-70	2(1.37%)	1(0.68%)	3(2.05%)	
>71	2(1.37%)	0(0.00%)	2(1.37%)	
Total	**118 (80.82%)**	**28 (**19.18%)	**146** (100%)	

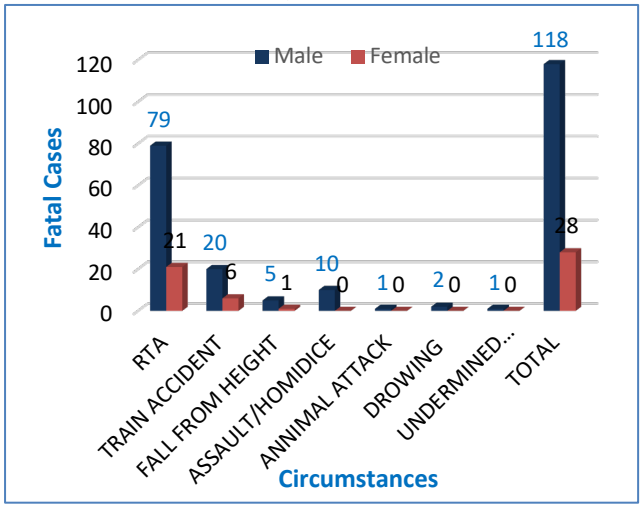
Table No. 2: Distribution based on under scalp h emorrhage in fatal cases (N=146)

Haemorrhages under the scalp	No. of Cases	Percentage (%)	p-value
Present	131	89.73	0.001
Absent	15	10.27	
Total	146	100	

p value calculated by chi square test.

It was observed that among all 146 cases, in 131(89.01%) cases Haemorrhage under the scalp was appreciated, while in 15(10.27%) cases that was absent. The difference among observed head injury cases having intracranial Haemorrhage was statistically significant (p=< 0.05) (**Table no. 2**).

Graph no. 1: Fatal cases according to circumstances and manner of causation of injuries or events



Fracture of skull was present in 101 (69.18%) cases awhile skull was intact in 45 (30.82%) cases. Out of total skull fracture cases (n=101) of, skull vault was involved in 83 cases, while base was fractured in 36 cases. The difference among observed head injury fatal cases having fracture skull was statistically significant (p=< 0.05) (**Table no. 3**).

Table no. 3: Distribution based on presence of fracture of skull

Fracture Skull	No. of cases	Percentage Out of 146	p value
Fracture of vault of skull	65	64.36(%)	0.001
Fracture of base of skull	18	17.82(%)	
Fracture of both vault and base of skull	18	17.82(%)	
Total	101	100(%)	

As per the pattern of intracranial traumas are concerned, from this table it had been shown that, Intracranial Haemorrhage was the commonest finding and seen in 139 cases (95.20%), followed by Oedema or swelling of brain in 110 cases (75.34%). In 42.47% cases, brain showed contusion only, in 3.42%

laceration only, in 4.79%, combined contusion and laceration. Injury to brain stem was in 1 case (0.68%), and shifting of midline could be detected in 7 cases (4. 79%). In 5 cases, there were either crush injury to brain or brain liquefaction and in 4 cases, neurosurgical intervention was done (**Graph no. 2**).

Graph no. 2: Distribution According To Type Of Injury To Brain Matter In Fatal Cases.

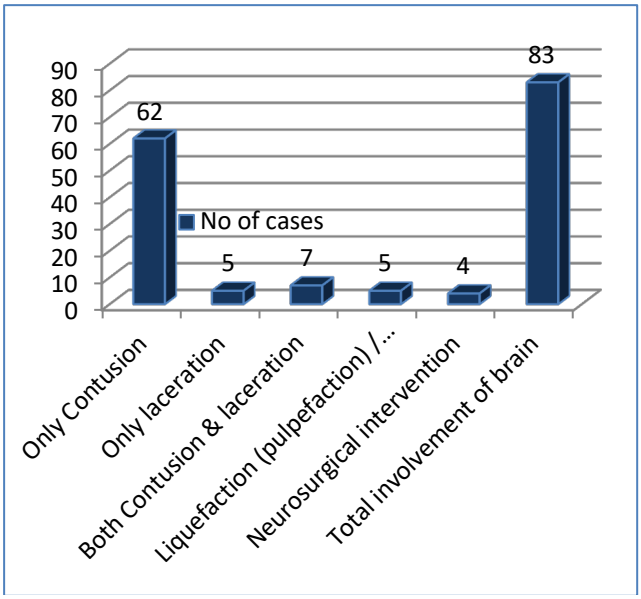


Table No. 4: Types and Percentage of Intracranial Haemorrhage (n=146).

Type Of Haemorrhage	No. Of Cases	Percentage (%)
Extradural Haemorrhage (EDH)	56	38.36
Subdural Haemorrhage (SDH)	100	68.49
Subarachnoid Haemorrhage (SAH)	115	78.77
Intracerebral Haemorrhage (ICH)	30	20.55
Intraventricular Haemorrhage (IVH)	38	26.03
SDH+SAH	84	57.53
EDH+SDH+SAH	39	26.71
EDH+SDH+SAH+ICH	9	6.16
EDH+SDH+SAH+ICH+IVH	7	4.79

Intracranial Haemorrhage was observed in139 cases, of which Subarachnoid Haemorrhage was most commonly observed in 115 cases (78.77%) followed by Subdural Haemorrhage (n=100; 68.49%) and Extradural Haemorrhage (n=56; 38. 36%). Intraventricular Haemorrhage was seen in 38 cases (26.03%) while Intracerebral Haemorrhage was found in 30 cases (20.55%). If the Haemorrhage were considered in combination, then combined subdural and subarachnoid Haemorrhage (SDH+SAH) was most common (57.53%) followed by EDH+SDH+SAH (26.71%), EDH+SDH+SAH+ICH (6.16%) and EDH+SDH+SAH+ICH+IVH (4.79%) (**Table no. 4**).

Out of 146 cases, injury to brain matter was observed in 83 (56.85%) cases. Among these 83 cases, only contusions of brain were present in 62 (42.47%) cases, only lacerations in 5 (3.42%) cases, while combination of contusions and lacerations in 7 (4.79%%) cases.

4. Discussion:

The present study was undertaken in order to find out the scenario of fatal head injury cases in this area and their Forensic point of view evaluation. With the obvious aims of finding some pathway to avoid such type of incidences, this study also presents a motto to fetch a newer perspective of representation of evidence to judiciaries that may help in disbursement of justice.

In the present study, out of 146 cases of fatal head injury, 118 were male and 28 were female. Male to female sex ratio was 4.21:1

Present study was in accordance with Tirpude et al[3], Gupta et al[4], Pathak & Desania[5], Govekar et al[6], Murkey et al[7], Bandu Ramteke et al, [8] Sidramappa Gouda et al [9] and conclude that preponderance of male victim was higher over females. High preponderance of males in fatal head injury cases may be because males are bread earners, for which they have to go outside more than that of females. Such bulk of activities and assignments make them more prone to high risk factors leading to head injuries. No age is immune for head injury to occur.

In the present study Victims from age group of 21-30 years were maximum (53.42%), followed by 31-40 age group (19.86%). Our findings were in accordance with Tirpude et al[3], Gupta et al[4], Murkey et al[7], Bandu Ramteke et al[8] and Seikh et al.[10] Study was not in accordance with Eqabal et al[11] who observed that the maximum number of casualties occurred in age group of 0-10 years, both in male and female. The maximum number of cases of head injury in the age group of 21-30 years can be explained by the fact that this age group is supposed to be the most active group to move out of house for day-to-day activities. The fewer incidences at above 70-year age group were probably explained by the Indian rural scenario of habit of avoiding outside activities and to enjoy a sedentary retired lifestyle. Out of 146 fatal cases, 100 (68.49%) were of RTA, in which 79

(54.11%) were male and 21 (14.38%) were female, followed by Train or Railway accidents 26 (17.80%) cases out of which 20 (6.14%) were male and 6 (4.10%) were female. Study findings was in consistent with Pathak et al[5], Goyal et al[12] and Dash et al[13], these studies show that fatal craniocerebral injuries are commonly caused by Road traffic accidents. And was not in accordance with Eqabal et al[11] who observed that the fall from height were commonest circumstance.

Haemorrhages under the scalp-

In present study of fatal head injury cases, evidence of Subgaleal Haemorrhage has been observed in 131(89.73%) cases. Our findings were in accordance with Sangeet Dhillon et al[14], Sanjeeva et al.[15]

Fracture of skull-

Fracture of skull was present in 101 (69.18%) cases awhile skull was intact in 45 (30.82%) cases. Out of total skull fracture cases (n=101) of, skull vault was involved in 83 cases, while base was fractured in 36 cases. These findings were in accordance with following studies Anand Menon et al,[16]Akhilesh Pathak et al,[5] Tirpude B.H. and Naik R.S,[3] Kumar et al.[17]

In the present study, linear vertex fracture was the commonest type because in an accident, head strikes by the forcible contact with broad resisting surface like ground especially in a moving condition and it leads to fracture.

Intracranial Haemorrhage-

It had been observed that Subarachnoid Haemorrhage (n =115 cases (78.77%)) was most commonly intracranial Haemorrhage followed by Subdural Haemorrhage (68.49%) and Extradural Haemorrhage (38.36%). Present study findings were consistent with J. Chandra et al.[18]

Tirpude BH, Naik RS, in their autopsy study of craniocerebral injuries on 80 victims of RTA observed that commonest was EDH (20.37%), followed by SDH (14.81%) SAH was 7.40%. ICH-3.70%. While combination haemorrhage was 12.96%. Tirpude et al.[3] B R Sharma et al,[19] found that the commonest intracranial haemorrhage was subdural haemorrhage (62%), followed by subarachnoid (23%) and extradural haemorrhage (16%).

A severe intracranial Haemorrhage may be caused by application of even moderate force to the head. The Extradural or Epidural Haemorrhage was caused almost exclusively by trauma. The bleeding may be arterial (Middle Meningeal artery), venous (Diploic veins) or combined. This is the least common type of meningeal bleeding. Subdural Haemorrhage is generally caused by rupture of bridging veins at subdural space, while the Subarachnoid Haemorrhage is caused by rupture of bridging veins, rupture of Berry aneurysms or contusion and laceration of brain. Subarachnoid Haemorrhage is supposed to be the commonest type of intracranial Haemorrhage of traumatic origin.[1]

Involvement of brain matter (Injury to brain)-

Out of 146 cases, injury to brain matter was observed in 83 (56.85%) cases. Among these 83 cases, only contusions of brain were present in 62 (42.47%) cases, only lacerations in 5 (3.42%) cases, while combination of contusions and lacerations in 7 (4.79%%) cases. Present study was in accordance with the Tirpude et al,[3] Gupta et al,[4] and Sharma et al.[19]

Contusions and lacerations are two degrees of the same process. Contusions may occur on surface of cortex or deeper down. There is no actual tearing of tissues, and may occur even without injury to the skull. Cerebral contusions are often seen associated with Subarachnoid Haemorrhage.

5. Summary and Conclusion:

In the present study, out of 146 cases of fatal head injury, 118 were male and 28 were female. Male, female sex ratio is 4.21:1.The total 146 autopsies were conducted out of those 100 cases were of RTA (68.49%), followed by Train or Railway accidents 26 cases (17.80%). Fracture of vault of skull (n= 83; 56.84%); was maximum as compared to base of skull (n= 36; 24.65%). Subgaleal Haemorrhage was observed in 131(89.73%) cases. Subarachnoid Haemorrhage (n =115 cases (78.77%)) was most commonly intracranial Haemorrhage followed by Subdural Haemorrhage (68.49%). Most commonly observed injury to brain matter was contusions of brain and seen in 62 (42.47%) cases.

6. Recommendations:

Fatal head injuries probable preventive measures can be handled by providing adequate road safety measures while engaged in activities such as cycling, skateboarding, rollerblading or any other sport or recreational activity that poses a risk of head injury. Use seat belts and make sure seat belts are properly adjusted and secure. Using safety

equipment (e.g., safety harnesses) when working at heights. Childproofing such as secure heavy furniture and appliances to the walls, pad sharp corners and edges, install window guards, and use safety gates to prevent access to stairs or other hazardous areas.

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Original Research Article

Pattern of Fatal Injuries Sustained by Two-Wheeler Riders Due to Road Traffic Mishap in Agra Region

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Abstract

Introduction: Prospective autopsy-based study was conducted on two-wheeler riders who were victim of fatal road traffic accident (RTS), to find pattern of fatal injuries sustained by them & to know their relevant sociodemographic profile. **Material & methods:** 136 cases fulfilling the criteria are discussed in detail. **Results:** Majority of them (76.5%) were motorized two-wheeler riders. Male (91.2%) were more involved in fatal mishap. People between 21-30 years were most commonly effected (29.4%). Most victims receive multiple fatal injuries in various regions of body. Specially in head region (80.9%), followed by thorax region (28.7%). Head is most vulnerable region to receive fatal injuries and scalp laceration (66.9%) was commonest external injury on head. In thorax, rib fracture was commonest significant finding (27.2%), internally laceration of lung (18.4%) was commonest finding. In abdominal peritoneal hemorrhage was commonest sign (20.6%) and laceration of Liver was most common fatal injury (18.4%). **Conclusion:** Head is most vulnerable region to receive fatal injuries. Data can help to amend rules for safe commutation of two-wheeler riders and guide for swift management of injured.

1. Introduction

Accident is defined in dictionary as "An undesirable or unfortunate happening that occurs unintentionally and usually results in harm, injury, damage, or loss; casualty; mishap."[1] Road traffic accident (RTA) constitute major portion of fatal accident.

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According to institute national de la statuesque "A traffic accident is defined as an accident involving at least one vehicle on a road open to public traffic in which at least one person is injured or killed."[2] Global Status Report on Road Safety 2018 by World Health Organization states "Road traffic accident (RTA) causes death of 1.35 million commuters annually. Road traffic injuries has become leading cause of death of people in age group of 5-29 years. It is the 8th leading cause of death for all age groups. This burden is disproportionately borne more by pedestrians, cyclists and motorcyclists, particularly on those who are living in developing countries. Road traffic crashes cost most countries 3% of their gross domestic product."[3,4]

Report by Ministry of Road Transport & Highways, India, 2019 states "India ranks first in the number of road accident deaths across the 199 countries and accounts for almost 11% of the accident-related deaths in the World. It is nearly 20 times more than that reported in developed countries."[4,5] National Crime Record Bureau of India recorded 3, 54,796 RTA in India in 2020 causing 1, 33,201 deaths. In Uttar Pradesh, 28,653 road accidents caused 19,037 deaths and injuries to 15,982 persons.[6] Ministry of Road Transport & Highways, India, recorded 906 RTA in Agra region causing 514 deaths and injuring 633 people in 2020.[7] Report by US Department of Transportation states "motorcyclists are about 29 times more likely than passenger vehicle occupants to die in a motor vehicle crash and were 4 times more likely to be injured".[10] There is need to carry out studies which can highlight lacking areas which leads to fatal RTA, especially in case of two-wheeler, this can be achieved by corelating pattern of fatal injuries and socio-demographic profile of victim of fatal RTA.

2. Material & Methods

This prospective autopsy-based study was conducted in a tertiary level health care & medical education Institute in Agra region, between February 2012 to July 2013 after taking necessary permission. The aim of study was to know socio-demographic profile of victims of fatal RTA and to find out the pattern of fatal injuries inflicted on them by RTA. People who died due to road traffic mishap while commuting on two-wheeler and bought for postmortem examination at designated mortuary were included in the study. Cases with incomplete history, partially healed injuries or decomposed bodies were excluded from the study. Data was collected as per the preformed format. Information about socio-demographic profile of victims and conditions prevailing during fatal accident were noted from police inquest report. Details about the fatal injuries were collected from post mortem examination records. Identity of case (victim of RTA has not been disclosed). Data was statically analyzed by SPSS software.

3. Results

During the study period, a total of 450 cases due to fatal road traffic mishap were examined during autopsy. Out of which 136 (30.2%) cases (two-wheeler riders who die due to RTA) are included in present study. More than 3/4th of victims (104, 76.4%) were motorized two-wheeler (like motorcycle, scooter, moped etc.) riders, while about 1/4th (32, 23.5%) were pedal cyclist, as shown in **Table 1**. Male (124, 91.2%) were found to be affected much more than female (12, 8.8%) in fatal RTA. Majority of victims belong to the age-group of 21-30 years (40, 29.4%).

Table 1: Distribution of cases according to type of road user, gender and age.

S. No.	Type of road user	Male		Female		Total	
		Cases	%	Cases	%	cases	%
1	Occupant of motorized two-wheeler (motorcycle, scooter etc.)	94	69.1	10	7.35	104	76.5
2	Pedal Cyclists	30	22.1	2	1.5	32	23.5
Total cases		124	91.2	12	8.8	136	100

Maximum number of fatal mishaps (25, 18.4%) occurred during the evening rush hours i.e., between 6:00 PM to 8:59 PM. Fatalities were found to occur more on highways (80, 58.6%), followed by village road (24, 17.6%) and city road (22, 16.2%), as shown in **Table 2**. The most common highway involved was National Highway (NH) 19, followed by NH 3, 39, 44 and Yamuna express way. Most of the mishap (61, 44.9%), occur due to indulgent with heavy motor vehicles (buses, trucks, tripper etc.) followed by involvement with light motor vehicle like cars, jeeps, etc. (61, 44.9%), as shown **in Table 2**. Many cases receive multiple fatal injuries on various regions of body. Out of 136 cases, majority got fatal injuries in the head region (110, 80.9%) followed by thorax (39, 28.7%) and abdomen region (31, 22.8%), as shown in **Table 3**. Many cases have multiple fatal

injuries in head region. Laceration on the scalp (n=91, 66.9%) was found as most common significant injury or sign of dreaded internal injury, cases with skull fracture (including fissure fractures) were 70 (51.5%). Within cranial cavity focal hematoma in meningeal space were found as commonest significant injuries (92, 67.4%), out of which subdural hematomas (SDH) was most common (65, 47.8%), as shown in **Table 4**. Gross lesion in Brain parenchyma i.e., laceration or blood-filled ventricle, Trans-tentorial Herniation brain and lesion in brainstem lesion were found in 45 cases (33.1%) as shown in **Table 4**.

Table 2: Distribution of cases according to time, place and indulging vehicle or condition

S. No.	Time of accident (24-hour format)	No. of cases	%
1	00:00-02:59	7	5.1
2	03:00-05:59	12	8.8
3	06:00-08:59	17	12.5
4	09:00-11:59	23	16.9
5	12:00-14:59	18	13.2
6	15:00-17:59	20	14.7
7	18:00-20:59	25	18.4
8	21:00-23:59	14	10.3
Total		136	100
Place of accident			
S. No.	**Place of accident**	**No. of cases**	**%**
1	Highway	80	58.8
2	Village roads	24	17.6
3	City roads	22	16.2
4	Other place (drain/ canal/ farm/ undefined etc.)	10	7.4
Total		136	100
Offending agent/ Vehicle			
S. No.	**Offending agent/ Vehicle**	**No. of cases**	**%**
1	Heavy vehicles (trucks, buses etc.)	61	44.9
2	Light motor vehicle (Two-wheeler, cars, jeeps, etc.)	48	35.3
3	Others – fall in drainage, sewage, collision with stationary object like tree, wall, rock etc.	18	13.2
4	Unknown	9	6.6
Total		136	100

Table 3: Body region with sustained fatal injuries.

Body region	Cases	% Prevalence
Head (including face & neck)	110	80.9
Thorax	39	28.7
Abdomen (including pelvis)	31	22.8
Limb - crush or amputation	11	8.1

Table 4: Distribution of injuries in head (N=110)

Head region	Cases	% Prevalence out of 110 head injury cases	% Prevalence out of total 136 cases
Scalp laceration	91	82.7	66.9
Fracture of skull, face	70	63.6	51.5
Focal hematoma-	92	83.6	67.4
EDH	54	49.1	39.7
SDH	65	59.1	47.8
SAH	53	48.2	38.9
Gross lesion in Brain and brain stem	45	40.9	33.1

Table 5: Distribution of injuries in thorax region.

Thorax region	Cases	% Prevalence out of 39 thorax injury cases.	% Prevalence out of total 136 cases.
Fracture of ribs, sternum	37	94.9	27.2
Laceration of lung/ Hemothorax	25	64.1	18.4
Laceration/ contusion of Myocardium/ pericardial fluid	5	12.8	3.7

Table 6: Distribution of injuries in abdomen region.

Abdominal injuries	Cases	% Prevalence out of 31 thorax injury cases	% Prevalence out of total 136 cases.
Peritoneal hemorrhage	28	90.3	20.6
Laceration of Liver	25	80.6	18.4
Laceration of spleen	11	35.5	8.1
Laceration of kidney	7	22.6	5.1

Fatal injuries in thorax region were found in 39 (28.7%) victims. Rib fracture (37, 27.2%) was most common significant sign of fatal injuries in thorax, laceration of lung (25, 64.1%) was commonest fatal intrathoracic injury and hemothorax has been found almost common sign, as shown in **Table 5**. Fatal injuries in abdomen & pelvis region were noted in 31 (22.8%) cases. Peritoneal hemorrhage (28, 20.6%) was found to be as most common sign of significant injury. Laceration of liver (25, 80.6%) was most common intraabdominal fatal injury, as shown in **Table 6**.

4. Discussion

In million years of human history, first fatal road traffic accident occurs in1869[8] and within 150 years it become 8th most common cause of death.[3] Human have created one of largest pandemic for themselves. Exponential growth of population, rapid motorization, deficiency of road infrastructure, lacking proper driving skill and above all ignoring traffic law, leads to ever increasing road traffic mishap.[3, 9] During two-wheeler riding, minor disturbance, such as abrupt reduction of speed, damaged road, bump, pot hole, bad weather etc. can easily lead to disbalance & fall. On top of that two-wheeler lacks external structure, so riders are fully exposed and are more prone to get direct impact injuries from fall on road or other object (for e.g., heavier vehicles) which are at much different momentum, this cause severe injuries to two-wheeler rider at multiple anatomical sites.[4,11]

Out of total 450 victims of fatal road traffic mishap, 136(30.2%) were two-wheeler riders. Similar observations were noted in various studies. [12,13] Report by Ministry of Road Transport and Highways states that prevalence of two-wheeler in fatal total road traffic accidents varies between 10 to 30%.[12] Study by Sahu G, Choudhury JC, Mallick DK claimed that 24.6% victim of fatal RTA were two wheelers' riders.[13] Socio-demographic and injury profile of these 136 are discussed here. Out of 136 cases, majority (76.5%) were commuting on motorized two-wheeler and 23.5% were riding on pedal cyclist while they meet fate. This may due to the fact that motor cycle gains speed more rapidly and are much heavier than cycle, so many times they are difficult to balance/ control, especially when there is need of sudden decrease in speed. While pedal cycle remains at lower speed, so its rider has lesser chances to get severe injuries.

Majority of the cases belong to age group of 21-30 years (29.4%). Similar observations were noted in many other studies.[3,14-20] WHO`S Global Status Report on Road Safety 2018 states also states that Road traffic injuries are now the leading killer of people aged 5-29 years.[3] Study by Slater S, Subramaniyam S, Chandran R shows that majority (72, 30.9%) of victims belongs to group of 20 to 29 years of age.[14] This may be due to fact that, in this age group people are generally more active and indulged in career building & risk involving activities, which often induces for ruthless driving, also lack of financial buildup compels them to commute by low-cost vehicle like two-wheeler.

Majority of cases were male (91.2%) while only 8.8% female. Similar observation are mentioned in many other studies.[14,15, 21-23] Study by Slater S, Subramaniyam S, Chandran R, mentioned more that 93.1% victim of fatal two-wheeler RTA are male.[14] Study by K.Prasannan, P.A. Sheeju , mentioned majority (94.1%) were male.[15] Male have always been more exposed to RTA, as traditionally they have responsibilities of bread winning activities and have to perform more outdoor chores then female, often these activities, demand timely completion, stress, rash driving and thus increases chances of accident.[20-24]This ratio is even more disproportionate in case of two-wheeler, as in Indian females traditionally avoids / or have been denied to use two-wheeler.

In the present study, maximum number of accidents (18.42 %) were found to occur between 6 pm to 9 pm. Similar findings were also noted in many other studies.[14,19] Study by Slater S, Subramaniyam S, Chandran R stated that maximum number of accidents (39.2%) occurred between 6 pm to 12 am.[14] Study by Seethalakshmi M, Sudalaimuthu R, Mahendran J, Nagendrakumar observed that majority of accidents (39.5%) took place between 6 pm to 12 am.[19] This may be because it is one of peak traffic density time, people want to rush home after office in this time period. In the present study, majority of fatal accidents were found to occur on highway (58.8%). Study by Shruthi P, Varsha S observed found that majority (68%) of fatal two-wheeler accidents occur on National highways.[20] This may be due to fact that on highway provides opportunities of faster commutation, common city dwellers are not acclimatized to high-speed commutation and thus meets mishap.

In the present study, majority (44.9%) of mishap occur due to involvement of two wheeler with heavy vehicles (trucks, buses) either head-on collision, sideways or over run, this finding is in accordance with many other studies.[14,15] Study by Slater S, Subramaniyam S, Chandran R mention that majority(56.7%) of fatal accidents of two wheeler occur due to collisions with 4 wheeler.[14] Similarly Study by K.Prasannan, P.A. Sheeju found that majority of fatal two wheeler mishaps were caused due to involvement with Bus (21.5%), followed by Lorry (17%) and Tipper(11.1%). Combinedly heavy vehicles were involved in 49.6% of fatal two-wheeler

RTA.[15] In the present study, 80.8% of cases were found to have fatal injuries in their head & neck region. Blunt force injury in head region have been common cause of death in RTA. Similar pattern is found in many other studies too.[14, 15] Study by Slater S, Subramaniyam S, Chandran R state that 94.6% cases significant injuries in head region.[14] Study by K.Prasannan, P.A. Sheeju found that 70.23% drivers and 66.66% pillion riders of fatal two-wheeler mishap got fatal injuries in head region.[15]

Study by Piantini et al. found that majority of cases (55%) got significant injuries in head region. scalp contusions were found as most common external injury.[17] This may be due to fact that in case of two-wheeler ride, any disturbance in ride may lead to disbalance and fall of rider. Head is highest region of body, so on falling down it will strike ground/ object with higher momentum than other body part, also two-wheeler lacks external structure. Along with that, skull is non elastic structure so any external impact force will be transmitted intracranially with least dampening, thus cause greater damage. Any intracranial hemorrhage will lead to increase in intracranial pressure which will hamper blood flow causing further increase injury, oedema, ICT and vicious cycle of damage. [25] In the present study, laceration on scalp was found in 66.9%. It is one of the most common significant external injuries on head region (apart from other simple injuries like abrasion, contusion). Other researchers also noted similar finding.[14,15] Study by Slater S, Subramaniyam S, Chandran R shows that 75.1% cases got scalp laceration.[14] Study by K. Prasannan, P.A. Sheeju observed that laceration in head region were present in 29% driver & 23.5% pillion rider victim of RTA.[15]

In the present study, skull fractures fracture was found in 51.9 % cases. Similar observations were found other studies too.[14, 15] Study by Slater S shows that 63.5% cases got fracture in skull, out of which majority were fissure fracture of calvaria.[14] Study by K. Prasannan, P.A. Sheeju found fissure fracture in 32.59% of cases.[15] In the present study, focal hematoma around meningeal layer were found to be the most common significant of intracranial injury. Subdural hematoma (SDH) was found as most common type of focal hematoma- found in 47% cases, followed by Epidural hematoma (EDH) (39.7% cases) & Subarachnoid hematoma (SAH) (38.9%), Intra parenchymal hemorrhage were least common hemorrhage. Similar observations are mentioned in other studies too.15, 26, 27 Study by K.Prasannan, P.A. Sheeju found that focal brain injury were in 78.51% cases, SAH in 65 -67.87% of cases.15 Study by Sagar SMK states that combination of SDH and SAH accounted for 40% of cases.[26] Study by Amir A, Hoda MF, Khalil S, Kirmani S found intra cranial haemorrhage in 85.9% of cases, out of which SAH accounted for 55.8%.[27]

Many cases have multiple intracranial hematomata in different layers of meninges, sometimes laceration /tearing of meningeal lead to difficulty in differentiating/ isolating them. Meningeal hematoma (mostly SDH) occurs due to tearing of bridging veins by external blunt force injury. Superficial (Meningeal) hematoma can be readily managed with early diagnosis and its drainage with burr hole.[28] In the present study, 39 (28.7%) cases were found to have fatal injuries in thorax region, it is second most common inflicted region of body. Out of them, 27.2% got rib fracture, while 18.4%have laceration of lung with haemothorax. Similar findings were mentioned in other researches too.[11,15] Study by Sharma BR, Gupta N, Sharma AK, Sharma S found that with in thorax, rib fracture was present in 40.3% cases, sternum fracture in 3.73% cases, Haemothorax in 12.69% cases, Lung contusion/laceration in 9.7% cases Myocardial contusion/tear in 6.72% cases.[11] Study by K. Prasannan, P.A. Sheeju. found that among fatalities in two-wheeler occupants 51.19% driver and 43.13% rider of two-wheeler got fatal injuries in thorax, it is second most common region to receive fatal injuries.[15] The lungs occupy most of the thorax and thus more vulnerable to injury than heart. In present study 22.8% cases have fatal injuries in abdomen & pelvis region. Peritoneal hemorrhage 20.6% was most common sign of significant intraabdominal injury. Laceration of liver (18.4% cases) was found as most common fatal intra-abdominal injury, followed by lacerated spleen (8.1%) & kidney. Similar finding was stated by other authors also.[4,11]

Study by Gupta V et al found that abdominal injury was cause of death in 15.7% cases. They found that out of all abdominal injuries 27.8% got fatal injuries in Liver, 19.2% got fatal injuries in Spleen, 13.6% got fatal injuries in Kidney.[4] Study by Sharma BR, Gupta N, Sharma AK, Sharma S found that Liver laceration was present in 27.6% cases, spleen rupture 20.2 % cases, kidney rupture in 10.5% cases, Intestinal perforation in 4.5% cases Myocardial contusion/tear

in 6.72% cases.[11] Liver being the largest internal organ, lying anteriorly often receives blunt force trauma, along with-it organs lack elastic tissue which can control bleeding. The WHO mentions following new risk factors for vulnerability in road traffic accidents in 2021- socio economic status of countries, age, speeding with and without alcohol consumption, correct helmet use, distracted driving by mobile and hands-free usage, inadequate post-crash care, and inadequate traffic laws.[3]

5. Conclusion

Integrated efforts should be initiated from governmental, non-governmental organizations and society to check RTA. Data obtained can highlight loopholes in road safety. Often fatal deep intracranial focal hematoma presents with minor external head injuries like abrasion or contusion, leading to its omission. Prompt action should be taken by competent at local authority level bypassing long waiting.

6. Recommendations

- There should be more stringent rules & their implementation to ensure use of helmet by drivers and pillion riders.
- Government should restrict number of vehicles on road, by allowing only one four-wheeler per family especially in metro cities.
- Continuous monitoring with AI enabled surveillance camera, which can identify defaulter & automatic send notification or challan
- Teaching of road traffic law and rule in school, driving subject should be included in school level with temporary driving licensing facility (may be for without gear two-wheeler)
- Initial training via online/ virtual training modules.
- There should be compulsory special training for drivers of heavy & public transport vehicle (Truck, bus etc.) before allowing them on highway.
- Private and government institute should restrict entry/ exit of two-wheeler riders in their premises, who are riding without helmet.
- Separate path for two-wheeler or slow vehicles along highways.
- Establishing basic level health facility along road along with specialized ambulance equipped with critical care equipment.
- Basic level health care provider should be trained to identify obscured injuries/ head injuries in RTA, so that treatment can be started promptly in specialized ambulance and secondary hospital.

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Original Research Article

A Retrospective Study of Homicidal Deaths Autopsied at a Tertiary Care Centre in Maharashtra

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Key words
Homicide,
Sharp weapon,
Blunt weapon,
Autopsy,
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Abstract

Introduction: In the present age of urbanization and industrialization, homicidal crimes are inevitable part of all offences. Homicide is one of the leading causes of unnatural deaths. **Material and Methods:** This was a cross sectional, descriptive study that included all cases of death due to homicide during the period of May 2017 to May 2020, for which post-mortems were performed in the mortuary of the department. **Results:** The study of deaths due to homicide indicates male predominance. Maximum number of cases were in the age group of 20 to 29 years, followed by 30 to 39 years. Over all, the most common motive was revenge. Sharp edged weapon injuries were more common than blunt weapon. In majority of the cases death occurred on the spot or within first 24 hours and cause of death was head injury and haemorrhagic shock. **Conclusion:** Revenge, argument, financial disputes, infidelity, love affairs, poverty, easy accessibility to addictive substances and weapons of violent offences, poor temperament, unemployment etc, are some of the provocative circumstances for such type of violent offences and homicidal deaths. Nationwide registry for reporting of all homicidal cases should be maintained to plan necessary authorities' actions and to prevent homicides.

1. Introduction

Homicide is the most serious crime and is as old as the human civilization and reported as early as in Bible.[1] Homicide is defined as killing of one human by another human being.[2]

Killing of an individual is the highest level of aggression found in all the culture. Since ages, the most common motive for these killing has remained same viz., lust for money, women or land. To commit a murder, two elements: "Mens – rea", which means preplanning or afore thought, and "Actus-reus", which means the actual execution; should work together to constitute crime.

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The identification, resolution, and adjudication of homicide, a terrible crime against people, are crucial to the well-being of the entire community.[4] The data on homicide vary from nation to nation and area to region. Homicide trends may be a helpful indicator of the social stressors in a community and may also offer information that is relevant for law enforcement initiatives.[5]

The global data collection methods for homicides are operative in almost all the countries. The United Nations advises using homicide statistics in addition to survey-based data on violence to track progress towards reaching crime-related Sustainable Development Goals (UNODC 2019). The WHO uses a dataset on the causes of mortality to gather information on homicide from public health sources. The UNODC typically obtains its data from criminal justice sources, though in some nations it also uses public health data. The common methods of homicide that are reported throughout the world are stabbing, mechanical asphyxia, blunt head injury and shooting with firearm.[6]

In a study from AIIMS, New Delhi the data from 20 years were analyzed. There were a total of 1048 male and 323 female homicide cases. They found that the most frequent means of execution were blunt-force head injury, stabbing, gunshot wounds, strangulation, and head injuries, with the head, neck, and chest being the most often chosen target areas of the body. Defense injuries were observed to be present in 7.9% of cases, much more frequently in men, and most frequently in the form of active incised wounds.[7]Many previous studies have been done to evaluate the age and sex of the homicide victims, the pattern of injuries, motive behind the crime, time of death after assault etc.[8 - 11]The present study attempts to study and analyze pattern of homicidal deaths at a tertiary care centre in Maharashtra.

2. Materials and Methodology

This was a retrospective cross-sectional study conducted over a period of 3 years from May 2017 to May 2020. All the cases brought to the department of Forensic Medicine, for medicolegal autopsy, either confirmed or later registered as homicide by investigating officer, were considered for the study. The cases subjected for autopsy with alleged or suspected history of homicide but which were later registered as non-homicidal, based on the autopsy findings, circumstantial evidence and investigation by the police, were excluded. Total data of 260 homicidal deaths cases was collected for the study purpose from post-mortem findings, police, requisition papers, hospital case papers and information furnished by family members and accompanying relatives. Study was approved by ethical committee of the institute. Data was collected using a pretested study proforma, and collected data was entered in Microsoft Excel 2013. Data is presented in frequencies and percentages. Chi square test was used for association using Epi-Info software version 7.2.1. Statistical significance was considered at $p < 0.05$ at 95% confidence interval.

3. Observations and Results

There were 260 cases of deaths due to homicide during the period May 2017 to May 2020. The results are analyzed and tabulated as frequency and percentage in following tables and graphs. In the present study the victims of homicidal deaths had male preponderance 169 (65%) compared to females 91 (35%) (**Figure no. 1**).

Fig No. 1: Gender distribution of Homicide victims

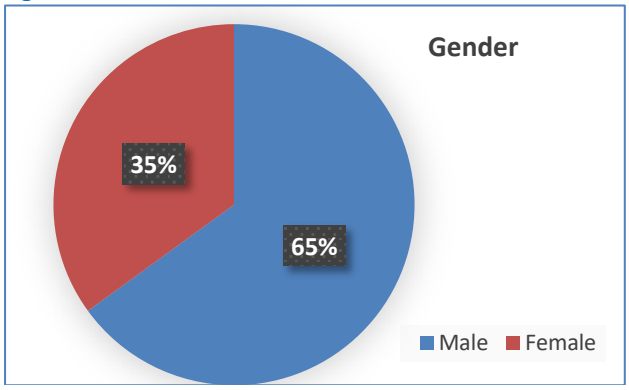


Table No.1: Age wise distribution of Homicidal cases

Age (yrs)	Frequency	Percent
0 to 9	4	1.53%
10 to 19	25	9.61%
20 to 29	104	40%
30 to 39	77	29.6%
40 to 49	25	9.61%
50 to 59	23	8.84%
60 & above	02	0.76%
Total	260	100%

Maximum number of cases was seen in the age group of 20-29 years (40%), then 30 to 39 years (29%) followed by 10 -19 years (6.7%), most less (60 & above). The mean age of the homicide victims was 26.54 ± 12.14 years (**Table no. 1**). The most common motive was revenge (31.3%), followed by argument

(14.9%), financial conflicts (11.8%) and 15% cases reported other reasons (Table no. 2).

Table No.3: Distribution of cases according to pattern of Homicide

Pattern of Homicide	Frequency	Percent
Sharp weapon injuries	116	44.5%
Blunt weapon injuries	75	28.9%
Sharp and Blunt weapon injuries	52	20%
Asphyxial deaths	6	2.2%
Thermal Burns	9	3.4%
Poisoning	2	1%

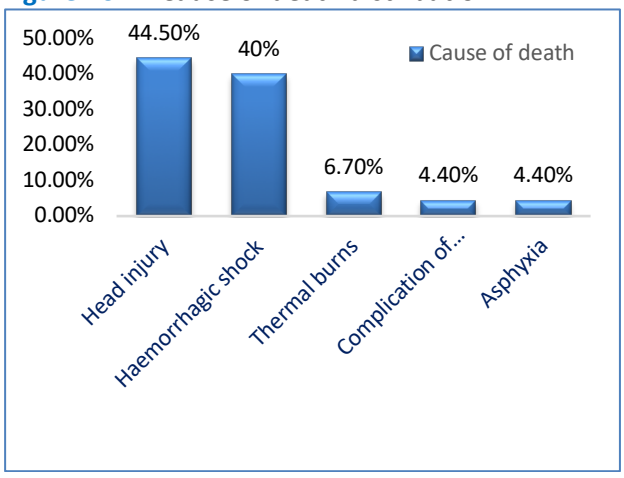
Sharp weapon was the most common used 44.5% and then followed by blunt weapon28.9%, combined sharp and blunt weapon 20%, Asphyxia 2.2%, thermal burn death shows 1% (Table no. 3).

Table No.4: Period of survival

Period of survival	Frequency	Percent
Spot Death / less than ½ hour	143	55%
½ hour to 1 day	66	25.2%
1 day to 7 days	33	13%
More than 7 days	18	6.8%

In this study, death occurred on spot in 55% cases and within first 24 hours in 25.2% cases, followed by 1 to 7 days (13 %). 18 cases had deaths after admission in hospital and from consequences of the injuries after 7 days of crime (6.8%) (Table no. 4).

Figure no. 2: Cause of death distribution



Cause of death was due to head injury in 116 (44.5%) cases, followed by haemorrhagic shock in 105 (40%) cases, thermal burns in 17(6.7%) cases, complication of injury and asphyxia in 11 cases each (4.4%) (Figure no. 2).

In all the homicidal cases the percentage of use of sharp weapon is highest of 44.5%, followed by blunt weapon is 28.9%. In males it is more common than in the females. Asphyxia death and poisoning is equal in both sexes. Homicidal burn is more in females than in males. No any significant difference was seen in the male and female sex and method of homicide. (p=0.456) (Table no. 5).

Table No.5: Showing number of cases in relation to sex and method of homicide

Type of trauma	Cases	Percentage	Male	Female
Sharp weapon	116	44.5%	71	45
Blunt weapon	75	28.9%	40	35
Sharp + Blunt weapon	52	20%	25	27
Asphyxial deaths	6	2.2%	3	3
Burns	9	3.4%	3	6
Poisoning	2	1%	1	1
Total	260	100	142	118
				$X^2 = 4.68$, p = 0.456*

4. Discussion

In the present study, cases of homicide constituted 5% of the total autopsy cases. Majority of victims were male (65%) male to female ratio near about 2:1 and the commonly affected age group of victims was 20 to 29 year (40%), followed by 30 to 39 year (29.6%) which matches with previous studies such as S Jhaveri et al [12], K Zanzrukiya et al.[13] The high incidence of cases of males may be because of outside activities, aggressive physical activities and risk-taking behavior and also reason of age group 20 to 29 years of being victim of homicide may be due to person in this age group are more aggressive, short tempered with minimal tolerant.

In most of the cases of homicide, the motive was revenge (31.3%) followed by argument and others (15.6%) which include marital discord, socioeconomic stress, sexual jealousy etc. Similar observations were also made by Hugar[14] in his study wherein the main native was revenge (26.55 %), followed by others.

Use of sharp weapon (44.5%) for homicide was more common followed by blunt weapon (28.9%). This observation is similar to study of Hugar B S, et al.[14] Though it contraindicates with the studies of Gambhir O et al. [15] and Patel D J et al.[16] Modi[17] quoted that in India most of the scalp injuries are generally produced by hard and blunt weapons/objects. Combined sharp and blunt weapon (20%), Asphyxia (2.2%) and burns (3.4%) injuries like these could be due to unpremeditated aggressive/explosive response. Similar findings were

seen by Parmar DJ et al.[18] wherein sharp weapon injuries were common, but in contrast study conducted by Rastogi AK et al blunt injuries were common these variations may be due to the local availability and cultural differences of choice of weapons in various states and communities.

The death occurred on spot (55%) or within 24 hour (25.2) and the most common cause of death was head injury (44.5%) followed by hemorrhagic shock (40%). These findings are in contrast with Hugar BS et al.[14] and ParmarDJ et al[18] as they reported most common cause of death is haemorrhagic shock. Asphyxial deaths were observed in 4.4% cases which contradicts with the findings of M.I. Sheikh[20], P.Prajapati et al[21], and J.Shah et al.[22] These could be due to lethality of the weapons which are used. Bhupinder S et al[5] observed that the majority (37%) of the homicidal victims were in the 20-39 years age group. The male: female ratio was 3:1. The majority of deaths were caused by blunt instruments (46%), followed by stab/slash wounds (25%) and asphyxiation (12%).

The incidence of asphyxia deaths was nearly constant in both sexes. Organ chlorine insecticide Endosulphan (Thiodane) was chemically detected in an alleged case of homicidal female poisoning in our study.

5. Conclusion

Homicide is vast varied and intricate topic, yet retrospective analysis of autopsied homicide victims is a tangible attempt to break the shell by exploring certain physical aspects of injuries of homicide. Most common type of weapon used for the offence was sharp edged and pointed ended weapon but mere manual force was also used in significant number of cases. Most common method for homicide was producing mechanical injuries mainly by sharp cutting weapon. The pattern of homicidal deaths revealed from this study showed a high incidence in male. The maximum numbers of cases in the 20 to 29 years group and the common motive were revenge. In majority of cases sharp weapon injuries were commoner compared to blunt weapon and death was due to head injury and haemorrhagic shock.

In the present modern age of industrialization, urbanization, homicides are becoming inevitable part of all offences. Revenge, argument, financial disputes, infidelity, love affairs, poverty, stress, poor socioeconomic status, easy accessibility of addictive substances and weapons of violent offences, poor temperament, unemployment, and substance abuse etc. are some of the provocative offences. Two cases of alleged poisoning were found. Also, a suggestion for future studies is that multicentered studies should be done regularly to have a more specific accurate scenario of trends of homicidal crimes in a state or nation. To curb the menace of homicide, state and society should ensure education, employment and socioeconomic wellbeing along with strict law enforcement. But authors feel that murder is an act of moment in mind so any decision made under excitement or incitement is the real culprit. Therefore, we would like to wrap up this by suggesting to improving once ability to think over any problem with a balanced and reasonable tolerance. Nationwide registry for reporting of all homicidal cases should be maintained to plan necessary authorities' actions and to prevent homicides.

National guidelines for homicide prevention should be made by analyzing this data, state and district wise customizations should be done. Police and other law enforcement agencies should follow these guidelines to prevent homicides.

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Original Research Article

A Retrospective Study of Road Traffic Accident Cases Brought For Medico-Legal Autopsy at a Tertiary Care Hospital In Meghalaya.

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Key words
Road traffic accidents,
Two-wheelers,
Head Injury,
Fatal injuries.

Abstract

Introduction: India tops the global list of deaths due to Road Traffic Accidents (RTA). Meghalaya, in the north-eastern part of the country, has its own unique climate and geographical landscape. The present study is important in this area because the rugged terrain and unpredictable weather conditions are safety concerns for driving. **Materials and methods**: This was a retrospective observational study utilising data from hospital records to include all the cases of RTA from Jan 2017- Dec 2021 that were subjected to medico-legal autopsy at the institute mortuary (consecutive sampling). Data were entered in MS Excel sheet and analysed using SPSS Version 21 by descriptive statistics. **Results:** A total of 114 cases were included in the analysis. The commonest vehicle involved was the two-wheeler. Most victims belonged to the age group 21-40 years, involving males in 84% of cases. Head injury was the most common cause of death. In 45% of cases, accidents occurred during winter season. 32.46% of accidents took place at night. **Discussion:** Road Traffic Accidents lead to unwanted and untimely death. This study generates valuable data regarding fatal injuries and specific factors responsible for RTA in our region which would aid administrators in formulating road traffic policies and introducing preventive measures to reduce their occurrence.

1. Introduction

Death due to road traffic accidents (RTA) has become a world crisis. Every year, approximately 1.3 million people die due to RTA worldwide making it the 4thleading cause of death. India holds the top most position in the global list when it comes to death due to traffic accidents. Along with modernisation, motorisation has eased our lives but we can't discard the fact that this benefit has also cost lots of lives simultaneously. Hardly a single day goes without reporting road traffic accidents in the casualties.

According to the data from International Road Federation "previously China topped India in Road Traffic Accidents (RTA) but now China has taken hold of the situation"[1], whereas in India the situation is getting worse day by day.

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According to Ministry of Road Transport and Highways, "the number of RTA cases in the year 2019 was 449,002 and number of deaths accounted to 151,113.In the year 2020, death due to road traffic accident is claimed to be around 1.32 lakh lives which is the lowest in last 11 years and the reason for this is considered to be lockdown due to Covid-19.[2]So, if we see, the scenario as a whole remains the same. Death due to road traffic accidents accounts for the most amongst all autopsies conducted at our institute mortuary. The study is important in this area because the rugged terrain and unpredictable weather conditions affect an individual's ability to drive and negotiate safely under such circumstances.

Aims and Objectives

1. To find out the pattern of fatal injuries due to RTA
2. To find out the specific factors responsible for RTA in this geographical area
3. To recommend preventive measures that can reduce road traffic accidents in this geographical area

2. Materials and Methods

This was a retrospective observational study utilising data from hospital records to include all the cases of road traffic accidents from Jan 2017-Dec 2021 that were subjected to medico-legal autopsy at the institute mortuary (consecutive sampling). The records were examined in the Department of Forensic Medicine and a pre-designed proforma prepared for data collection. Data extracted were then entered in MS Excel sheet and analysis was performed using SPSS Version 21 by descriptive statistics. Coded ID numbers were assigned for each of the cases for anonymity. Results were expressed in frequency (n) and percentage (%).

Ethical considerations:

Ethics committee approval was obtained for the study from the Institutional Ethics Committee (IEC) on 13th Dec 2021; reference no. NEIGR/IEC/M1/F7/2021.

3. Results

A total of 269 medico-legal autopsies were conducted during the study period out of which114 (42%) were attributed to RTA. Of the 114 cases, males accounted for 96 cases and females accounted for 18 cases which is 84% and 16% respectively and it is observed that male is to female ratio is 5:1. The age wise distribution of the victims of road traffic accident in this geographical area (**Figure 1**) reveals that the age group from 0-10 years comprised 1.76%, 11-20 years consisted of 17.54%, 21-30 years comprised 28.07%, 31-40 years accounted for 27.19%, 41-50 years consisted of 14.04%, 51-60 years consisted of 6.14%, 61-70 years comprised 2.63%and 71-80 years consisted of 1.76%. Hence, in our study most common age group was found to be 21-40 years of age that accounted for 45.26% of the total RTA cases.

Fig 1: Age wise distribution of victims (*n=114*)

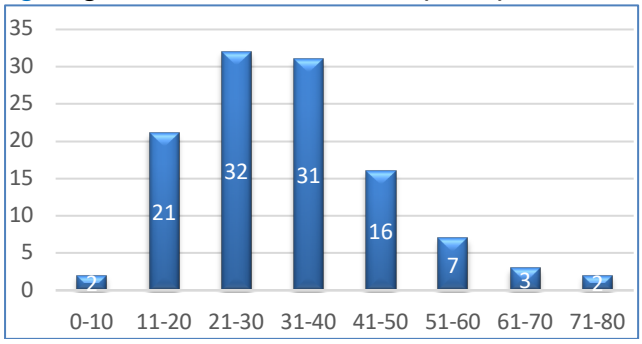

Fig 2: Anatomical location of injuries in victims (*n=114*)

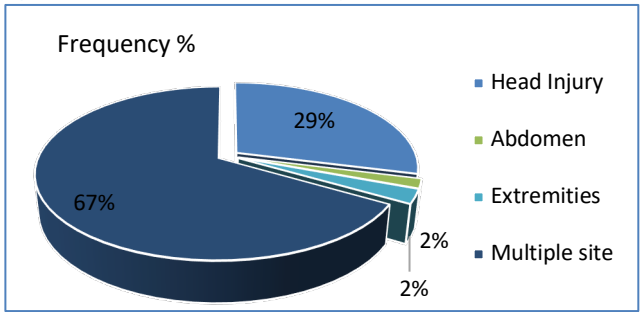

Table 1: Cause of death (*n=114*)

Cause of death	Cases	Percentage (%)
Head injury	83	72.81%
Haemorrhagic shock	22	19.30%
Septicaemia	4	3.51%
Aspiration pneumonia	3	2.63%
Peritonitis	2	1.75%

Table 2: Victims as per Seasonal Variation (*n=114*)

Climate	Frequency (n)	Percentage (%)
Winter	52	45%
Spring	17	15%
Monsoon	33	29%
Autumn	12	11%

As per anatomical location involved (**Figure 2**), most of the fatalities had multiple injuries that accounted for 66.67%, followed by head injury alone that comprised 28.95%. Abdominal injury and injury of extremities accounted for 2.63% and 1.75% respectively. It is seen that the most common cause of death was due to head injury that accounted for 72.81%. This was followed by haemorrhagic shock which was 19.30%. Other non-specific causes like

septicaemia, aspiration pneumonia, and peritonitis accounted for 3.51%, 2.63% and 1.75% respectively which is seen in case of patients who were admitted and survived for prolonged period following RTA but finally succumbed to injuries (**Table 1**). Unlike other studies winter was the most common time of year that witnessed 45% of RTA (**Table 2**) followed by monsoon which accounted for 29% of the total cases. Most of the crashes took place between 4.00 pm - 12.00 am and night time accounted for 47% of all the cases (**Table 3**).

Table 3: Victims as per time of occurrence (*n=-114*)

Time of occurrence	Frequency (n)	Percentage (%)
12.00AM-8.00AM	17	14.91%
8.00AM-4.00PM	31	27.19%
4.00PM-12.00AM	37	32.46%
Not known	29	25.44%

Table 4: Offending vehicles at time of accidents (*n=114*)

Types of vehicles involved	Frequency (n)	Percentage (%)
Two-wheeler motor vehicle	46	40.35%
Four-wheeler motor light vehicle	20	17.54%
Four-wheeler heavy motor vehicle	19	16.67%
Bicycle	3	2.63%
Auto rickshaw	3	2.63%
Unknown	23	20.18%

Unknown timings accounted for25.44% that indicates “hit and run cases”. Two-wheeler motor vehicles were the most common vehicle (40.35%) involved in the accident followed by four-wheeler vehicle that accounted for 34.21%. Bicycle and auto rickshaw occupants comprised 2.63% each. Unknown 20.18% again indicates ‘hit and run case’ **Table 4**). Out of 114 cases, 25 victims were pedestrians that accounted for 22% of the cases.

4. Discussion

Road Traffic Accidents lead to unwanted and untimely death. There are multiple factors that are responsible for RTA in this geographical area of India. Two-wheelers were the commonest vehicle involved in the accidents. This may be correlated with the fact that these are light vehicles and are usually moved with high speed, simultaneously the extreme weather in this terrain also acts as add on factor. Similar findings were revealed by Singh et al and Pathak SM et al in their studies.[3,4] Most of the victims belonged to the age group 21-40 years, similar results were found in studies conducted by Pathak SM et.al in Pune (AFMC) [3] and Reddy NB at Bangalore.[5] National Crime Records Bureau, Delhi has also mentioned that most of the victims of RTA are from the age group 15-44 years of age. Vollrath M et al in his study in Germany have mentioned higher incidence of RTA amongst young drivers as compared to the older drivers.[6] Hadaye RS et al in their studies have mentioned that “males drive the vehicle more often and show more risk taking behaviours than females”.[7]

Pathak SM et al also found in their study that “males are affected 5.7 times more than females” and he stated the reason of this as “males being more active outdoors”.[3] In contrast to this, Meghalaya being a matrilineal society, females are equally active in outdoor activities, hence driving being one of the convenient means of communication, but still male predominance in RTA is seen in 84% of cases with a ratio of 5:1 and it is at par with other studies.[1,3] In our study most of the fatalities had multiple injuries and head injury was the most common cause of death that may be related with the fact that most two-wheeler drivers are reluctant to use helmet. The studies of Jalilian MM et al also revealed that only “50% of two-wheeler victims had used helmet”.[8]

Unlike other studies, where monsoon was held responsible for most of the accidents,[1,3,7] in our study winter witnessed 45% of accidents. This may be correlated with the climate of this geographical area. As winter is very foggy, one of the major causes of accidents in this area could possibly be due to impaired visibility to drive and negotiate a vehicle safely under the circumstances. Around 47% of the crashes took place in the night hours with peak time between 4pm-12 midnight. Similar results were revealed in the studies of Hadaye RS et al and Kiran et al.[7] This can help us to summarise that evening and early night hours are the busiest whereas the drivers are reluctant in late night. Singh SK in his study also concluded that “road accidents are relatively higher in extreme weather and working hours”.[4] Pedestrians contributing to 22% of RTA in our study reflects the lack of traffic knowledge and display reckless driving. Ameratunga S et al also concluded in their study that the pedestrians form the most vulnerable group of RTA.[9]

Most of the RTA are recorded in the National Highways NH44 and NH40 in this region. Although the scenic beauty and landscape of this region are incomparable, the rugged terrain is equally

dangerous, especially in winters when it is too foggy. Sugandhi DS et al in their study also concluded that "most of the traffic accidents that are fatal occurs in NH" (National Highway). [10]

RTA is a major cause of death in the younger age groups and creates an extra burden on the health system, especially in a developing country like ours where the government can only allocate 2-3% of its GDP on the health system and is still considered as infant in comparison to the western countries.

5. Conclusion

Our study revealed that head injury is the leading cause of death in road traffic accidents in this geographical region. Majority of accidents occurred in winter and during night hours. Therefore, it is recommended that preventive measures be followed through strict implementation of traffic rules, compulsory wearing of helmets, using of fog lights in winter, cautious driving during night journeys, and creating awareness about traffic rules in the community. These measures would go a long way in decreasing the accident rate and promote a culture of safety in our roads and highways.

Limitation of the study

As this was a retrospective study based on hospital records, we could not determine other relevant socio-demographic factors like alcohol consumption, over speeding of vehicles, overtaking while driving, using of safety measures, etc. However, no smell of alcohol was present as per the autopsy report for the cases that were done.

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

Contributor ship of Author: All authors equally contributed.

Conflict of interest: None to declare.

Source of funding: None to declare.

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Original Research Article

A Histopathological Spectrum of Granulomatous Skin Lesions in a Tertiary Health Centre in Western Maharashtra

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Leprosy,
Spectrum.

Abstract

Background: Granulomatous disorders remain to be a major cause of morbidity and mortality amongst samples received in the histopathology department of a tertiary health center. Natural causes of deaths have certain medicolegal concerns in various sudden deaths. The present study was undertaken to assess the histopathological spectrum of various skin conditions that were characterized by a granulomatous reaction pattern on histopathology**. Material and Method:** A Total of 120 patients who presented with clinical features suggestive of granulomatous disorder of the skin, were enrolled during a period of one year prospectively were included in this study. **Statistical analysis and Results:** The mean age of patients was 38.09 years with male predominance (61.7%). 93.3% of cases within the state of Maharashtra. 68(59.16%) cases belong Kuppuswamy class 4. Infectious causes (78.07%) outnumbered non-infectious causes (21.93%). Among infections, leprosy (58.29%; 67 cases) and cutaneous Tuberculosis (14.2%; 17 cases) while among non-infectious causes, erythema nodosum (8.3%) was most common. **Conclusion:** The present study highlights the importance of the histopathological spectrum in arriving at a final diagnosis in cases of granulomatous disorders of the skin. Certain medicolegal concerns can be settled in better way with confirmation of natural causes of deaths.

1. Introduction

A granuloma is defined as a localized aggregation of inflammatory cells such as macrophages, epithelioid cells, giant cells, eosinophils, lymphocytes, plasma cells, etc. with connective tissue and blood vessels, and may contain ingested foreign material or pathogens.[1] Because of the focal and well-defined nature of this reaction, it is called a granuloma (Granul = granule or grain; oma = tumor).[2]

Depending on the pathophysiological stage at which the biopsy is taken, a granuloma can appear ill-defined or well- defined. However, granuloma formation can take place in any tissue depending on the site of the triggering agent, and

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immune mechanism activated by it. Formation of a granuloma begins primarily as an attempt by the body's immune system, to isolate any substance it recognizes as 'foreign' or 'non-self' and is unable to destroy as a whole (a poorly or partially soluble antigen). This process is termed as a granulomatous reaction.[3] It is a type IV Coombs and Gell hypersensitivity reaction.[4]

The cutaneous manifestations of the granuloma are polymorphic, and these dermatoses are diagnosed with a combination of a high index of suspicion based on presenting features and findings on histopathology. In many cases, the clinical or histopathological features do not align, and in such cases, additional investigations may be done. The final diagnosis in most cases, is always a product of histopathological correlation.[5] Hence the present study aims to document the varied presentations of these granulomatous skin lesion, to histological spectrum correlating the presenting skin lesions with their histopathology in order to arrive at the final diagnosis.

2. Materials and Methods:

After obtaining Institutional Ethical Committee approval, this open, prospective, hospital–based, cross-sectional study was conducted in 120 patients having granulomatous skin lesion sample were received in the Department of Pathology of a tertiary health center. All these included patients with skin lesions clinically diagnosed as granulomatous and suffering from tuberculosis, leprosy, sarcoidosis, syphilis, sporotrichosis, chromoblastomycosis, blastomycosis, histoplasmosis, mycetoma, leishmaniasis, atypical mycobacterial infections, botryomycosis, cat scratch disease, lymphogranuloma venereum, malakoplakia, pyoderma gangrenosum, halogenodermas, xanthogranulomas, granuloma annulare, necrobiosis lipoidica, rheumatoid nodule, vasculitis such as Wegener's granulomatosis, Churg-Strauss syndrome, Erythema Induratum, Erythema Nodosum, Takayasu disease, foreign body reactions, granulomatous mycosis fungoides and co-incidental detection of granulomatous reaction on histopathology (in patients who had come to seek advice for some other cutaneous problem).

A detailed history was taken, and sociodemographic data included education and occupations of head of the family, total monthly income of the family, Kuppuswamy`s socio-economic status scale 2021 were noted. Special staining techniques for histopathology were used in relevant cases, if required. For Fite-Faraco staining of tissue sections, sections were deparaffinized with two changes of 12 min each of xylene-peanut oil and stained in carbol fuchsin stain for 30 min, washed in running tap water, decolorized by 5% H_2SO_4 differentiated in 25% ethanol followed by washing again under running tap water. Slides were counterstained with Harris hematoxylin for 3 min. Excess hematoxylin was washed off, blotted, and kept for a few minutes for air dry and finally mounted with DPX (Dibutyl phthalate Polystyrene Xylene). Data recorded in the case record format and obtained via department records was organized in a master chart and was correlated with skin biopsy findings.

Data collected were, final diagnosis after histopathological correlation, proportion of cases where histopathological findings showed a positive correlation and uncommon presentation/ findings, if any were mentioned accordingly. At the end of the study, an analysis was done as to how many histopathologically diagnoses showed the histological features as mentioned in literature, and in how many, histological spectrum was essential in reaching a conclusive diagnosis.

3. Results and Observations:

Total 120 patient's samples were received during the study period. Most of the cases were in the age group of 18-64 years (93.96%) with mean age of 38.09 years and a male predominance (61.7%). Majority i.e., 68 (59.16%) cases belonged to the Kuppuswamy class 4 and 93.3% cases were from within the state of Maharashtra region.

Multiple complaints in a single case have been counted separately. As per our data, (59.62%) 68 cases had raised lesions, being the most common presenting complaint, followed by ulcers (18.42%), white spots (17.52%), swelling (15.78%) loss of sensation (12.28%), and discharge (purulent) (10.52%). Patients most commonly complained of lesions on upper limbs (59.2%), followed by lower limbs (28.3%), and face (0.8%). Exactly 66.9% cases had an insidious onset of lesions and remaining 34.41% reporting sudden onset of lesions. Gradual progressive lesion found in 76.7%, rapidly progressive in 18.3% and non-progressive (5.0%).

Number of infectious causes (78.07%) outnumbered the non-infectious causes (21.93%). Amongst infections, the commonest was leprosy

(58.29% - 67 cases), followed by cutaneous TB (14.2% - 17cases)

Hansen's disease (leprosy):

Out of 120 cases, 66 were clinically diagnosed to have Leprosy. Further this diagnosis was confirmed using SSS and Fite-Faraco staining in all cases. Using SSS sensitivity, specificity, positive predictive value, negative predictive value and accuracy were 48.48%, 100.0%, 100.0%, 66.0% and 74.24% respectively. Whereas using Fite-Faraco staining sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were 22.58%, 100.0%, 100.0%, 59.32% and 63.64% respectively.

Histopathological features in Leprosy:

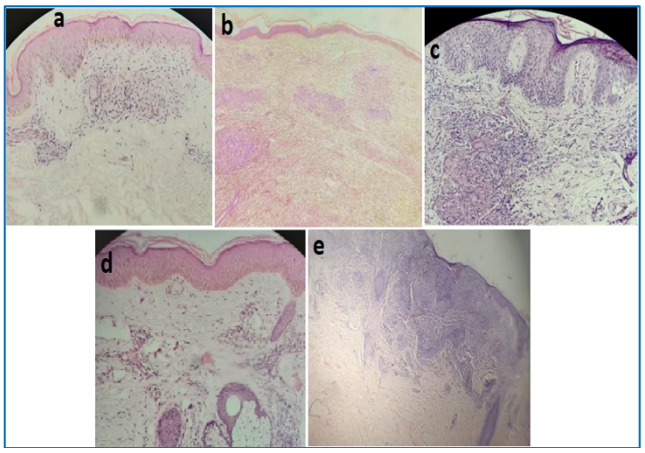
Overall, the most consistent epidermal feature was flattening or loss of rete ridges 42.42%), followed by hyperkeratosis (27.28%), unremarkable epidermal changes (22.3%), and increased basal layer pigment (13.28%). The least consistent features were acanthosis, orthokeratosis, and follicular plugging, each seen in only 3.3% of cases. Acanthosis was appreciated in only Pure Neuritic cases. In the dermis, the most consistent feature overall was a perivascular/ periadnexal / perineural inflammatory infiltrate, seen in 86.3% cases, the cellular components of which (in decreasing order of frequency), were lymphocytes (68.3%), macrophages (25.0%), foamy histiocytes (37.5%), epithelioid cells (13.3%), neutrophils (43.3%), Langhans giant cells (37.5%), and eosinophils (3.1%). Grenz zone was appreciated in only 1 case of type 1 reaction. Majority of biopsies showed unremarkable changes in the subcutaneous tissue.

Histopathological spectrum of Leprosy:

Histopathological spectrum was indispensable for the final diagnosis of Leprosy, and classification into its subtypes. The degree of agreement of histopathological diagnosis was maximum in Histoid and pure Neuritic Hansen's (50%), followed by type 2 reactions, Borderline Tuberculoid Hansen's (BTH), and Borderline Lepromatous Hansen's (BLH). Overall, the strength of histopathological spectrum in this study was found to be 76.754%. This is much higher than the strength of diagnosis after only histopathological examination (only 40.90% cases detected). All cases had Leprosy as a provisional diagnosis,

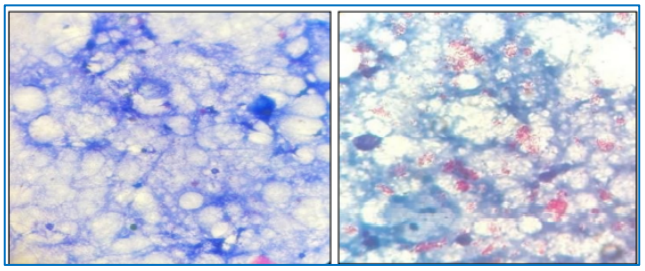
Borderline Lepromatous Hansen's- Microscopy showed a thin Grenz zone with diffuse inflammatory infiltrate and foamy macrophages [**Figure 1(a)**]; Histopathological findings of **Lepromatous Leprosy** showed diffuse lymphocytic infiltration with foamy macrophages with several ill-formed granulomas in mid-dermis [**Figure 1(b)**]; Histopathological findings of **Tuberculoid Hansen's** showed sparse perivascular and periadnexal inflammatory infiltrate comprised of epithelioid cells, lymphocytes and occasional giant cells [**Figure 1(c)**]; Histopathological findings of **Erythema Nodosum Leprosum** showed diffuse and focal granulomatous infiltrate with foam cells and a dense lobular and septal panniculitis [**Figure 1(d)**]; Histopathological findings of **Histoid leprosy** showed upper and mid-dermal granulomas with dermal oedema [**Figure 1(e)**].

Figure 1 (a-e): Histopathological findings of Lepromatous Leprosy



Slit skin smear shown in **figure 2(a)** in a case of BTH with a bacillary index of 2+, compared to **Figure 2(b)** (right), showing a bacillary index of 5+ in a case of LL Hansen's. Abundant acid-fast bacilli with globi or cigar-bundle appearance can be seen in **Fig.2(b)**- signifying a high bacillary load. Modified ZN stain, 40x.

Figure 2 (a-b): Histopathological findings of Borderline tuberculoid Hansen's disease.



Cutaneous tuberculosis:

Cutaneous TB was found more likely to present as a single lesion (63.636%), and in case of multiple lesions, monomorphic (81.818%). A strong association was found to exist between the

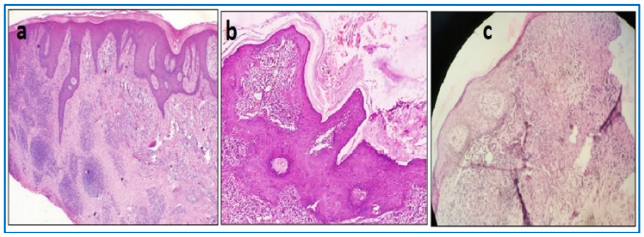
occurrence of cutaneous TB and active/past Tuberculosis or a close contact with Tuberculosis (54.545% cases). Clinical presentations of cutaneous Tuberculosis (TB): The most common skin lesion was a plaque (63.636%), followed by scars (36.364%), ulcers (36.364%). Scarring was a feature seen in both Scrofuloderma and Lupus Vulgaris but absent in TBVC. Lupus vulgaris had the most variable lesions, showing papules, plaques, nodules, ulcers, and scarring. The commonest site of involvement was extremities (54.545%), Lips (1.7%) and face (0.8%) (in decreasing order of frequency).

Histopathology features of cutaneous TB:

In the epidermis, the commonest feature seen was hyperkeratosis (81.818%), followed by acanthosis (54.54%) while dermal features in order of decreasing frequency were an inflammatory infiltrate (100%) (which comprised of lymphocytes (100%), neutrophils (100%), and epithelioid cells forming granulomas (90.909%)

On histopathology, the epidermis was unremarkable, but the dermis showed perivascular and periadnexal lymphoplasmacytic inflammatory infiltrate, areas of haemorrhage and haemosiderin-laden macrophages with extracellular brown pigment. However, there was a strongly positive correlation between clinical and histopathological features in both cases of Scrofuloderma, 100% agreement between clinical and histopathological diagnosis. Histopathological findings of **Lupus vulgaris** showed acanthosis with diffuse mixed inflammatory infiltrate [Figure 3(a)]; Histopathological findings of **Tuberculosis Verrucosa Cutis** showed pseudoepitheliomatous hyperplasia and mixed inflammatory infiltrate with extravasation of RBCs [**Figure 3(b)**]; Histopathological findings of **Scrofulderma** showed dense inflammatory infiltrate with acanthosis, areas of caseation necrosis and dilatation of blood vessels [**Figure 3(c)].**

Figure 3 (a-c): Histopathological findings of Lupus vulgaris



Non-infectious granulomatous disorders of the skin:

The commonest clinical lesion was a papule (56%), followed by plaque (52%), nodule (32%), and the least common lesion was a sinus (4%). On histopathology, the commonest epidermal features were hyperkeratosis (52%) followed by acanthosis (48%). In the dermis, a mixed inflammatory infiltrate was most commonly seen (84%) which showed lymphocytes (84%), plasma cells (32%), neutrophils (20%), eosinophils (20%) and histiocytes (32%) in varying proportions

Histopathological findings of **Cutaneous Malakoplakia** showed epidermal breach (focal ulceration) with areas of hyperkeratosis, and a dermal inflammatory infiltrate of neutrophils, lymphocytes, dilated blood vessels [**Figure 4(a)**]; Histopathological findings of **Pyoderma Gangrenosum** showed ulcerated epidermis with mixed inflammatory infiltrate, no granulomas were seen [**Figure 4(b)**]; Histopathological findings of **Granuloma Annulare** showed hyperkeratosis and Hypergranulosis, with a lymphohistiocytic infiltrate in the dermis, and areas of mucin deposition [**Figure 4(c)**]; Histopathological findings of **Granulomatous Cheilitis** showed multiple well-formed epithelioid cells granulomas with lymphocytic inflammatory infiltrate [**Figure 4(d)**]; Histopathological findings of **Tattoo Granuloma** showed mounds of hyperkeratosis with mixed inflammatory infiltrate in upper dermis [**Figure 4(e)**]; Histopathological findings of **Erythema Nodosum** showed dense lymphocytic inflammatory infiltrate in the dermis and subcutaneous tissue [**Figure 4(f)**]; Histopathological findings of **Hidradenitis Suppurative** showed periadnexal lymphocytic inflammatory infiltrate [**Figure 4(g)**]; Histopathological findings of **Wegeren's Granulomatosis** showed mixed inflammatory infiltrate with abundant neutrophils, no eosinophils and many lymphocytes [**Figure 4(h)**].

Figure 4 (a-h): Histopathological findings of Cutaneous Malakoplakia

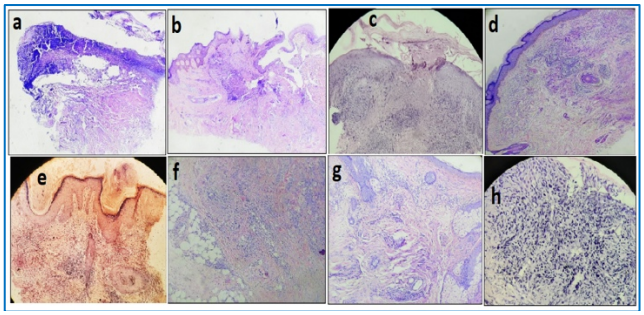


Table 1 represents the percentage of clinical and histopathological agreement in each diagnosis encountered in this study. The overall

histopathological concordance in this study was found to be 87.24%.

Table 1: Histopathological correlation and degree of agreement

Diagnosis	% of Histopathological concordance
Leprosy	86.38
Cutaneous TB	87.87
Granuloma annulare	71.42
Erythema Nodosum	100
Granulomatous cheilitis	100
Cutaneous malakoplakia	100
Wegener's granulomatosis	100
Pyoderma Gangrenosum	54.54
Hidradenitis suppurativa	100
Foreign body (tattoo) granuloma	100
Average value	87.24

4. Discussion:

In the present study, highest number of cases were in the third and fourth decade of life, which are the periods of maximum physical exertion, active social and professional life and greater personal or professional stress. These factors may be contributory to the occurrence of these disorders in this age-group. The incidence among males was twice that of females. Males being more likely to work outdoors, suffer trauma, migrate, or travel to different regions, have been known to be more commonly affected with infectious diseases.[6,7]

Maximum cases (59.16%) belonged to Kuppuswamy class IV. The lack of sanitation, frequent overcrowding, and poor hygiene prevalent in this socio-economic stratum play a major role in the spread of infectious diseases. Majority of cases (93.3%) were from within the state of Maharashtra region. The large proportion of migrants in the city of Mumbai and the poor living conditions may play a large role in the concentration of infectious cases in this city and active spread of such diseases.[8,9]

The number of infectious causes outnumbered the non-infectious causes which is compared with the other studies.[8,10] Among the infectious causes, Hansen's disease (Leprosy) was the largest etiological condition with 57 cases, followed by cutaneous tuberculosis with 6 cases which is in accordance with the study done by Bal et al, Chakrabarti S et al and Gautam K et al.[10,11,12] This reflects the high burden of these infectious diseases in the community, and calls for stronger preventive measures, mass education and better access to healthcare, as infectious diseases are associated with poor sanitation, lack of awareness and health infrastructure. Among non-infectious causes, most cases were erythema nodosum (18.3%) followed by granuloma annulare (4.2%).

Leprosy:

Amongst leprosy cases, there was 36 (30%) of borderline tuberculoid, 14.2% cases of tuberculoid and 6 (5.0%) cases of pure neuritic leprosy. 4 (3.3%) cases of leprosy in reaction. Skin lesions in leprosy were more common in males which is comparable with the Gautam K et al.[12] We did not come across any case of indeterminate leprosy, but there were three cases where histopathology showed features of indeterminate leprosy. On histopathology, granulomatous inflammation was seen in most cases of leprosy. Well-formed granulomas could be appreciated in 23 cases of BTH, 4 case of BLH in type 1 reaction, (total 23.49%). In the remaining cases, dense inflammatory infiltrate with poorly formed granulomas could be seen. Langhans giant cells were seen in 5 cases of BTH and 2 case of BTH in type 1 reaction (total – 6.09%). Similar results are reported in previous studies.[12,13]

Special stains (slit skin smear and Fite-Faraco) showed more consistent results in the lepromatous pole of the disease (Leprosy). Hence their utility is limited in the diagnosis and management of leprosyas their sensitivity was 44.8% for SSS and 28.5% for Fite-Faraco staining which is correlated with the other studies.[8,14] Histopathological spectrum was highest in cases of tuberculoid (TT), Borderline Lepromatous Hansen's in type 1 or 2 reaction, and Pure Neuritic Hansen's (100%) followed by Borderline Tuberculoid Hansen's (79%), BTH in type 1 reaction (68%). The mean histopathological spectrum was 86.38%. It can be seen that the histopathological spectrum of Hansen's disease was higher in current study than most other studies.[12,15,16] This highlights the importance of histopathological correlation in the diagnosis and management of Hansen's disease.

Cutaneous tuberculosis:

Out of 11 patients of cutaneous TB, a majority of patients had active/past history of pulmonary TB or a close contact with TB. Among cutaneous tuberculosis, we had 6 cases (3.3%) of lupus vulgaris, 1 case (0.87%) of scrofuloderma and 1 case (0.87%) of tuberculosis verrucosa cutis (TBVC) which is similar to Bal et al and Grover et al [10,17] study. In all cases, the tuberculin test was strongly positive, which is in

agreement with the fact that Lupus vulgaris occurs in immunocompetent individuals.[13,14]

The presentation was that of a hyperpigmented plaque with central scarring and atrophy over the right hand, similar to the common presentation described in previous studies.[8,13,14] We could not find any case reports of HIV coexisting with cutaneous TB. Histopathological concordance was present in 4 cases of lupus vulgaris (63.636%) and in 100% cases of Scrofuloderma and TBVC. Hence the overall clinicopathological concordance was 87.87% in cutaneous TB. In 1 case of Atypical mycobacterial infection, there was a 100% clinicopathological concordance. However, the limiting factor was the lack of comparability as there were single cases of each condition.

Non-infectious granulomatous dermatitis:

The various non-infectious granulomatous dermatoses seen in current study were Granuloma Annulare, Erythema Nodosum, Granulomatous Cheilitis, Cutaneous Malakoplakia, Wegener's Granulomatosis, Pyoderma Gangrenosum, Hidradenitis Suppurativa, Granulomatous Rosacea, and Tattoo Granuloma. Majority of the patients were young with a female predominance, similar to the study conducted by Friedman-Birnbaun et al and Mohan et al.[18,19] On histopathological examination there was dominance of an interstitial pattern. Palisading pattern of presentation was seen in 5 of the total 5 cases. Similar findings have been seen in studies done by Gautam K et al and Friedman-Birnbaun et al.[12,18]

All 10 cases of erythema nodosum were non-infectious in nature, and there was no history of TB or TB contact in these cases. All presented with tender nodules and plaques, which were located over upper limbs. They all showed septal panniculitis on histopathology, which has classically been described in literature.[12,20] None of the 2 cases of granulomatous cheilitis had any nerve palsy, only isolated lip swelling was seen. There were no systemic symptoms or findings. Histopathology in all 2 cases showed well-formed epithelioid granulomas with dermal Oedema and inflammation. Amongst non-infectious causes of granulomatous reaction, a strong positive correlation between clinical and histopathological features was noted in 3 out of 5 cases of Granuloma annulare (71.429%), all 10 (100%) cases of Erythema nodosum, all 2 (100%) cases of Granulomatous cheilitis, as well as 1 case (100%) each of cutaneous malakoplakia, Wegener's granulomatosis. We had 11 cases of Pyoderma gangrenosum, out of which clinicopathological concordance was noted in only 6 case (54.54%). 1 case each, of Hidradenitis suppurativa, and 3 cases of foreign body (tattoo) granuloma, showed the classical clinical and histopathological features with a clinicopathological concordance of 100% as similar to the previous studies.[7,11,12,15]

5. Conclusion:

The present study highlights the importance of histopathological spectrum in the process of arriving at a final diagnosis in cases of granulomatous disorders of the skin. Granulomatous skin lesions have various modes of presentation. A classical clinical picture may not always be present. Skin biopsies still remain to be the gold standard as they help in confirming diagnosis, provided a proper history is taken and clinical correlation utilized.

Special stains play a supporting role in infectious granulomas, but most of them have a low sensitivity. In the end, it depends on the clinical acumen of the treating doctor and the diagnostic accuracy of the pathologist to correlate the findings and arrive at a final diagnosis, which is the major factor affecting patient outcomes in this group of disorders. From medicolegal point of view, correct diagnosis of these lesions is of prime importance which can be misinterpreted with the injuries in various stages of healing over the body.

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Original Research Article

Determination of Asenapine Maleate from Maggots by Solid-Phase Extraction and Gas Chromatography - Mass Spectroscopy.

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Entomo-Toxicology, Entomological Fauna, Post Mortem Interval, Drug Detection.

Abstract

Introduction: Forensic entomology and Forensic entomo-toxicology are two fields which are interconnected and are creating a niche of their own in the area of research. In certain cases of drug abuse/ intoxication, when there are no viscera samples available for toxicological analysis, the fly larvae which feed the deceased flesh can be of great help in detection of the drug. In this process, environmental factors like temperature, rain, humidity etc. work as the variables, affecting the process. **Methodology**: Different concentrations of Asenapine maleate were spiked in five goat meat samples weighing 250 grams each, along with a blank control sample. They were then placed in an open environment to observe and study the natural decomposition process and the different life stages of the sarcophagus insects (flies). **Results and Discussion**: The drug was found in the maggots of samples containing 20 µg/ml, 30 µg/ml, 40 µg/ml and 50 µg/ml drug, but it was not found in the sample containing 10 µg/ml drug. The reason behind this is the limit of detection. **Conclusion**: It has been reported that different drugs are being abused regularly by humans for various reasons. Several cases have been reported wherein overdose of these drugs leads to death. In this study, an attempt was made to develop a protocol for detection and determination of drugs in relation with entomological specimens.

1. Introduction

The field of Entomo-toxicology was developed in 1980 by Beyer and his co-workers. They first used the insects feeding on the flesh of the deceased to identify the drug which was taken prior to death.[1] However, the field of forensic entomology was in use since long before for estimating the post mortem Interval (PMI). In China, a lawyer, Sung Tzu, who was also an

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investigator of death, conducted and documented the first case of forensic entomology in the 13th century. [2, 3] These two fields are completely based on the process of decomposition and the various factors affecting it. The process of decomposition of a body starts immediately after death. It is a process, and not an event, and it can be divided in to five different stages: i) fresh, ii) bloated, iii) decay, iv) post decay and v) skeletonization.[4] The rate of decomposition always depends on the external environment, exposure and other such conditions.

The decomposition rate automatically increases in the open, when the body is exposed to decomposers like flies, beetles etc.[5] Different species of flies are capable of laying different quantities of eggs on the corpse. These eggs grow into larvae which feed on the corpse and in a few days to weeks, it becomes skeletonised. Therefore, there will not be any tissues or blood left for toxicological analysis. In such cases, maggots found feeding on corpse are used as alternate specimens for toxicological analysis,[1] as they were actively feeding on the tissues which were carrying the drug.[6,7]

Drugs which are extracted from the decomposer species larvae are considered as evidence in the courts.[8] The development rate of maggots depends on many factors like environmental temperature, humidity level, drugs present in the tissues of the cadavers, etc. which sometimes increase or inhibit their development.[9-14] The larvae of calliphorid family and others show a great power of acceptance for drugs and drug induced tissues containing high dose of morphine,[15] barbiturates,[9] and amitriptyline,[16] in a dose which is considered lethal for an adult human. Significant development has occurred in the field of forensic entomo-toxicology.[17-19] In those countries where high temperature is generally observed, the use of insects for toxicological analysis is gaining much popularity. As the rate of decomposition increases with increase in temperature, the decomposition rate is high in these places. Hence sarcophagus insects and the field of entomo-toxicology are valuable for gathering evidence of drug related deaths.

Different techniques have been utilised for entomotoxicological analysis. These include gas chromatography, [20-23] liquid chromatography, [24-27] liquid chromatography mass spectroscopy and immunoassay.[28-30] Asenapine maleate [Saphris (3aRS,12bRS)-5-chloro-2-methyl-2,3,3a,12b-tetrahydro-1H-dibenzo (2,3:6,7) oxepino (4,5-c) pyrrole] is an atypical antipsychotic drug which can be used for the treatment of bipolar disorders and schizophrenia and is approved in the USA since 2009. This drug belongs to the dibenzo-oxepino pyrrole class and has a molecular weight of 285.8 g/mol. The empirical formula of asenapine maleate is $C_{17}H_{16}ClNO$.[31] It is a prescription drug and is generally prescribed as 5 and 10mg sublingual tablets. With a single 5 mg tablet, the adsorption of this drug occurs within 1.5 hours.The steady state of this drug is reached in 3 days. The metabolism of asenapine maleate occurs by glucuronidation and the oxidative metabolism through cytochrome P450 system in the liver. Its half-life is 24 hrs and about 50% can be recovered from urine and 40% recovery can be done from faeces. Common side effects of this drug include: drowsiness, restlessness, dizziness, numbing of mouth, weight gain etc. [30]

Asenapine maleate was reportedly involved in several suicide cases, according to a report by National Center for Biotechnology Information (NCBI).[32] Information regarding the analysis of asenapine maleate from visceral samples is limited. Researchers performed the analysis of asenapine with solid-phase extraction (SPE) or liquid-liquid extraction followed by high-performance liquid chromatography (HPLC), liquid chromatography with tendem mass spectrometry (LC-MS-MS) and Gas chromatography mass spectrometry (GC-MS). [33,34]

2. Materials and Methodology:

Apparatus - A total of 6 jars of 1kg capacity each, were used for keeping the meat substrates. Six boneless goat meat pieces weighing 250gms each, were purchased from a butcher shop in Sector 67 Mohali, India.

Reagents – The drug asenapine maleate was purchased from Indian Pharmacopeia with 99.9 percent purity. The methanol was HPLC grade from Qualigens. Liquor ammonia, 25%V/V was purchased from Fisher Scientific.

Physical and Chemical properties of the drug - Asenapine maleate is soluble in water and methanol. The pka of the drug is 7.24. It is a non-hygroscopic off-white powder with a boiling pointof 357.9ºC at 760 mmHg and melting pointof 141-145°C. Flash point is 170.2ºC. Its molecular formula is $C_{21}H_{20}ClNO_5$ and molecular weight is 401.84.[35]

Sample Treatment

A. Stock solution was prepared by dissolving 10 mg asenapine maleate in 10 ml methanol of HPLC grade resulting in a solution of 1mg/1ml w/v.
B. Working solutions of 10µg/ml, 20µg/ml, 30µg/ml, 40µg/ml and 50 µg/ml were prepared by using solvent methanol for tuning of mass spectrometry and selectivity of experiment.

All the working solutions and stock solution were stored at -20^0 C till use.

Geographical and environmental conditions - The experiment was performed on location NL 30◦45'51" EL 76◦37'40" in Mohali city of Punjab, India. The location is situated in Malwa region of Punjab. The minimum temperature during experiment was 4^0 C and the maximum temperature was 24^{0}C, with an average temperature of 12^0 C. The average humidity was 89% during the experiment. The experiment was set up in an open garden area of a rented house in sector 115, Mohali, Punjab.

Sample preparation - Different spiked drug concentrations were injected in to the meat samples in the ratio of 10, 20, 30, 40, 50 µg/ml each, excluding the control, respectively. Then, these five different concentrations and the blank control entomo-toxicological samples were kept in open for observation of the natural decomposition process.

Sample collection - The process of decomposition was observed carefully and each life stage of insects was recorded through photographs. The larvae of the feeding and post feeding stage were collected after an interval of every 8 hours; a total of 50 larvae from each concentration of the drug and the blank sample. For the purpose of cleaning, larvae were washed and rinsed with water to avoid the surface drug amount from detection through the instrument as an artefact. After washing, the larvae were stored in air tight containers and preserved in the freezer at -10^{0}C till analysis.

Figure 1: Samples placed in different jars named A, B, C, D, E & F

Figure 2: Various Stages from development (Egg deposition, maggot formation, pupa & adult fly).

Isolation, cleaning-up, extraction and purification procedures - Maggots of each concentration were first minced using surgical blade and placed in Borosil® beakers separately. After that, 5 ml methanol was added to all the maggot samples. The pH was adjusted to 9 using liquid ammonia as the best extract was found in pH 9. Solvent pH was checked using pH strip. After checking pH, mixture was filtered using filter paper. (Whatman®125mm). The filtrate was then vortexed and centrifuged at 2500 rpm for 5 minutes. The clear liquid obtained after centrifugation was used for solid-phase extraction.

Solid-phase extraction - SPE instrument used was the offline Superclean Ultra 2400 model with reversed phase discovery c8 column. The clear liquid was poured through the cartridge and proper vacuum was maintained during extraction. The extract was then poured in a china dish and covered using aluminium foil after making holes using a pin and was left for 24 hours.

Instrumentation

Gas chromatography (GC) - Routine analysis and separation of commonly using psychotropic substances, narcotic drugs and pesticides were done with an auto-sampler Shimadzu AOC-20N Plus coupled to a GC–MS Shimadzu QP-2020 NX (Kyoto, Japan) equipped with a split/split less injector in the split-less mode using a SH- RXi-5Sil-MS fused silica capillary column of 30 m×0.25 mm ID×0.25 µm stationary film thickness, manufactured by Shimadzu (made in USA) with the following conditions: constant flow of Helium (He) 1.2 mL/min; initial inlet temperature 90°C ramped to 290°C at 200°C /min after a 30sec delay; injection volume 5µL (LVI) onto a Carbofrit plug in the liner with an open purge valve

(30:1 split ratio) for 10s, closed until 3.0 min and open again (30:1) until the end of the run; oven temperature program: 85°C for 3 min then25°C /min ramp to 180°C followed by a 10°C /min ramp to 300°C and held for 4 min. The total time for one GC-MS run was 23 min.

Mass spectrometry (MS) - The MS instrument transfer line temperature was 240°C; ion source temperature 230 °C; ionization mode – electron impact at 70 eV full-scans (30–550 m/z). The optimization of the retention times and chromatographic resolution were done in the scan mode with all prepared standard concentrations.

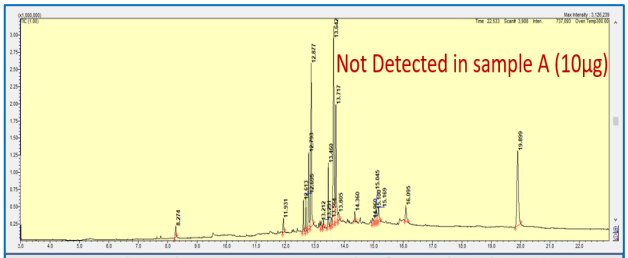
3. Results and Discussion:

The drug was found in the maggots' samples containing 20µg/ml, 30µg/ml, 40µg/ml and 50µg/ml; but it was not found in the sample containing10µg/ml drug (**table 1 and Graph 1 to 6**). The reason behind this is the limit of detection. The drug in the quantity 10µg/ml is usually not detectable as it is below the limit of detection. The drug was also not detected in maggots of the Blank sample, used as control sample. This particular drug was not found in literature survey used for entomo-toxicological studies. By using this drug, a new protocol for the detection of this drug has been made and it can be used in future cases related to this particular drug. This drug is reportedly abused and involved in many deaths.[35] Maggots are compatible for qualitative analysis of drug and in future quantitative analysis can be the focus of research. This drug was previously used in different studies in which asenapine was spiked in human plasma and urine. The extraction was done using automated solid phase extraction and analysed using HPLC-MS/ MS and liquid chromatography-tandem mass spectrometry [33,34] whereas in present study the drug was spiked in meat substrate and extracted from maggots by using solid phase extraction and analysed through GCMS. In another study, nineteen different drugs were spiked in tissue, larvae and hairs. The analysis was done using GCMS and chemiluminescence method but the drugs were analysed in tissue and hairs but drugs were rarely detected in maggots [36] whereas in present study drug detection was done more accurately. There was a study done for nicotine detection through maggots using liquid-liquid extraction and analysed using GCMS but in present research, different extraction technique was used and lower detection limit was gained.[37]

Table 1: Results found in different samples carrying different concentrations of drug.

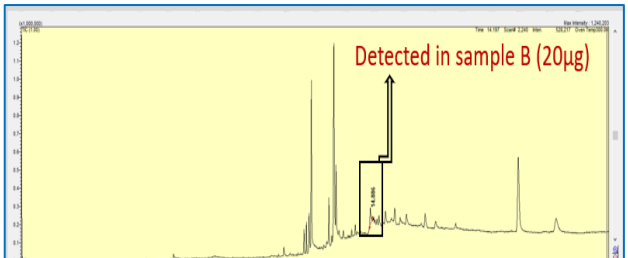
Samples no.	Drug Concentration	Detection
A	10µg/ml	Not detected
B	20µg/ml	Detected
C	30µg/ml	Detected
D	40µg/ml	Detected
E	50µg/ml	Detected

Graph 1: GCMS Graph of sample A (10 ug)



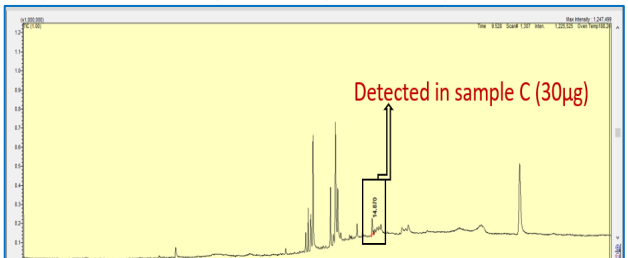
Graph 1. showing GCMS graph of sample A (10µg)

Graph 2: GCMS Graph of sample B (20 ug)



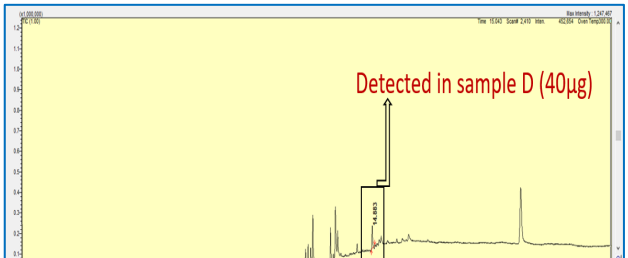
Graph 2. showing GCMS graph of sample B (20µg)

Graph 3: GCMS Graph of sample C (30 ug)



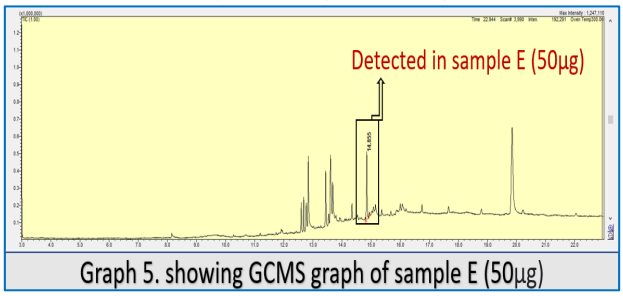
Graph 3. showing GCMS graph of sample C (30µg)

Graph 4: GCMS Graph of sample D (40 ug)



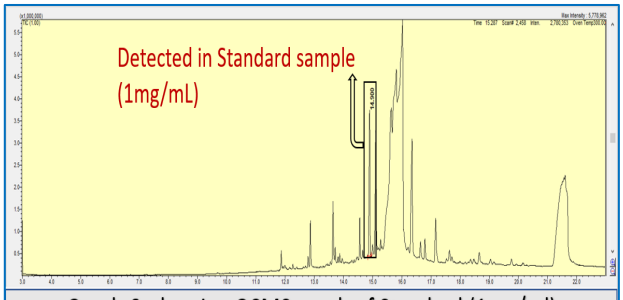
Graph 4. showing GCMS graph of sample D (40µg)

Graph 5: GCMS Graph of sample E (50 ug)



Graph 5. showing GCMS graph of sample E (50µg)

Graph 6: GCMS Graph of standard sample (1 MG/ML)



Graph 6. showing GCMS graph of Standard (1mg/ml)

5. Conclusion

According to this research, Asenapine maleate, a drug that has been linked to numerous cases of drug abuse and death, can be detected through the larvae, even when the visceral organs are not available for drug analysis. Insects found at a crime scene can be helpful in estimating the time since death by observing their growth stage, but the effect of drugs on the life cycle of insects can alter the estimation of post-mortem interval (PMI). Since different drugs have different effects on different insects, further studies should be carried out using different drugs and insect species to improve knowledge in this field. This would allow investigators to narrow down the pool of suspects. In addition, future entomo-toxicological studies should focus on documenting a detailed summary of drugs and their correlation with insect species, as well as quantifying drugs in these specimens.

The findings of this study are significant because they offer an alternative way to detect the presence of Asenapine maleate in the absence of visceral organs. While insects found on crime scenes have traditionally been used to estimate PMI, the presence of drugs can alter the life cycle of insects and complicate these estimations. Therefore, it is important to understand the effects of drugs on different insect species, which would help investigators to better estimate PMI and narrow down the pool of suspects.

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

Contributor ship of Author: All authors equally contributed.

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Original Research Article

Study of Medico-Legal Awareness among the Medical Professionals

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Medical service, Awareness, Medico-legal, Medical ethics.

Abstract

Background: Medical service is the noblest service to the mankind. In recent era shifts in patient's attitude towards the doctor has resulted in making the law an inseparable entity of health care today, being a reflection of increased public awareness and inappropriate practices by the healthcare professionals. Many doctors are apprehensive in dealing with Medicolegal cases, may be because of fear, laws and regulations, attending and answering by the court questions or police etc. Knowledge of Forensic Medicine and laws related to medical practice is also important when medical practitioner have to give evidence as expert witness in court of law. **Aim:** The aim of this study is to assess the doctors of a tertiary health care institute, regarding their awareness and consciousness towards the different medico-legal terms. **Material and methods:** Study was carried out on the basis of questionnaire developed and a total of 165 doctors were assessed on the basis of their responses. **Results & Conclusion:** In this study, we found that few doctors had basic knowledge regarding different medico-legal terms. Most of the participating doctors felt need for planning and conducting training programme related to legal medicine.

1. Introduction

The relationship between doctor and patient is based on trust and confidence. Now days, the doctor-patient relationship has deteriorated considerably and medical negligence is on the increase.[1] Global trends in medico-legal issues are gradually catching the attention of the public and complaints against physicians seem to be escalating in developing countries[2], the reasons for these are media (electronic and print), professional accountability and decision making.[3]

Indian society is experiencing a growing awareness regarding patient's rights. The provisions of consumer protection act now covers deficiency of service by medical professionals in such cases to provide redresses to the patients.[1] With the increasing use of technology, paradigm

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shifts in patient's attitude towards the doctor has resulted in making the law an inseparable entity of health care today. Today, the fundamental principles of medicine insist that doctor should be aware about various medico-legal issues, understand the nature of these obligations and fulfill these obligations to best of his ability.[3]

Usually what happens is that medico-legal duties of Registered Medical Practioners are taught in second year of M.B.B.S.' / Graduation and unfortunately afterwards nobody bothers about it till one faces some problem like compensation case or case of negligence.[4] The syllabus for undergraduate students of this important subject has been reduced over the years, hence is losing its significance. Keeping the above facts in mind, medical colleges all over India should increase the importance of Forensic Medicine and Toxicology subject by covering all its aspects theoretically in 2nd and 3rd phase of MBBS and also by conducting regular medico-legal workshops all through their course, as it is very common that they will forget the subject in course of time and need to be refreshed on regular basis.[5]

The curriculum on medico-legal issues may not be adequate or practical enough to enable the medical student reliably address all ethical dilemmas likely to be faced in practice.[2]

Most of doctor, irrespective of his/her specialty, would have been faced certain cases, which at the time or subsequently, would be labeled as medico-legal. Members of the medical profession are liable to be called upon to give medico-legal assistance in varied circumstances and situations by police and law. Like any other witness, the medical practitioner is also bound to answer truly all questions posed to him in the court of law.[6] There have been many reports stressing the importance of incorporating ethical and legal issues into medical curricula.[7]Keeping in mind above mentioned scenario, this study was conducted to assess the medicolegal awareness among faculties in medical college, a tertiary health care and teaching centre.

Aims and Objectives

1. To find out status of knowledge about common medico legal terminologies/cases.
2. To suggest possible solutions or corrective measures.

2. Material and Methods

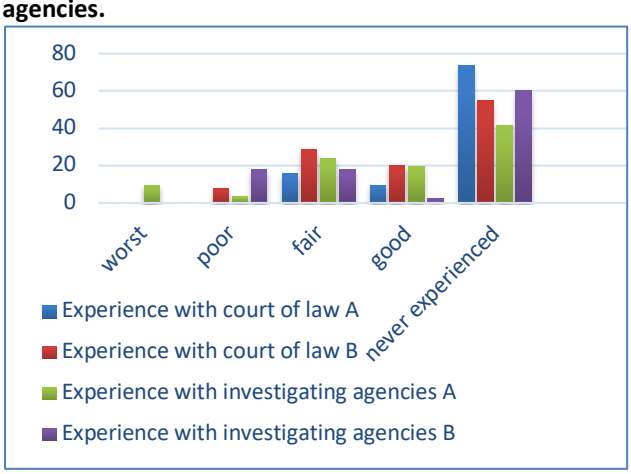
The present study was carried out at a Medical College in Udaipur. The doctors who have completed their post-graduation (MD/MS) course and working in the Institute were included. Keeping in view the ethical considerations, the participants were explained the purpose and the methodology of the study and individual consents were obtained. The study was approved by the institutional ethical committee.

An open-ended questionnaire was prepared comprising of 30 multiple choice questions. Faculty members were divided into two groups according to their work experience i.e., with experience < 4 years (110) and > 4 years (55). A total of 188 doctors responded, 23 responses were rejected/ excluded based on incomplete responses and by ineligible doctors (non-postgraduates). Knowledge of faculty members was assessed on the basis of their answers for the questionnaire designed. The individual written responses to the provided questionnaire were studied in detail. The particular response of the group of the professionals was studied and analyzed in relation to issue in question. Finally, responses were tabulated, grouped and analyzed.

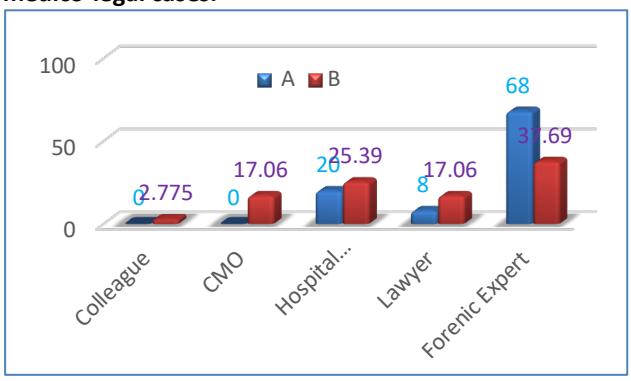
3. Observations and Results

Out of 188 faculties 165 participants in this survey study, out of these 165 faculties 110 contributed to group A (Having experience <4years) and remaining 55 contributed to group B (Having experience >4years) (**Graph 1**). About 72% faculty of both the groups opined UG teaching and exposure to medico-legal cases was not sufficient (**Table no.1**). We observed that 52% of group A and 42.5% group B faculty were not having adequate knowledge of injury certification. Around 16% of the members of both groups claimed to have knowledge of injury certification (**Table no.1**).

Graph 1: Experience with court of law and investigating agencies.



Graph 2: Preference of consultation in issues related to medico-legal cases.



Regarding certification of cause of death, 48% of Group A and 33.7% of Group B members claimed to have adequate knowledge while, 32% of Group A and 38.4% of Group B members were not having adequate knowledge and 20% of Group A and 25.3% of Group B members claimed to have some knowledge of certification of death. Only 16% of Group A and 26.5% of Group B members possess adequate knowledge and 40% of Group A and 48% of Group B members do not have adequate knowledge of examination of victim/ accused of sexual assault. About 38% of Group A and 14.3% of Group B members were having some knowledge, while 34% of Group A and 50.7% of Group B members were having no knowledge of examination and certification of case of alcoholism (**Table no.1**).

Graph 3: Competency in dealing medico-legal cases.

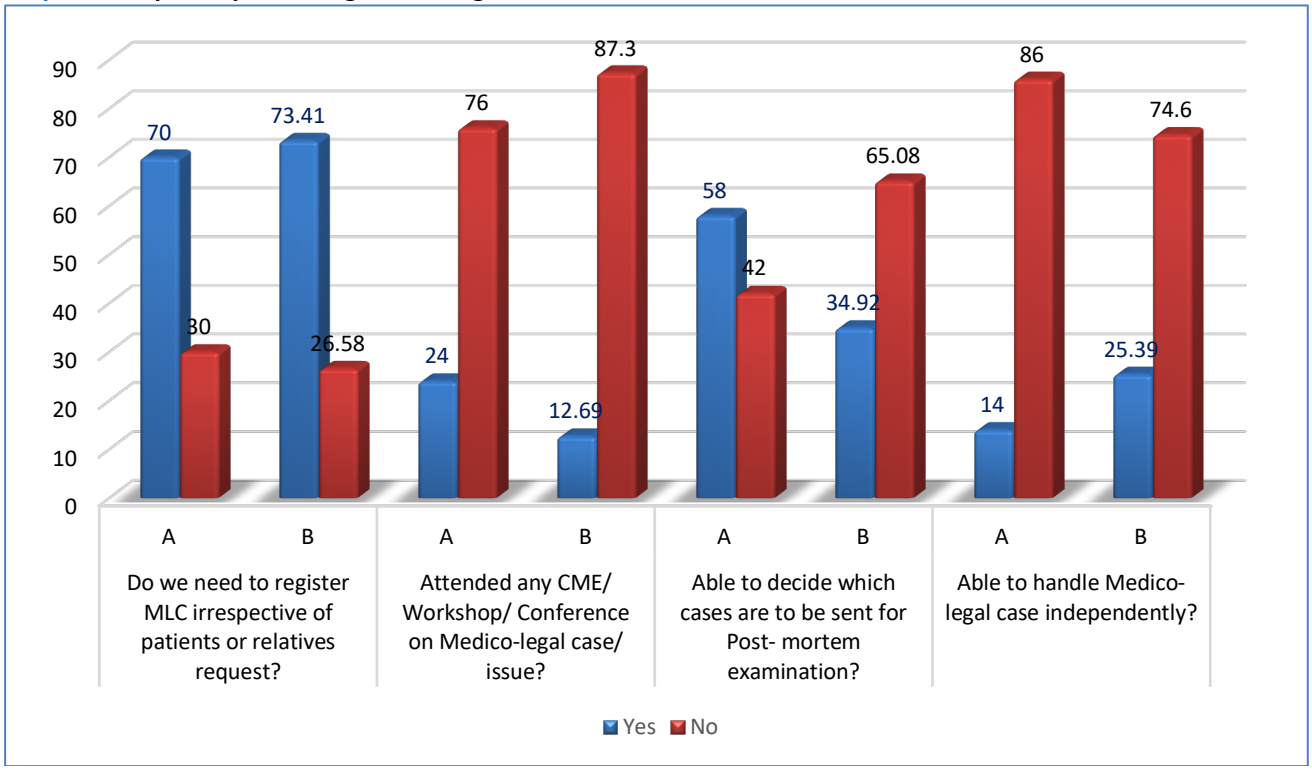


Table no. 1: Opinion regarding exposure to medicolegal cases in UG and awareness regarding different certifications

Sr. No.	QUESTION	GROUP A				GROUP B			
		YES	NO	CAN'T SAY	SOME WHAT	YES	NO	CAN'T SAY	SOME WHAT
1	Sufficient exposure TO medico-legal cases and responsibilities in UG curriculum?	24%	72%	4%	0%	20.24%	75.59%	4.17%	0%
2	Knowledge of injury certification?	16%	52%	4%	28%	16.66%	42.46%	29.76%	11.11%
3	Knowledge of death certification?	48%	32%	0%	20%	33.72%	38.45%	2.77%	25.29%
4	Knowledge of examination of victim/accused of sexual assault?	16%	40%	6%	38%	26.58%	48.01%	5.55%	19.84%
5	Knowledge of examination and certification of case of alcoholism?	22%	34%	6%	38%	23.80%	50.79%	5.55%	14.28%

Table no. 2: Awareness regarding consent, indemnity insurance, negligence, liability and record keeping.

Sr. No.	QUESTION	GROUP A				GROUP B			
		YES	NO	CAN'T SAY	SOME WHAT	YES	NO	CAN'T SAY	SOME WHAT
1	Know how to explain and write informed consent?	82%	12%	0%	6%	53.57%	18.2%	2.77%	25.28%
2	Know about professional indemnity insurance?	34%	46%	20%	0%	46.42%	45.24%	8.33%	0%
3	Knowledge of Medical Negligence?	48%	12%	0%	40%	30.95%	26.98%	0%	42.06%
4	Knowledge about Vicarious Liability?	48%	18%	6%	28%	28.17%	46.43%	2.78%	22.62%
5	Aware about importance of evidence preservation?	54%	14%	6%	26%	38.09%	21.03%	0%	40.88%
6	Importance of record keeping.	84%	8%	1%	6%	61.9%	2.77%	2.77%	32.53%
7	Guidelines for preservation of medical & medico-legal records.	26%	28%	2%	44%	28.17%	28.17%	12.69%	30.95%

Table no. 3: Awareness regarding important acts related to medical practice.

Sr. No.	QUESTION	GROUP A				GROUP B			
		YES	NO	CAN'T SAY	SOME WHAT	YES	NO	CAN'T SAY	SOME WHAT
1	Aware of consumer protection act and its importance in doctor patient relationship?	38%	26%	4%	32%	45.238%	29.76%	5.55%	19.44%
2	Aware of MTP act?	80%	12%	2%	6%	66.26%	15.47%	2.77%	15.47%
3	Aware of PCPNDT act?	68%	18%	1%	6%	39.28%	28.17%	9.92%	22.61%
4	Aware of The Human Organ Transplantation Act?	40%	18%	2%	40%	28.17%	30.95%	9.92%	30.95%
5	Aware of Human Rights?	58%	10%	2%	30%	42.46%	21.03%	2.77%	33.72%
6	Aware of rights & duties of patients in India?	38%	28%	6%	28%	25.39%	19.84%	12.69%	42.06%

Regarding awareness about examination and medicolegal responsibilities in case of poisoning 28% of Group A and 16.6% of Group B members were aware of it. About 30% & 40% of Group A and 60.7% &20% Group B members were not aware of have some knowledge of the same. About 60 % of Group A and 50.39 % of Group B members were of the opinion that they are bound to report every case of poisoning to investigating authorities. It was observed that, 82% of Group A and 53.7% of Group B members could explain and write informed consent. Around 12% of Group A and 18% of Group B members could not explain and write informed consent. 46% of Group A and 45.2% of Group B members were not aware of professional indemnity insurance, while about 34% of Group A and 46% of Group B members were aware of it (**Table no.2**).

84% of Group A and 61.9 % of Group B members were aware about importance of record keeping. Still only 26 % of Group A and 28.17 % of Group B members were aware about guidelines of preserving medical and medico-legal records, about 28% of both groups were having no knowledge of the guidelines. In this study, about 54 % of Group A and 38.09 % of Group B members were aware about importance of evidence preservation in medico-legal cases while, 18% of Group A and 21.03 % of Group B members had no knowledge about it (**Table no.2**). Regarding medical negligence 48 % of Group A and 30.95 % of Group B members had adequate knowledge, while 12% of Group A and 26.98 % of Group B members had no knowledge about it. About 48 % of Group A and 28.17 % of Group B members were aware of vicarious liability while, 18% of Group A and 46.43 % of Group B members were not (**Table no.2**).

About consumer protection act, only 38% of Group A and 45.2% of Group B members were familiar with consumer protection act and its importance in doctor patient relationship, 26 % of group A members and 29% of group B participants had no idea of it. Around 80% of Group A and 66.2% of Group B members were aware of MTP act; at the same time about 12% of group A & 15% of group B

participants had no idea about MTP act. It was observed that, 68% of Group A and 39.2% of Group B members were conversant with PCPNDT act while about 18% of group A and 28 % of Group B members were not.

40% of Group A and 28.1% of Group B members were aware about Organ Transplantation Act while 40% of Group A and 30.9% of Group B members were having some knowledge of it. We observed that, 58% of Group A and 42.4% of Group B members were aware and 30% of Group A and 33.7% of Group B members claimed to have some knowledge of human rights. For medicolegal and ethical issues of artificial insemination 18 % & 40% of Group A and 42.4% & 28.1% of Group B members expressed awareness and some knowledge respectively. Only 20% of Group A and 5.5% of Group B members were aware of medico-legal & ethical issues of surrogacy in India (**Table no.3**).

We observed that about 38% of Group A and 25.4% of Group B members were aware while 28% of Group A were having some knowledge OR no knowledge about rights & duties of patients in India while, 42% of Group B members were having some knowledge and 19.8% had no knowledge about it (Table no.5). Regarding experience with investigating agencies and court of law, 42 % group A & 60 % group B never had any kind of experience with investigating authorities at the same time about 20% of group A & 2.8% of group B had good experience. About 74 % group A & 55 % group B never had any experience of court of law, whereas 10% of group A & 20.47% of group B rated it as a good experience (**Graph no. 1 & 2**).

Regarding preference of consultation in need of help in medico-legal cases, 68 % group A & 37.69 % group B would like to consult Forensic medicine personal, only 8 % of group A & 17.06 % of group B would like to consult lawyer, about 20 % of group A & 25.39 % of group B would like to consult hospital administration, 17% of group B would like to consult CMO and about 3% 17% of group B would like to consult their colleague (**Graph no. 3**).

We observed that, 70% of Group A and 73.4 % of Group B members were aware about need of registering MLC irrespective of request by relatives etc. About 76 % of Group A and 87.3 % of Group B members did not attend any CME /Workshop on medico-legal case/issues after completion UG education. About 42% of Group A and 65.08 % of Group B members could not decide which body is to be sent for postmortem examination. Majority of the participants, 86 % of Group A and 74.61 % of Group B members could not handle medico-legal case independently.

The data was statistically analyzed (chi square test) and we observed Statistically non - significant difference (P value >0.01) in opinions among the two groups regarding sufficiency of UG teaching about medico-legal responsibilities, exposure of MLC in UG teaching, knowledge of cause of death certification, consumer protection act, MTP act, opinion towards registering MLC irrespective of request of relatives and compulsion of informing cases of poisoning to authorities. Except above mentioned parameters statistically significant difference (P value <0.01) was observed in opinion of participants of the two groups. The difference in awareness may be attributed to fresh knowledge and over confidence of group A participants and gradual awareness of incompetence's, increasing knowledge with experience among group B participants.

4. Discussion

This study was an effort to investigate the awareness of medico legal issues among medical faculties in a medical college in Udaipur. The outcome provides a valuable information regarding awareness among faculty member about medico-legal issues, medical jurisprudence and its practical application. The opinion of both the groups UG teaching and exposure to medico-legal cases during UG was not sufficient, was supported by similar observations by Baheti MJ[3] and Rao GV[5] contradicted by Barnie BA.[2] We observed that knowledge of different medicolegal certification varied among the faculty members, about 16% of both group A & group B faculty showed adequate knowledge of it. This finding was similar to findings of Singh AK[6] and Rao GV.[5]

With regard to cause of death certification 48% of Group A and 33.7% of Group B members were having adequate knowledge, similar observations were reported by Nanandkar SD[4], while Singh AK[6] and Rao GV[5] both reported Poor knowledge of cause of death certification. Only 16% of Group A and 26.5% of Group B members were having knowledge of examination of victim/accused of sexual assault. Similar findings were observed by Nanandkar SD[4] along with Singh AK.[6] Contrary observation was reported by Rao GV.[5] In our study, 82% of Group A and 53.7% of Group B members were able to explain

and write informed consent. Similar findings were reported by Haripriya A[1], Chavda KL[10], Rai JJ[9], Rao GV[5], and Senthllkumar S.[11]Converse finding was reported by Pandey U.[12] We found that, 46% of Group A and 45.2% of Group B members were not aware of professional indemnity insurance. Our findings were supported by Baheti MJ[3] and Senthllkumar S.[11]

We observed that, 38% of Group A and 45.2% of Group B members were not aware of consumer protection act and its importance in doctor patient relationship. Findings were similar to that of Baheti MJ[3] and Senthllkumar S.[11] Better results were reported by Haripriya A[1] and Chavda KL.[10] Among our study participants, 80% of Group A and 66.2% of Group B members were aware of MTP act which is contrary to findings of Nanandkar SD[4] and Singh AK.[6] About 68% of Group A and 39.2% of Group B members in our study were aware of PCPNDT act while somewhat similar finding was reported by Nanandkar SD[4] and poor knowledge about PCPNDT was reported by Singh AK.[6] In our study, 40% of Group A and 28.1% of Group B members were aware of organ transplantation act. Chavda KL[10] reported better awareness while Rao GV[5] reported poor awareness.

Among our study participants around 18% of Group A and 42.4% of Group B members were aware of medico-legal aspect & ethical issues of artificial insemination. Varghese AM[8] reported higher awareness about it. We observed that about 38% of Group A and 25.4% of Group B members were aware, of rights & duties of patients in India, similar result was reported by Singh AK.[6] In our study, 70% of Group A and 73.4 % of Group B participants were of the opinion that we need to register MLC irrespective of any request or denial by relatives. Similar finding was reported by Rao GV.[5]

84% of Group A and 61.9% of Group B members were aware of importance of record keeping, similar to Haripriya A.[1] Regarding guidelines for preservation of medical and medicolegal records we found that, about 1/4th of the participants were aware about it. Slightly better results were reported by, some Rao GV[5] and Rai JJ.[9] It was found that, 72% of Group A and 78.9% of Group B members were of the opinion that they were not exposed to sufficient medico-legal cases in UG, similar to observations by Rao GV[5] and Senthllkumar S.[11] Further it was observed that 76% of Group A and 87.3% of Group B members did not attend any CME/Workshop/conference/ training on medicolegal case/issues after completion of professional education. Similar results were reported by Baheti MJ[3] and Senthllkumar S.[11] In was observed that, 48% of Group A and 30.95% of Group B members were having knowledge of medical negligence. Similar results were reported by Nanandkar SD[4], Varghese AM[8], Senthillkumar S.[11] Better results were observed by Rai JJ[9] and Chavda KL[10] with more than 80% participants aware of medical negligence whereas Singh AK[6] reported poor awareness about negligence.

In this study, 48% of Group A and 28.17% of Group B members were aware about Vicarious Liability. Chavda KL[10], Varghese AM[8] and Rai JJ[9] reported bit higher variable awareness about Vicarious Liability. We found that, 54% of Group A and 38.09% of Group B members aware about importance of evidence preservation, comparatively better than Nanandkar SD[4] and Singh AK[6] who reported awareness among less than 30% participants.

We found that, 58% of Group A and 34.92% of Group B participants could decide which cases are to be sent for Post-mortem examination. G V Rao[5] reported opposite observation with more than 2/3rd of participants being able to decide. Only few participants, 14% of Group A and 25.39% of Group B members were confident to handle medicolegal cases independently. Contrary to Rao GV[5] with 60% of PG participants being able to handle MLC independently.

Most of our study participants do not have any experience with investigating agencies or court of law. 42% Group A & 60% Group B never had experience with investigating authorities. Similarly, 74% Group A & 55% Group B never had experience with court of law. Slightly better findings were reported by S D Nanandkar[4] who found that 41.77% and 37.98% had good experience with investigating agencies & court of law respectively. We found that 68% Group A & 37.69% Group B would like to consult Forensic Medicine personal for help in issues related to medico-legal cases. Different choice was reported by Rai JJ[9] and Hariharan S.[7]

5. Conclusion

- During UG, teaching & exposure to Medico-legal cases is not sufficient.
- The knowledge of cause of death certification is bit better than other medicolegal certifications.
- Awareness about MTP, PCPNDT, CPA etc is variable & not up to satisfactory level.

- More than 2/3rd faculties are aware about record keeping & MLC registration but most of them are not aware about guidelines for preservation of MLC records.
- Most of the faculties have not attended any CME/Workshop/Conference related to medico legal cases.
- Majority of the faculty members are not exposed to Investigating agency or Court.
- Senior & Junior faculties wish to consult FMT expert for medico-legal cases while middle level wish to consult CMO/Admin/Lawyer.
- Overall, less than 50% faculties are aware about Medical Jurisprudence.
- About 2/3rd faculties can decide which cases are to be sent for postmortem examination.
- Most of the faculties cannot handle MLC independently**.**

Recommendations

- Teaching hours in UG curriculum should be increased further with involvement of new methods of teaching & learning.
- Casualty posting should be under Forensic Medicine Department.
- There should be compulsory clinical posting to mortuary during UG course and internship.
- There should be regular workshops at institute level or in small groups.

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Case Series

Autopsy in Occupational Blasts- A Case Series.

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Blast Wave,
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Explosion Injuries.

Abstract

Introduction: We live in times of rapid industrialization and urbanization leading to induction of large workforce in the formal and informal occupational sectors. Every occupation has its own inherent risks and some of them can cost the life and limb of manpower at times. It is an undeniable fact that human errors are responsible for a lot mishap at workplace that is preventable with due care and caution. Occupational safety legislation regulates the formal industrial sector whereas the large informal sector in our country remains unregulated and highly prone to serious fatalities. **Case study:** Explosion cases have a peculiar presentation at autopsy and the autopsy findings of such cases are described in this case series along with fault analysis leading to each blast and thereby suggesting prevention strategies in similar industrial/occupational settings. **Conclusion**: The occupational safety and health regulations are laid down by statute and enforced through agencies like Directorate General Factory Advice Service and Labour Institutes, DGFASLI, Government of India and the state level inspectorates of factories & boilers in India. These standards are to be scrupulously followed to prevent any industrial mishaps in the formal industrial sector.

1. Introduction

Safety at occupational sites has become a concern across the globe in view of ever-increasing accidents at workplace. The International Labour Organization (ILO) estimates that some 2.3 million women and men around the world succumb to work-related accidents or diseases every year; this corresponds to over 6000 deaths every single day.[1] Blasts at occupational sites in both industrial set up and in the informal sector are one of the significant causes of mortality. In this case series, we present nine occupational blast cases reported at different medico-legal centres, analyze the reasons for blast and discuss the prevention strategies.

Case 1: On the fateful morning of 17/02/2016, the deceased a 43 years old man and his friend, residents of Manchirevula village, Rajendra Nagar, Ranga Reddy district, Telangana state went to trade their scrap paint boxes in sale unit located within

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the limits of Narsingi police station. The deceased sitting on a chair attempted to break open half used ten-liter paint tin by placing it on the floor between his both legs. The tin suddenly exploded causing severe blast injury (Fig. 1). The blast also set two 'shrapnel' among multiple fragments of tin into projectile motion. The scrap tin projectiles entered the abdomen of the deceased by penetrating through his right groin and caused widespread trauma leading to his death. A bomb disposal squad and a team of forensic experts made a preliminary assessment at the blast scene and made out it to be a prima facie compression blast. Physical evidence was collected at the scene for subsequent final opinion. The corpse was subjected to autopsy at Medico legal center, Osmania General Hospital, Hyderabad.

Shirt of deceased got torn at multiple sites, blood and soil strewn on the surface of the clothes. A rent extending from crotch point parallel to the center seam is noted on the right slack of trousers, moist blood stains and fine yellow sandy particles are present on it. Corpse is in supine position, eyes closed, and mouth partially open, thin built and is of dark complexion. Bluish green color paint stains are present on the anterior surface of both palms. Dried blood stains present on the face and front of thighs. A loop of large intestine protruded from the right groin. Skin over the lower part of abdomen and groin is blackened.

Figure 1: Crime Scene showing the fragments of the chairs along with the exploded Tin

Multiple contused abrasions present on face and front of chest. Multiple abrasions and lacerations are present on fingers of right hand. A penetrating injury measuring 12 cm x 2 cm over the right groin, paint smudged over margins. Comminuted fracture of right superior ramus of pubis present. Multiple omental tears and mesenteric contusions present. Haemoperitoneum noted, right kidney lacerated and perinephric hematoma present and bowel loops protruded out. All visceral organs pale. The cause of death in this case was due to hemorrhagic shock due to penetrating injury over the right groin consequent upon pressure blast.

Case 2:

On the fateful morning of 23/03/2021, the deceased a 28-year-old man and his friend were manually loading oxygen cylinders in their auto at their workshop within the limits of town VI police station, Nizamabad. One of the oxygen cylinders exploded while being placed on the trolley of the auto and caused fatal injuries to the deceased leading to his death on the spot (Fig. 2).

Figure 2: Crime Scene showing exploded oxygen cylinder along with the trolley of the auto.

Figure 3: Exposed viscera through the disrupted thoraco-abdomino-pelvic cavities.

The shirt of the deceased is burnt in its lower half, torn in to pieces at places and trousers also charred at sites. Blast injury over back of lower chest, abdomen and pelvic cavities with an open laceration of size 99cm x 36 cm x cavity deep, margins of the injury are burnt and viscera torn and exposed through the disrupted thoraco-abdomino-pelvic cavities (Fig. 3). Dermo epidermal burns present over upper half of anterior surface of right thigh. 5-12 ribs fractured at multiple sites and levels on both sides. Lungs, diaphragm and abdominal viscera lacerated and multiple blood clots present. D10, L1, L2 vertebrae fractured with disruption of spinal cord. A 3cm x 1cm abrasion present over nose and another 2cm x1 cm

abrasion present over right cheek. The cause of death in this case was due to hemorrhagic shock due to blast injury to the chest and abdomen consequent to oxygen cylinder blast.

Case 3:

A 28-year-old male, working as an AC technician in Hyderabad city attended for repair and Service of split AC in an apartment along with his untrained helper on 23/06/2017 at 10 am. During the process of repair of the split AC, he needed to refill the gas (**Fig. 4**). So, he started gas filling and assigned his helper to supervise the task and left for attending some other work. When he returned and inspected the process of refill, the compressor of the outdoor unit exploded suddenly. The AC technician sustained a fall from height and was later shifted to OGH Hyderabad for treatment where doctors declared him brought dead and shifted to mortuary for post mortem examination.

Figure 4: Crime scene showing the exploded compressor along with the equipment.

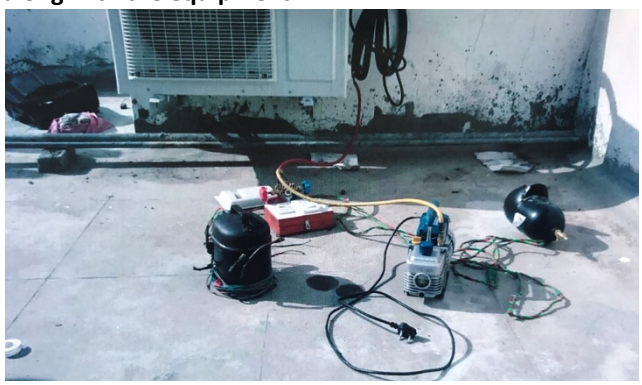

Figure 5: External injuries seen during the postmortem examination.

During the post mortem examination, on external examination there were two reddish contused abrasions each of size 2cm x 2cm on the right mid axillary line along the 7th and 8th intercostal space and a reddish contused abrasion of size 3cm x 2cm on the left scapular region 10 cm away from midline and 3cm below and 8cm inwards from left tip of the shoulder (**Fig. 5**). Apart from these injuries no other external injuries were present.

Figure 6: Lacerated liver seen during postmortem examination.

On internal examination, 7th and 8th ribs fractured with corresponding hemorrhage in the surrounding area with laceration of the liver (**Fig. 6**). Mesenteric vessels ruptured at the root of the mesentery in the upper part near the duodeno-jejunal flexure. The cause of death was due to blunt injury to the chest consequent to AC unit compressor blast.

Case 4:

A 40-year-old male, working as chemist in a pharmaceutical company was on duty at his workplace. On the early hours of 08/02/2016 at around 6:15 am the Nutsche filter attached to reactor exploded resulting in the death of the individual who was working in the reactor room. During the post-mortem examination, the body of the individual was seen to be completely mutilated by the explosion of the reactor leaving only the lower third of both legs intact. There was complete disfiguration of face with underlying comminuted fracture of whole skull including the mandible with only remnants of brain matter in the skull cavity. The trunk along with upper limbs was completely mutilated and all the internal organs dissipated across the room, bowels charred and shrapnel deposited on the body parts. The skin is hardened due to the chemical spillage on them. The

cause of death was due to blunt injuries all over the body. The manner of death was accidental.

Case 5:

A 24-year-old male, working as helper in a pharmaceutical company was on duty. On the early hours of 08/02/2016 at around 6:15 am the Nutsche filter attached to reactor exploded resulting in the death of the individual who was working in the reactor room. During the post mortem examination, body of the individual was supine and the whole body including the clothes was covered with intermediary chemicals which spilled out from the exploded reactor. On external examination the projectile from the reactor explosion has caused traumatic amputation of the right upper limb at the shoulder level and at the elbow corresponding to the laceration of the chest and abdomen causing multiple fractures of the entire right rib cage along anterior axillary line and evisceration of the bowel loops from the abdomen. Another projectile from the reactor explosion caused traumatic amputation of the right lower limb at the hip and the middle third of the right leg exposing the underlying tissues.

On internal examination, the rib cage is fractured on the right side causing the rupture of the right lung along with rupture of the liver and perforation of the bowel loops along with mesenteric rupture and part of bowels ruptured and eviscerated. The exposed bowel is burnt and became like a string. Internal organs are pale. The cause of death was due to hemorrhagic shock consequent to multiple injuries. The manner of death was accidental.

Case 6;

A 42-year-old male, working as chemist in a pharmaceutical company was on duty. On the early hours of 08/06/2021 at around 6:15am the Nutsche filter attached to reactor exploded resulting in the death of the individual who was working in the reactor room. During the post-mortem examination, the body of the individual was completely mutilated by the explosion of the reactor leaving only the lower third of the both legs was intact. There was complete disfiguration of face with underlying comminuted fracture of whole skull including the mandible with only remnants of brain matter present in the skull cavity. The trunks along with upper limbs were completely mutilated and all the internal organs were dissipated across the room, bowels charred with deposition of shrapnel on the body. The skin is hardened due to the chemical spillage on them. The cause of death was hemorrhagic shock due to multiple injuries. The manner of death was accidental

Case 7:

A 25-year-old male, working as helper in a pharmaceutical company was on duty. On the early hours of 08/02/2016 at around 6:15 am the Nutsche Filter attached to reactor exploded resulting in the death of the individual who was passing by along the stairs outside next to the reactor room. During the scene examination, body of the individual was found in the rubble as result of collapse of the walls of reactor room due to the blast. After retrieving the body and on examination, the whole body including the clothes is covered with intermediary chemicals spilled from the exploded reactor. Injuries on the body included, a laceration of the size 6cm x 3 cm x muscle deep on the outer aspect of the upper third of right arm exposing the underlying tissue along with traumatic amputation of lower third of the left thigh exposing the underlying tissue including the bone.

On internal examination, A reddish colour sub scalp contusion of size 3cm x 2cm present on the right temporal region. On opening the abdomen, around 1 liter of blood-stained fluid present in the peritoneal cavity along with multiple lacerations on the surface of the liver with extravasation of blood into surrounding tissue. The cause of death was hemorrhagic shock due to multiple injuries. The manner of death was accidental.

Case 8:

A 23-year-old male, working as helper in a pharmaceutical company was on duty. On the early hours of 08/02/2016 at around 6:15 am the Nutsche Filter attached to reactor exploded resulting in the death of the individual who was standing outside next to the reactor room. During the post-mortem examination, on external examination the whole body including the clothes are covered with intermediary chemicals spilled from the exploded reactor and the body of the individual was lying supine with both upper limbs covering the face and in rigor, right lower limb is adducted, internal rotated with swelling at the hip joint. Avulsed laceration of the right foot at the level of the metatarsal phalangeal joint exposing the underlying tissue including the bones with extravasation of blood into the surrounding tissues. Left leg is shortened with swelling, abnormal mobility with crepitus with underlying fracture dislocation of both bones of left leg along with avulsed laceration of the skin of the

sole completely exposing the underlying fascia. On internal examination multiple contusions 3cm x 5cm are present over the frontal region of the scalp. On opening abdomen organs are pale with multiple lacerations over the surface of the liver. Closed fracture dislocation of the pelvic bone at the symphysis pubis and right sacroiliac joint. The cause of death was hemorrhagic shock due to multiple injuries. The manner of death was accidental.

Case 9:

A 22-year-old male, working as helper in a pharmaceutical company was on duty. On the early hours of 08/02/2016 at around 6:15 am the Nutsche filter attached to reactor exploded resulting in the death of the individual who was working in the reactor room (**Fig. 7**). During the post mortem examination, the head of the individual is served from the trunk at the level of C6 and C7 vertebrae. The trunks along with upper limbs are completely mutilated and all the internal organs are dissipated across the room, bowels charred with deposition of shrapnel on the body parts (**Fig. 7-10**). Skin was hardened due to the chemical spillage on them. The cause of death was hemorrhagic shock due to multiple injuries. The manner of death was accidental.

Figure 7: Crime scene showing the rubble due to collapse of wall as a result of reactor explosion.

Figure 8: Complete disintegration of the body as a result of reactor explosion.

Figure 9: Amputation of the upper limb and lower limb along with evisceration of bowel loops as result of the projectile arising from the reactor explosion.

Figure 10: Eviscerated bowel loops as result of the projectile arising from the reactor explosion.

4. Discussion:

Probable hypothesis for blast in this case 1:

Any remnants of thinner used in painting or thinner soaked cloth material might have supposedly caught fire due to a spark generated on sudden strike of axe on the iron lid. Burning of thinner material might have generated gasses which found difficult to get out through the small vent created by the deceased. The compression generated thereby might have led to a blast. Few other things like a plastering trowel piece left in the tin may have taken a projectile course. Thinner used in paints contains Mineral spirits/ white spirit, Acetone, Turpentine, Naphtha, Toluene, Methyl ethyl ketone (MEK), Dimethyl formamide (DMF), 2-Butoxyethanol, or any of the other glycol ethers which are potential inflammable materials

Probable hypothesis for blast in case 2:

Sudden breaking of pressure/flow regulator knob of the oxygen cylinder while placing it in the trolley of auto led to a sudden decompression of pressurized oxygen leading to a heat and blast wave generation which led to shattering of glass and

disruption in scene and death of individuals handling the cylinder.

Probable hypothesis for blast in case 3:

Failure of the valve that regulated pressure/volume flow in to the AC compressor led to increased thrust of the gas inside, which led to sudden explosion.

Probable hypothesis for blast in cases 4-9:

Industrial safety experts concluded that pressure dysregulation within the agitated nutshce filter lead to a reactor blast causing the fatalities.

Table no. 1: Causes and prevention of common occupational blasts[2, 3, 4, 5, 6, 7, 8, 9, 10]

S.No	Occupational Set-up	Reasons for Explosions	Prevention
1	Boiler blasts/Reactor blasts/Furnace blasts	Tube failure in steam boiler or heat exchanger, furnace explosion and boiler explosion are caused due to wear and tear of the industrial apparatus and improper maintenance in several industries. Ex: cracks in the boilers etc	Intensification of repair and maintenance works. Regular safety audit of apparatus.
2	Working in scrap units/plants	Hammering/dismantling an old bomb shell for retrieving metal, reaction between chemical solvents in scrapped containers, unexploded explosives catching fire when they are manipulated during scrapping operations. Unexploded ordnance (UXO) in scrap can be a reason.	Scrap should be segregated at source and personnel working in this sector should be educated about proper management of scrap.
3	Working with unauthorized LPG refilling	Pressure differential, faulty technique and using unfit adapters for transferring LPG from a large cylinder to smaller cylinders.	Refrain from unsupervised and unauthorized transfer of LPG from one cylinder to another.
4	Working with Air Conditioning units/ Refrigerators for gas refilling related tasks	Filling different types of gasses, using inexpensive, inappropriate coolant gas and dysregulation of pressures while filling, failure of pressure/volume control. Blasts can also occur if coolant is filled without clearing nitrogen gas used for testing any leak.	Use only R22, R12, R32, R410 or R134 as coolants and never use propane/butane as coolant which is highly inflammable.
5	Working with Oxygen/Nitrogen/ Hydrogen gas cylinders- manufacture and supply	• Placing oxygen cylinders under the sun, using lubricants like oil or grease, lifting the cylinders at the neck/junction of the valve and completely emptying the cylinder. • Though nitrogen gas is not inflammable, sudden pressure decompression incidents lead to blasts. • Reactions inside pressure vessel can lead to hydrogen cylinder blasts	• Using proper material like Cu, Fe for making the cylinders, placing the cylinders gently on ground without any jerk to prevent mechanical shock, always transport cylinders in trolley/ lifting bucket / pallet. • Design the filling plants with all due precautions from regulatory authorities like the OSHA.
6	Other industrial fires & explosions	• Improper management of combustible dust. • Hot work including brazing, burning, welding, torch cutting etc. • Flammable liquids and gasses in chemical plants. • Faulty equipment and machinery. • Electrical Hazards	• Applying the safest industrial vacuum for the workplace. • Ensure that hot-work area is clear from flammable or combustible materials. • Storing flammable liquids properly, controlling the ignition source and providing PPE. • Training personnel, proper cleaning and housekeeping & regular maintenance. • Proper load management of circuits, avoiding extension cords and using antistatic equipment where required

All the blast scenarios discussed above produced typical injuries described in literature which included abrasions, contusions, lacerations, penetrating trauma and internal injuries like blast

lung, acoustic trauma, disruption and perforation because of blast wave.[11] Injuries due to explosions are generally categorized as primary, secondary, tertiary and quaternary blast injuries.

As discussed above, sometimes there can be fatal internal injuries due to blast wave with trivial external injuries for humans working within the vicinity of the explosion. Apart from specific causes and prevention strategies described in the table, one has stress upon the use of appropriate personal protective equipment and safety awareness as a culture in formal industrial setup to reduce morbidity and mortality due to explosions.

5. Conclusion:

The occupational safety and health regulations are laid down by statute and enforced through agencies like Directorate General Factory Advice Service and Labour Institutes, DGFASLI, Government of India and the state level inspectorates of factories & boilers in India. These standards are to be scrupulously followed to prevent any industrial mishaps in the formal industrial sector. Maintaining check lists, running mock safety drills; doing early hazard analysis, ensuring regular maintenance of equipment will do a great favor in reducing the loss of life and limb due to explosion injuries. However, the bigger challenge before all of us is to look after the safety of a large chunk of workforce in the informal sector which is largely composed of semiskilled manpower. Conducting regular free skill training and safety workshops will transform their lives by instilling as sense of care and caution in their work.

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Original Review Article

Anti-Forensics: Tool Against Cyber Forensics

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and concealing.

Abstract

Introduction: Anti-forensics refers to a set of strategies and actions used by someone to obstruct a digital inquiry. **Objective:** The aim of this work is to organize the different anti-forensic tools, discussing their potential anti-forensic applications on a system, and provide a category data set that would be helpful to the digital forensic community. **Methodology:** This review paper examines a variety of Anti Forensic methods and procedures, including data concealing, system data erasing, and an attack against forensic technologies that aid in criminal investigations. With the increase in advancement of technology, it will increase cybercrime activities due to this the need of anti-forensic is compulsory for dealing with cybercriminals. **Result & Discussion:** Present backdrop provides important information about anti-forensics in cybercrime. Cybercriminals have recently improved their ability to decrypt forensics tools by practicing new skills. Investigators can recreate an intruder's activities and recover lost files thanks to the various forensic technologies. **Conclusion:** Cybercrime detectives and academics are becoming increasingly interested in Anti- forensic. The exchange of knowledge can be facilitated by a formal definition of anti-digital forensics and common terminology that is relevant to it and makes it possible for better mitigating measures. Any attempts to change, interrupt, negate, or otherwise interfere with forensic investigations that are supported by science are anti-forensics. They categorise anti-forensic mechanisms, tactics, and methods and assess their effectiveness.

1. Introduction

Digital forensic is useful in examination & analysis techniques to gather & preserve evidence from a suitable computing device in a form that is admissible in court. Despite being a relatively young scientific discipline, digital forensics has attracted a lot of attention during the past ten to fifteen years.[1] Digital cyber forensics' objective is to conduct a thorough examination while preserving a recorded chain of evidence to determine precisely what was discovered on that computing device. Examiners and analysts now regularly employ digital forensic techniques.

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The enormous volume of data generated by contemporary computer systems, which have emerged as a key source of digital evidence, is what has drawn this attention.[1,2]The offender and the crime scene always exchange information, according to Locard's concept. The cyberspace-related Locard principle improves understanding of the interconnectedness of these types of evidence, their precise time frames of occurrence, and the most significant method to recognize offenders. Anti-forensic investigators dissect & compile all the information into a solo assertion that describes the nature & progression of a certain action.[2] Contrarily, anti-forensics is primarily focused on concealing or changing digital evidence to make it useless in legal proceedings, making it expensive and time-consuming to recover and examine. These concerns are present, along with others regarding the best forensic tools for anti-forensics work.[3]To put it briefly, anti-forensics compromises the usability and benefit of proof in procedures together with forensics for professionals. Anti-forensics actions can be carried out in a variety of ways, and once they are in place, they can have an impact on the course of an inquiry at any point.[2,4]

While most of the techniques are intended specifically to undermine digital forensics, some of these techniques have valid uses. For instance, digital watermarking prevents copyright infringement while encryption safeguards organizational assets.[4] Using such methods against computer forensics may prevent investigators from accessing crucial information.[5] Nevertheless, very little actual work has been done to evaluate the methodologies and essentially determine their suitability up to this point. The goal of this review is to recognize the most common digital AF procedures and examine them with forensic tools. The query of "whether computer anti-forensics can impede the investigation process and prevent real artifacts from being discovered and acceptable in the judicial process" is one of the main issues that needs to be taken care of.[6]

The review study used a variety of methods to find the best review sources. First, rely only on reliable sources from governmental organizations like the judicial system and organizations in charge of developing technical standards.[7] Due to computer-related crimes, digital forensics is an emerging and quickly expanding field.[5,7] Solving instances involving the abuse of digital technology has grown to be the enforcement agencies' main focus. According to several studies and academics, many criminals utilize anti-forensics strategies to conceal their actions so that forensic investigators won't catch them.[8] For instance, AF, as objected to the additional traditional research approaches on automated forensics, is mostly to blame for the dearth of sufficient hypothetical investigations. The forensic expert's retrieval and examination of a digital system must follow specific protocols for electronic evidence to be admissible in court.[9]

The main goal of anti-forensics is as follows:

- Avoid catching any evidence of nefarious conduct that has already occurred.
- Interfere with the acquisition of information by making it nearly unfeasible for the forensic investigator to find any proof that could be used against them.
- When an obstacle is placed in the way of the inquiry, the examiner must spend more time to conclude the case. The procedure is slowed down by anti-forensics, and dissatisfaction sets in. The exhaustion caused by this can make the digital forensic investigator consider giving up.[10]
- Doubting forensic reports or witnesses' testimony, so casting doubt on the admissibility of the evidence in the eyes of the jury or judge.
- Quickest attacks on the forensic examiner, such as finding and altering the examiner's network or bombing the same network which is being investigated, can be used to sabotage forensic tools by utilizing the same methods to target organizations within.

Digital forensics emerged as a new area of computer science in recent decades and has attracted a lot of interest. This is important to take into account because current computer systems store enormous amounts of data, which is effectively the best source of evidence when conducting an investigation.[11] Where the proof must be a comprehensive, dependable, accurate, experimentally lawful, and legally measured evaluation of this evidence reveals and recognizes its relevance.[6] Conlan outlined some of the limitations of a digital forensic inquiry as follows to provide more contexts:

a) Psyche: All forensic investigators employ a variety of techniques during the investigations.[3] Some procedure efficacy varies based on the investigator's intelligence, experience, and background, as well as factors like education and experience. To perform

investigations in a way that is comfortable for them, many forensic investigators have built their techniques and procedure. These may have evolved through experience.[7]

b) Implementation of tools: Tools are a key component of forensic investigations. These, however, are vulnerable to compromise, which has an impact on the effectiveness and soundness of evidence results. For example, a forensics expert uses a limited set of techniques, which could hurt the conclusion of their inquiry, as in the case of memory forensics. The cost of purchasing commercial forensic equipment might be very high. The functionality of open-source tools could also be constrained, and they might require some add-ons that aren't always easy to come by.[6,7]

c) Logical/physical challenges: These include timetables and the issue of funding an inquiry, as well as the accessibility or insufficiency of implementing tools such as storage devices, write blocks, firewalls, etc.[7] The pace of technological advancement is faster than the speed of light, and forensics professionals must be adaptable and resilient to keep up.

Due to conflicting technological and regulatory I ssues, no. of difficulties is faced. For instance, encryption is frequently employed as a tactic to protect confidential papers.[11] At the same time, hackers employ encryption to thwart forensic investigations. The famous Apple Vs the FBI order is based on the San Bernardino case, in which the judiciary gave Apple orders to create a new program that would overcome the software security lock, allowing the government to unlock the phones and retrieve the data without going around the security measures. One of these demands was for Apple to digitally sign forensic software that would allow phones seized from suspects in the San Bernardino massacre to be unlocked.[12,13] The authorities asked for help from outside parties to unlock the phones after Apple refused to comply with their demands. The assumption that law enforcement agencies have the right to access these individual areas and details presents several legal issues regarding their eligibility for usual access to such data.[14]

In this study, just three anti-forensic methods will be investigated. These methods consist of:

- Masking of Data
- Encapsulation of Data
- Erasure of Data

The following instruments will be analyzed to gauge the effectiveness of forensic analytical tools:

- Autopsy
- Encase
- FTK Imager

Encase and Autopsy are two programs that can be used to analyze hidden processes and metadata, while FTK Imager can be used to create memory dumps and analyze email traces. While we conducted our investigation using free source software, commercial software is now available with improved reporting and analysis capabilities. As a result, our focus was strictly on the software's analysis of the results.[7,15,16]

2. Review of Literature and discussion

Defining anti-digital forensics:

As stated earlier, academicians and cybercriminal investigators are becoming increasingly interested in anti-digital forensics. Practitioners and scientists may be tempted to oppose anti-digital forensics with their definitions, based on their own experiences, which will differ, if there is no agreed-upon standard definition. Practitioners must be able to recognize the same anti-forensic activities that others have come across in the past, given the development of cybercrime and the abundance of software that can be used to obstruct forensic investigations. Better mitigation techniques can be implemented with the help of a defined definition of anti-digital forensics and a standardized vocabulary of terminology that is relevant to it. So, it would be good to start by highlighting how earlier research defined anti-digital forensics.[17]

Tackling the anti-digital forensics issue

It would be appropriate to become familiar with prior approaches that address the domain as a whole before addressing anti-digital forensics. Numerous works seek to define the subfield of anti-digital forensics and suggest potential solutions for the expanding issue. With the development of technology, forensic investigators are increasingly using new methods to carry out their investigations quickly, efficiently, and successfully.[18] Anti-forensic methods or procedures are those employed to undermine forensic investigation.[19] The recognition and unsheathing of forensic information that may be important to the examination come after the securement of the data source. Data concealment frequently employs the following three methods:

encryption, steganography, and trail obfuscation.[20] Masking and cipher are tools used by cyber criminals to thwart investigators' attempts to identify them and acquire forensic data while maintaining access to themselves.

Encryption, which is frequently used to safeguard data from unauthorized access, has been adopted by cybercriminals to thwart forensic investigations. The tactic is that the existence of the information is not concealed from the examiners, but its legibility is rendered unfeasible, barring additional decryption work.[21] File-based and disc encryption are the 2 types of encryptions that computer criminals most frequently use. File-based encryption converts the contents of the file into a ciphertext that can only be decrypted with the correct key to be read. Disk encryption encrypts the whole storage partition that houses the data, making it impossible to access the disc without a decryption key. Both forms of encryption are supported by encryption programs like Vera Crypt and Cipher Shed.[22]

Steganography

Steganography is a method for hiding data, messages, or files behind more obvious data, messages, or files. As an illustration, consider a subtle watermark tucked away inside a document. The method is applied to video/audio files, photos, and written materials.[23] Once the investigators catch wind of its use, it is quite straightforward to crack. FTK Imager is one example of a simple tool for deciphering ciphered texts. Second, the strategies are only applicable to extremely small amounts of data. Last, hiding a file inside another file changes its appearance, which the investigators may readily detect. Steganography can be used in conjunction with other encryption techniques, such as cryptography, to increase its effectiveness.

Trail obfuscation

The use of various tools and techniques to obfuscate the path of a computer crime is known as trail obfuscation. By altering the timestamps of the files, for instance, to provide a way for the investigators to look in the inappropriate periods, the goal of the present strategy is to deceive or redirect the investigator's line of inquiry away from the criminal's traces. A culprit can successfully make a file pointless in a courtroom by using these kinds of technologies. A criminal can change a file header's metadata using Transmogrify to hide it. For instance, renaming an image's extension to (.doc) will cause the scanner used by a forensic investigator to leap the altered image because of its (.doc) extension. According to Perklin, a forensic inquiry can be hampered by trail obfuscation for around 15 hours. He suggests several masking methods; file locating, for instance, entails the formation of a record that loop, when followed, returns a monotonous fallacy. This new header contains the source and destination addresses of the following onion router in the network. The messages are encrypted to make sure they arrive at their destination anonymously. Reverse routing is the primary method used by forensic specialists to decrypt the message, which takes a lot of time.

Fake Spoofing is the process of hiding communication to access a structured organization without the necessary user privileges. Internet Protocol spoofing happens the moment an attacker conceals their true IP address by using many IP addresses to carry out malicious actions. When conducting a Distributed Denial of Service Attack, attackers mostly use IP spoofing (DDoS).[24] *Modifying the Metadata Data* that offers details on other data is referred to as metadata; other metadata can often be referred to as "data for a data." There are specific metadata 11 that are related to each file, such as the file's title. Metadata is crucial for learning more about a file because it is descriptive in nature. The type of the file, its size, the author, and the creation/modification date are further instances of metadata.[24]

Any time information is added to or modified in a file that information becomes the file's metadata. Metadata can be created manually or automatically; manually created metadata involves manually entering metadata items by a user; automatically created metadata involves an automated entry by software. Since a user has the freedom to insert any information, they think pertinent, manual production frequently results in more accurate results. Automated metadata is frequently restricted to a small number of components, including a file's size and its *Modification, Accessed, and Created* (MAC) dates, which display some metadata of an image file titled "Metadata."[25] Administrative data describes the Intellectual Property Rights (IPR) of a file and gives technical information about an asset, such as the author of the asset. The handbook advises using an automatic degausser to erase data from hard disc drives; the masquerader works by obliterating the

central platters of the hard disc. However, the kind of wiping program, not the category of storage media, is what matters most when erasing data. A common procedure for permanently wiping data from storage devices to stop it from being recovered is called data sanitization. Many professionals in the forensic sector employ and investigate certain data-wiping standards that have generally been shown to be quite effective; few of these procedures constitute the following: [26,27]

- DoD 5220.22 M The US National Industrial Security Program is in charge of creating and maintaining this standard. It functions by overwriting particular data that is kept in a storage device. There are two basic variations of DoD 5220.22 M: a *3-phase* and a *7-phase* series of stages. Three steps make up the dexterity implementation. Writes a zero and checks the write, a one and checks the write, and a random character and checks the write.
- The US National Security Agency created and assisted NCSC-TG-025 The standard is implemented and functionally equivalent to DoD 5220.22 M, although it provides duplicate info.
- P-5239-26 NAVSO The US Navy helped to develop and promote this method. It is implemented like the AR 380-19, but it replaces specified characters with normal character complements and random personalities.
- Gutmann scored 35 passes. Peter Guttmann created this technique. The approach requires 35 passes of overwriting a random part and confirming, as the name would imply. This method is regarded as being outmoded, nevertheless, as storage device technology advances.

3. Conclusion and Future Prospects

The objective of the immense efforts was to gather and organize anti-forensic tools, specifying their potential anti-forensic uses on a system, and providing a category dataset that would be helpful to the AF community. The creation of an expanded taxonomy for the true AF anatomy was another objective, to capture all potential applications within the anti-forensics field. The category data set's scope could be expanded in future work to add more tools, of which there are a number of them. According to the findings, identifying information on anti-digital forensic tools and compiling it into a body of knowledge that is easily available has the potential to be useful and helpful to digital forensic ideologues. Last but not least, scientists working in computational linguistics may be interested in techniques to automate the classification of anti-forensic tools because this may potentially be done by analyzing tool information online and using machine learning. The developing issue of anti-digital forensics would be helped by a further study on this topic as well as in the field in general.

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Original Review Article

Molecular Autopsy in Sudden Unexpected Death: A Review

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Abstract

Introduction: The term "molecular autopsy" refers to a technique in forensic medicine that focuses on the use of genetic diagnostic in post-mortem samples in the absence of a definitive diagnosis, therefore classifying the death as sudden unexplained death (SUD). In addition to traditional autopsy, these post-mortem molecular investigations have the ability to identify genetic changes that may have contributed to the disease that resulted in the SUD. **Challenges**: There are multiple reasons for implementation of this procedure, comprising of economic causes or the legal restrictions involved with the sample collection, The storage time and the number of genes analysed, as well as the ethical implications of inheritable results attained after a molecular necropsy. **Medicolegal issues**: Post-mortem examinations within the country are performed as per the minimal prescribed standards, there is void in uniformity of the procedures followed in multiple countries thereby creating hindrance to appropriate rendition in clinical practice. A negative autopsy in the cases of sudden death creates a room of suspicion or dissatisfaction in the minds of the relatives of the deceased about the death of the deceased. In such case molecular autopsy can be considered as critical approach to uncover the pathogenic inheritable condition. **Conclusion:** Ascertaining of the cause of death of the deceased permits to satisfy the family members of deceased to exclude suspicion. It also aids the treating doctors to detect promptly the occurrence in the condition in the relatives of the deceased and performing the preventive measures of causing genetic abnormalities.

1. Introduction

Sudden cardiac death (SCD) is defined as a natural unexpected death without an obvious non-cardiac cause arising within 1 hour of onset of symptom, while in unwitnessed settings the natural unexpected death occurs within 24 hours of last being observed in normal health.[1] Adult sudden fatalities are primarily brought on by terminal ventricular arrhythmias and atherosclerotic coronary artery disease.[2] Aortic dissection, myocarditis, hypertrophic cardiomyopathy, congenital coronary artery anomali-

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es, such as the left coronary artery's anomalous origin from the right sinus of Valsalva, and congenital coronary artery anomalies can all be used to explain many sudden deaths in young people.[3] Although there were no aberrant autopsy results, children who had previously been healthy account for roughly half of all abrupt fatalities. These fatalities are written off as cases of SUDS (sudden unexplained death syndrome).[4] Because potentially fatal arrhythmogenic illnesses including long QT syndrome (LQTS), Brugada syndrome, and Wolf-Parkinson-White syndrome leave no evidence at autopsy examination, forensic pathologists could only surmise that a fatal arrhythmia might be at the core of SUDS in the past. Molecular autopsy can be of immense help in such cases.[5]

The term "molecular autopsy" refers to a technique in forensic medicine that focuses on the use of genetic diagnostic in post-mortem samples in the absence of a definitive diagnosis, therefore classifying the death as sudden unexplained death (SUD).[3] In addition to traditional autopsy, these post-mortem molecular investigations have the ability to identify genetic changes that may have contributed to the disease that resulted in the SUD. Nearly 5% of all performed autopsies result in a comprehensive forensic autopsy of a deceased individual being non-conclusive (also known as a negative autopsy). [4] The incidence of sudden cardiac death is 40–100 per 100,000 person-years worldwide, accounting for 15–20% of all deaths.[6] After a thorough autopsy examination, almost 30% of SCD cases in young people still have an undetermined cause of death. [7, 8]

When an inherited arrhythmogenic Syndrome (IAS) is suspected, an underutilised tool from the current forensic field i.e. genetic testing is used. There is possibility that the family members are carrying pathogenic genetic modifications because most illnesses are inherited in nature, increasing the likelihood that they may develop the same malignant arrhythmogenic entity. Considering all available information, identifying the genetic change is essential for diagnosis, assisting in determining the most likely reason for an untimely death, as well as for preventing arrhythmogenic events in the families of the deceased. Early detection of genetic carriers who are at risk permits the implementation of preventive, personalised therapy. [9] Genetic analysis can now be done more quickly and affordably due to next-generation sequencing (NGS) technologies. In nearly 20% of instances, notably in the young population. [8,10–16]A clear pathogenic genetic change is found during a molecular autopsy utilising next-generation sequencing (NGS).

However, the majority of SCD cases still have a negative or inconclusive genetic diagnosis, primarily because uncommon variations found in known genes related with IAS are still categorised as having an unclear role or as having unknown significance. Despite this, the most recent clinical guidelines advise molecular autopsy in SUD cases with a highly suspected IAS cause of death. [9, 17, 18]

2. Conditions involving risk of sudden death in cardiac diseases with normal heart

In the majority of affluent nations, cardiovascular illnesses are responsible for nearly 90% of all cases of sudden death.[19] It has both coronary and non-coronary causes, with coronary factors being the predominant cause in most instances. Embolization, dissecting aneurysms, arteritis, and congenital anomalies are only a few of the non-atherosclerotic causes. Non-coronary causes include congenital heart defects, hypertensive heart conditions, illnesses of the heart valves, myocarditis, and other conditions.[19]Postmortem genetic testing becomes essential to determine the cause of death in genetic cardiac illnesses, such as channelopathies and cardiomyopathies, which are evaluated if the first forensic investigation cannot determine the cause of death.[20] LQTS, SQTS, CPVT, and BrS are all considered to be channelopathies. Hypertrophic cardiomyopathy (HCM), dilated cardiomyopathy, arrhythmogenic cardiomyopathy (ACM), restrictive cardiomyopathy, and specific and undefined cardiomyopathy are all included in the cardiomyopathy group. [21, 22]

Channelopathies are diseases brought on by genetic changes to the proteins or genes that code for the cardiac ion channels. No abnormality of heart structural anatomy is detected in cardiac channelopathies, but sudden mortality results from electrical anomalies including ventricular fibrillation or polymorphic ventricular tachycardia.[23, 24] About 10–25% of adult SUD and up to a third of SUD in babies and adolescents are caused by cardiovascular channelopathies. [22]

Long QT syndrome (LQTS): The term "LQTS" refers to a hereditary ion channel issue and excludes acquired causes of QT prolonging include heart conditions, medications, hypokalemia, and stroke, which are referred to as "acquired LQTS." This

syndrome is characterized by prolonged repolarization. The heart-rate-corrected QT interval (QTc) of greater than or equal to 480 ms can be used to diagnose it, as can the Schwartz criteria, which comprise the clinical history, family history, and 12-lead ECG. [24,25]

Catecholaminergic polymorphic ventricular tachycardia (CPVT) is more common in males and children between the ages of 4 and 12 years old. It is caused by exercise, especially swimming and manifest as syncope or cardiac arrest. It is less frequent than LQTS, but it is more severe because the postmortem CPVT results in cases of sudden arrhythmic death syndrome (SADS) are almost as often as LQTS. RYR2 and CASQ2 mutations are the most often found harmful mutations. In the resting ECG, CPVT has no abnormalities.[24,25] Hypertrophic cardiomyopathy (HCM) is one of the most prevalent autosomal dominant hereditary diseases among cardiomyopathies. It is a significant contributor to SCD in kids and athletes. It can be recognized by the asymmetrical hypertrophy of the ventricular septum, thickening of the ventricular wall, increased heart weight, and narrowed ventricular cavity. Both familial and sporadic pathogenic mutations have been linked to HCM. The third most frequent cause of SCD, accounting for 5.9–6.2% of all SCDs, is hereditary cardiomyopathy. [26]

Numerous epileptic diseases have underlying genetic abnormalities that enhance the incidence of SUDEP, such as familial focal epilepsy linked to the DEPDC5 gene[27], Dravet syndrome with a genetic variant in SCN1A, early infantile encephalopathy with a genetic variant in SCN8A, and early infantile encephalopathy. The importance of genetic analysis in SUDEP and the potential preventative measure for high-risk living relatives is highlighted by knowledge of these underlying genetics. [28] Metabolic disorders: SUDI is a term used to refer to all sudden unexpected deaths that occur between the ages of birth and up to 12 months, including occurrences of SIDS. [29]

3. Samples for genetic testing

Postmortem genetic testing for SIDS refers to cases where the cause of death can't be determined after an in-depth autopsy .[30] Blood is currently considered the optimal specimen for molecular genetics studies.[31] Currently, there are several technical platforms for genetic analysis, and each platform has its own specific protocols. Therefore, samples must meet the specific specifications of each system before an NGS study can be performed. It is recommended to retain at least 5 – 10 ml of blood and store it in Ethylene, Diamine Tetra Acid (EDTA) tube. Collection of blood less than 48 hours after the death is the best time to avoid progressive DNA degradation, which would prevent a proper NGS.

Still, tubes can be retained during first 48 hrs after collection even If no cold temperature is available for storage at room temperature. If the sample needs to be stored more than 2 days for DNA profiling, it's recommended to store tubes at 4*C (2 – 4 weeks). [32] Preservation at -20*C is an option available if DNA analysis will be performed after more than 2 – 4 weeks in order to preserve DNA integrity.[33] But storage of EDTA tube at freezing temperature to be avoided as there is possibility of damage to DNA structure. Similarly, 5 g of heart, liver, muscle or spleen tissue can also be preserved considering the fact that that testing to be done immediately. If the timing of the analysis is delayed, then the tissue can be placed in liquid nitrogen for one minute and then freezed at -20 to -80 * C till the DNA extraction is being done. Defrosting of the tissue is needed before DNA extraction of such tissue so as to prevent breaking of DNA sequence.

In routine protocols performing necropsy, formalin fixed paraffin embedded tissue samples are stored. But it is not recommended as the DNA extracted is highly variable in these tissues and quality or quantity of the DNA extracted is less for carrying out NGS study. [34]There is destruction of DNA during the process of paraffin embedding ultimately causes faults in the sequences. In spite of this there are studies where DNA can be extracted from FFPE tissues that is well suited for DNA sequencing. [35 – 38]

4. Recommendations

The main considerations affiliated to molecular necropsy were all cases of SCD in those under 40 times of age, the collection and acceptable storehouse of samples for the study, communication with the family, and a multidisciplinary approach that includes genetic counselling.

A comprehensive forensic necropsy should include a protocol for the collection and storehouse of tissue suitable for molecular autopsy. In depth familial history is essential to ascertain the cause of death in cases of SUD. If genetic testing is not possible then genetic testing of first-degree relatives needs to be done.[33]

5. Challenges for molecular necropsy

Eventually, despite the fact that molecular necropsy is extensively recommended, it isn't included in forensic protocols in many countries across the globe. There are multiple reasons for implementation of this procedure, comprising of economic causes or the legal restrictions involved with the sample collection, the storage time and the number of genes analysed, as well as the ethical implication of inheritable results attained after a molecular necropsy. Also due to the progressive number of rare variants which lead to obstruse role after a molecular necropsy, ultimately leading to large number of SUD cases remains unsettled. Hence it very essential to develop guidelines concentrated on variant interpretation in forensic Medicine.[39]

6. Medico-legal issues

Despite recommended in current guidelines, performing molecular necropsy generally depends on the authorization given by the competent public authorities.[40] Even if this authorization is granted, consent for the analysis isn't generally needed.[41] But, in certain countries and under specific conditions, consent of relatives can be still asked for authorization to preserve any tissue from the dead body. When an IAS is suspected, postmortem genetic testing should be considered be of public health significance, since these diseases are transmitted in a autosomal dominant fashion.[42] First degree relative, who are directly exposed to this threat, should be precisely counselled, thereby balancing health drawbacks.[43] It is advisable to provide information to the person who providing consent regarding reason and procedure of carrying out genetic study as well as the benefits for family members, and especially newborns.[31, 41]

In our country, foundation of multidisciplinary referral units at various levels in the postmortem opinion of SCD cases and treatment of their cousins with an implicit IAS is extensively recognised in spite of not ultimately enforced.[44] Currently there are great variations present in avoidance of SCD at level of judiciary and healthcare due to variation in the recognition of forensic skills as well as variances in the forensic organizations within the country.[45] In addition, even though post-mortem examinations with in the country are performed as per the minimal prescribed standards, there is void in uniformity of the procedures followed in multiple countries thereby creating hindrance to appropriate rendition in clinical practice.

7. Conclusion

A negative autopsy in the cases of sudden death creates a room of suspicion or dissatisfaction in the minds of the relatives of the deceased about the death of the deceased. In such case molecular autopsy can be considered as critical approach to uncover the pathogenic inheritable condition. Ascertaining of the cause of death of the deceased permits to satisfy the family members of deceased to exclude suspicion. It also aids the treating doctors to detect promptly the occurrence in the condition in the relatives of the deceased and performing the preventive measures of causing genetic abnormalities.

In these cases, the transition into clinical practice should be done with caution, and a close multidisciplinary collaboration including fore nsic experts, pathologists, cardiologists, pediatric cardiologists, and specialized geneticists is pivotal.

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Original Review Article

Importance of Polycyclic Aromatic Hydrocarbons as a Chemical Marker in Forensic Studies

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Abstract

Introduction: Polycyclic aromatic hydrocarbons (PAHs) are omnipresent micro-pollutants. They are ubiquitous and carcinogenic in nature and found in the environment. They are obtained from Petrogenic and Pyrogenic sources and hence found everywhere. **Medicolegal aspects:** In recent studies, they are used as chemical markers in source identification. When petroleum products and organic materials are burned they produce a specific and unique type of PAHs which are used as chemical markers in the source apportionment. In the present study importance of polycyclic aromatic hydrocarbons is explored in several fields of forensic science such as forensic toxicology, Environmental Forensics, Food Forensics, Petroleum Forensics, and in fire investigation. **Conclusion:** Polycyclic aromatic hydrocarbons are important in the different fields of forensic science such as forensic toxicology, environmental forensics, food forensic and petroleum forensic etc.

1. Introduction

Polycyclic aromatic hydrocarbons are omnipresent micro-pollutants (**Fig. no. 1**).[1, 2] They are two to five rings of hydrophobic organic aromatic compounds, oleophilic in nature. Pure chemical PAHs are colorless, or pale-yellowish color solid. On the basis of molecular weight classification, they are classified into two categories i.e. low molecular weight (LMW) and High molecular weight (HMW).[3,4]They are classified on the basis of its origin as Digenic, Pyrogenic and Petrogenic. Digenic when it is produce thorough the volcanic eruption and degradation of organic matter. When they are produce through the incomplete combustion of organic matter like wood, oil, vehicular emission, industrial emission then it is considered as pyrogenic and when they are produce due to contamination with petroleum product then it is considered as petrogenic PAHs (**Table 1**). Petrogenic PAHs are also called natural sources because they are produce from the erosion of petroliferous shales.[5,6]

2. Importance of Polycyclic Aromatic Hydrocarbons in Forensic Investigation

2.1 Forensic Toxicology

Modern toxicology deals with the identification of unknown chemicals that are found in living organisms.[7] PAHs consists of the largest class of cancer-causing chemicals and ranked 9th among chemical compounds threatening humans. It has the ability to accumulate in living soft tissues.

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They are not directly carcinogenic instead of that they act as a synergist. Its carcinogenic effect is due to its ability to bind DNA thereby causing disruptive effects that can result in tumor initiation. Most of them show genotoxic, mutagenic, teratogenic, and carcinogenic effects. It is a persistent organic pollutant more than hundreds of PAH compounds were identified however out of these only 16 was classified and identified by EPA as priority-listed carcinogenic PAHs. In one study on toxicity of benzo(a)pyrene (Bap) on mice conducted, it was found that it causes carcinomas distal to the point of application, 70% or more than that incidence of gastric tumors were found in mice fed 50-250 ppm for 4-6 months. In another study, tumors were observed in the forestomach, esophagus and larynx of rat who are ingested Benzo(a)pyrene. It was also found that 90% of contribution of BaP ingestion is due to food in non-smokers and only 1% contribution is due to air inhalation and to drinking water. Benzo (a)pyrene causes lung and liver tumor. They are found in urine, blood and tissues. They are enzymatically converted in mammalian cells to polar reactive intermediates, capable of covalently binding to cellular macromolecules.[8]

Exposure to benzo(a)pyrene at the celluar level leads to the formation of DNA adducts N^2-deoxyguanosine and N^6-deoxyadenosine with guanine and adenine nucleotides respectively.[9] One study conducted on analysis of PAHs associated with terrorist attack at world trade center (WTC), wherein pregnant women who were present at the time of attack at WTC were studied and it was found that women in the first trimester of pregnancy delivered infants with significantly shorter gestation (-3.6 days) and a smaller head circumference (-0.48 cm) compared with women at later stages of pregnancy, regardless of the distance of their residence or work sites from the WTC.[10]

Fig. no.1: Chemical Structure of United Nation Environmental Protection Agency Listed 16 PAHs

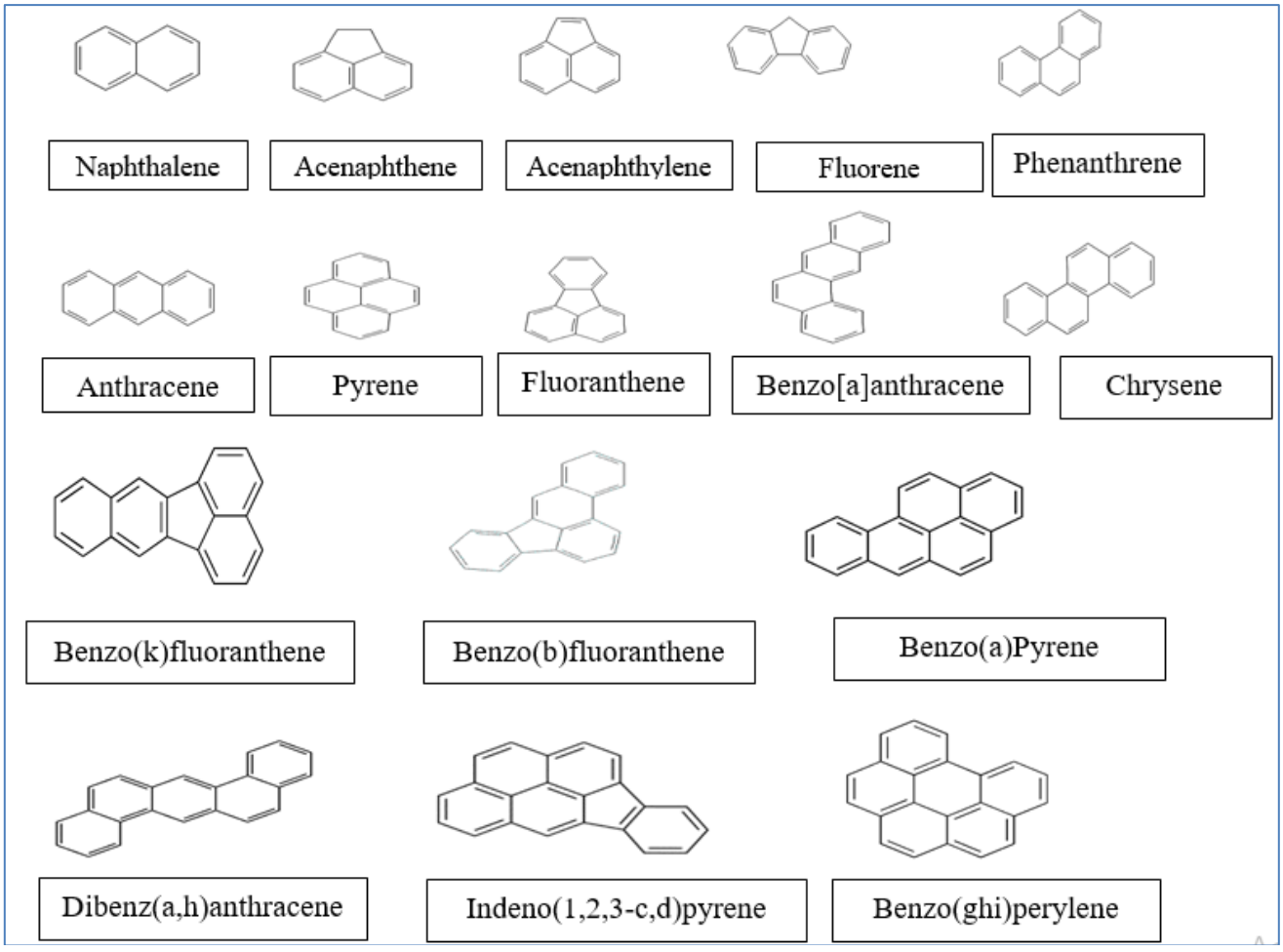

Table No. 1: Chemical Properties of United Nation Environmental Protection Agency Listed 16 PAHs

Sr. No.	PAHs	Abbreviation	Molecular Formula	Melting Point (°C)	Boiling Point (°C)	Flash Point (°C)	Relative Molecular mass	IUPAC name
1	Naphthalene	Nap	C_2H_8	80.2	217.9	79	128	Bicyclo[4.4.0]deca-1,3,5,7,9-pentaene
2	Acenaphthene	Ace	$C_{12}H_{10}$	93.4	279	125	154	1,2-dihydroacenaphthylene
3	Acenaphthylene	Acy	$C_{12}H_8$	92.5	280	122	152	Acenaphthylene
4	Fluorene	Fle	$C_{13}H_{10}$	114.8	295	151	166	9*H*-fluorene
5	Phenanthrene	Ph	$C_{14}H_{10}$	99.2	340	171	178	phenanthrene
6	Anthracene	An	$C_{14}H_{10}$	215	339.9	121	178	Anthracene
7	Pyrene	Py	$C_{16}H_{10}$	151.2	404	151.2	202	Pyrene
8	Fluoranthene	Fla	$C_{12}H_{10}$	107.8	384	198	202	fluoranthene
9	Benzo[a]anthracene	B[a]A	$C_{18}H_{12}$	155-157	437.6	209.1	228	benzo[a]anthracene
10	Chrysene	Chr	$C_{18}H_{12}$	258.2	448	-	228	chrysene
11	Benzo(k)fluoranthene	B(k)F	$C_{20}H_{12}$	217	480	-	252.3	benzo[k]fluoranthene
12	Benzo(b)fluoranthene	B(b)F	$C_{20}H_{12}$	168	481	-	252.3	pentacyclo[10.7.1.$0^{2,7}$.$0^{8,20}$.$0^{13,18}$]icosa-1(19),2(7),3,5,8(20),9,11,13,15,17-decaene
13	Benzo(a)pyrene	B(a)P	$C_{20}H_{12}$	176.5	495	-	252.3	benzo[a]pyrene
14	Dibenz(a,h)anthracene	DBahA	$C_{22}H_{14}$	269.5	524	-	278.3	naphtho[1,2-b]phenanthrene
15	Indeno(1,2,3-c,d)pyrene	IP	$C_{22}H_{12}$	163.6	536	-	276.3	hexacyclo[16.3.1.$0^{2,7}$.$0^{8,21}$.$0^{11,20}$.$0^{14,19}$]docosa-1(22),2,4,6,8(21),9,11(20),12,14(19),15,17-undecaene
16	Benzo(ghi)perylene	B(g,h,i)P	$C_{22}H_{12}$	278	550	-	276.3	hexacyclo[12.8.0.$0^{2,11}$.$0^{3,8}$.$0^{4,21}$.$0^{17,22}$]docosa-1(14),2(11),3(8),4,6,9,12,15,17(22),18,20-undecaene

In human PAHs absorb through three main routes i.e. inhalation of polluted air, skin contact and ingestion of contaminated food. In lungs absorption is depends on structure of the PAH, the size and chemical nature of the particles. Through skin coal cooking, petroleum refining and road paving associated PAHs absorbed in the body. PAH metabolism involves oxidation to a range of primary (epoxides, phenols and dihydrodiols) and secondary metabolites followed by conjugation with glutathione, glucuronic acid or sulfate.[9,11] Paver and roofers along with aluminium smelter also produces PAHs. Fluoranthene, Acenaphthene and Fluorene also produces commercially as an intermediate product in pharmaceutical industry.[12]

2.2 Environment Forensics

Subsequent to its production PAHs are exposed to various environmental matrices like air, water, soil and food.[12,13] Phenanthrene and some chrysene PAHs originated near-shore marine sediments, adjacent to forested shorelines they are produced due to diterpenoid, abietic acid, pimaric acid and triterpenoid degradation abundant in pine resin, terrestrial plants and wood ash. Typically forest soil consist of 5 µg to 100 µg/Kg. Rural area soil consists of 10-100 µg/Kg and urban soil consist of 600-3000 µg/Kg carcinogenic PAHs.[14] Large cargo ships carry petroleum products in the sea that contaminated sea water through the process of drilling activity, runoff water, oil spills and atmospheric fallout. Through that PAHs absorbs in the fish, quantic plants etc.[15] In water concentration

of PAHs found in ground water up to 1 ppt and in sewage water it is found around 1 ppm.[10]

Water also contaminated with PAHs due to leaching from linings of water storage tanks/distribution lines, and deposition from air. Most commonly found PAHs in water are fluoranthene, Benzo [b]fluoranthene, Benzo [k] fluoranthene, Benzo [a] pyrene, benzo[ghi]perylene and indebo[1,2,3-cd]pyrene collectively their concentration did not exceed 0.1µg/litre. A study conducted in Federal republic of Germany in 1981 estimated that 56% of 18 tons of air contamination were caused by heating with coal, 30% caused by coke production, 13% by motor vehicle and 0.5% by combustion of heating oil and coal-fired power generation.[14] Main indoor sources of PAHs are cigarette smoke, fuel and wood combustion and cooking and outdoor sources are vehicle exhaust, coal combustion, biomass burning, power plant, sewage plant, Burning of garbage, volcanic erruption and industrial facilities.[9,16]

2.3 Food Forensics

They are found in meat and meat products like poultry and eggs, Bacon, Sausages, smoked meat/beat/chicken, grilled sausages/duck.[17] They enter in the food through the soil contamination and through food chain. Through the contaminated water PAHs are absorb in mussels, fish, and shellfish. PAHs in food also produce through the thermal treatment like grilling, roasting, baking and frying.[5, 8, 13, 15] PAHs forms during grilling and roasting are due to pyrolysis of edible oil and fat at the surface of food and they burnt at the temperature of 150°C-400°C. process of frying takes less time than roasting and grilling hence produces lower amount of PAHs.[15] The presence of PAHs in food is result of time and temperature of burning, humidity, type of food processing, type of control and smoke used and the design and types of kilns.

2.4 Fire Investigation

Fire investigation conducted under the forensic chemistry sub branch of forensic science.[18, 19] PAHs are produce after combustion and fire is based on combustion process. In fire investigation PAHs are used as a source identifier. A study conducted wherein atmospheric PAHs are used as source identifier in forest fire detection.[20] During fire investigation presence of other combustion material affect the identification of accelerant. Hence in another study author used PAHs as a source identifier in detection of fire ignitable residues on different burned plastic carpets. Fluorene, anthracene, phenanthrene, methyl anthracene, methyl phenanthrene, fluoranthene, pyrene as a main component found in gasoline mixed combustion smoke of PVC plastic carpet.[21]

2.5 Petroleum Forensic

Petroleum forensic is a new emerging field of forensic science that deals with application of scientific knowledge of petroleum and related products to help in court of law. In the crude oil analysis, PAHs are considered as a biomarker to reflect the terrestrial source of the original organic material.[6] Natural activities such as offshore drilling, tanker leakage and ship leakage leads to contamination of sea water with petroleum oil that affect marine biota and they enter in to the food chain. PAHs are one of the contaminant found in petroleum oil which has bioaccumulation property. Diesel fuel contains significant levels of PAHs of smaller molecular size, the 2 to 3 ring PAH predominating. It was found that greater the number of rings, that the poorer the PAH destruction percent and destruction percent decreases with increasing alkylation.[22] Petroleum chemical fingerprinting techniques was used in Exxon vldaez oil spill cases wherein PAHs were characterized and differentiated among different petroleum sources in the Prince William Sound region after the spill.[23]

3. Conclusion:

Polycyclic aromatic hydrocarbons are important in the different fields of forensic science such as forensic toxicology, environmental forensics, food forensic and petroleum forensic etc. as discussed above. Hence in detail and enhanced characterization and identification of PAHs are required to incorporate its uses in different fields of forensic science.

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Original Review Article

Evolution of Arsenic as a Toxic and Therapeutic agent through ages- A Scientometric Study

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Abstract

Introduction: Arsenic is enormously toxic in chronic as well as in acute manifestations and this fact has been established in different works of literature. Arsenic gets inside the body by skin absorption, ingestion, and inhalation, then dispersed into different organs. **Methodology**: The objective of the study is to do a comparative study based on different research publications on Arsenic toxicity and its therapeutic uses. For retrieval of arsenic-related articles, the Scopus database was used and the results were presented in form of bibliometric tables. The articles which were published in the duration of 14 years from January 2008 to October 2021 were taken for this study. Total 7606 documents were retrieved from the SCOPUS database in which 6330 documents supported therapeutic nature and 1276 supporting toxic nature of Arsenic. Maximum documents on therapeutic uses of Arsenic (9.54 %) are published in the year 2020. **Conclusion:** Arsenic has been a source of constant fascination and has influenced the human psyche since time immemorial, owing to Arsenic's ability to act both as a therapeutic and toxic agent. A critical study of the publications on Arsenic can open new vistas in Arsenic research.

1. Introduction

Arsenic is commonly known as "The King of Poison", has influenced human affairs, for ages, owing both to its toxic as well as therapeutic potential. It has been a preferred homicidal poison, as it satisfies almost all the criteria required of a homicidal poison. It is cheap, odorless, tasteless, and easily available.

It is undetectable in food and drink and simulates food poisoning (cholera) in its acute clinical manifestation. These characteristics of Arsenic often cause considerable difficulty during diagnosis of death from Arsenic poisoning, giving ample time for the poisoner to escape in the ensuing confusion surrounding such deaths from Arsenic poisoning. History is replete with instances, where Arsenic has been used as a potent homicidal poison to kill rulers to usurp the throne and to kill rulers to usurp the throne and to kill wealthy

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individuals to grab their riches. Arsenic, apart from being a potent homicidal poison, also has the potential to be used in chemical warfare. In the year 1918, the respiratory irritant and vesicant properties of organic Arsenicals like Adamsite and Lewisite, have been a subject of intense research by the Army of United States, to develop them as potential Chemical Weapons, to be used in chemical warfare. However, they were never used in actual war. Both these arsenical compounds are still listed by the Center for Disease Control and Prevention (CDC) as potential bioterrorism agents.[1, 2, 3]

Arsenic is also a skin, lung, and bladder carcinogen, along with being a potent toxin for liver and brain tissues.[4,5,6] Though Arsenic has a fearsome reputation as a homicidal poison, it still enjoys a respectable position in the history of Medicine, especially in the treatment of Trypanosomiasis and Syphilis. In the year 1909, Paul Enrich and Sahachiro Hata discovered "Salvarsan" – an organic compound of Arsenic, which could be used for treating Syphilis.[7, 8] An inorganic compound of Arsenic – Arsenic trioxide, is currently allowed for treatment purposes in refractory acute promyelocytic leukemia.[9]

The objective of the study is to evaluate Arsenic as a toxic and therapeutic agent through the ages and to do a comparative study based on different research publications on Arsenic.

2. Methodology

For retrieval of arsenic-related articles, the Scopus database was used and the results were presented in form of bibliometric tables. For maximizing accuracy, the search query was manually changed using terms related to the article. Arsenic-related articles published in the period of 14 years i.e. from January 2008 to October 2021 were collected and different parameters were compared in our study.

Analysis of data recovered from different kinds of literature

In this retrospective study, a total number of 7606 articles were retrieved from the SCOPUS database.

Table 1: Year-wise distribution of published document related to Arsenic poisoning and therapeutic use

Year	Arsenic Therapeutics	% age of total documents	Arsenic Poisoning	% age of total documents	Total document
2008	442	6.98	72	5.64	514
2009	335	5.29	78	6.11	413
2010	396	6.26	81	6.35	477
2011	432	6.82	77	6.03	509
2012	423	6.68	97	7.60	520
2013	426	6.73	84	6.58	510
2014	431	6.81	101	7.92	532
2015	449	7.09	99	7.76	548
2016	428	6.76	96	7.52	524
2017	448	7.08	115	9.01	563
2018	494	7.80	95	7.45	589
2019	483	7.63	74	5.80	557
2020	604	9.54	116	9.09	720
2021	539	8.52	91	7.13	630
Grand Total	6330	100.00	1276	100.00	7606

Table 2: Type of documents published during these 14 years

Document type	Arsenic Therapeutics	% age of total documents	Arsenic Poisoning	% age of total documents	Total document
Article	4351	68.74	858	67.24	5209
Review	1542	24.36	216	16.93	1758
Book Chapter	229	3.62	115	9.01	344
Short Survey	34	0.54	11	0.86	45
Note	32	0.51	12	0.94	44
Editorial	33	0.52	8	0.63	41
Conference Paper	66	1.04	34	2.66	100
Book	12	0.19	14	1.10	26
Letter	31	0.49	8	0.63	39
Grand total	6330	100.00	1276	100.00	7606

In this comparative study, it is found that though Arsenic is a strong poison, it is also used for therapeutic purposes. This study reveals that out of 7606 documents, 6330 documents are published on Arsenic therapeutics and 1276 documents are relating to Arsenic poison (**table 1**).

The highest number of documents on Arsenic therapeutics is published in the year 2020 i.e. 9.54 % of total documents collected related to therapeutic use and 9.09% of total documents about toxic effects are published on Arsenic poisoning again in the year 2020 which is the highest number in a single year.

Table 2 indicates different documents published on Arsenic poison and Arsenic therapeutic effects and indexed in the SCOPUS database from 2008 to 2021. It is found that 4351 (57.20 %) of total documents (7606) are original research articles on Arsenic therapeutic whereas 11.28 % of total documents are original research articles on Arsenic poison. Out of the total of 7606 documents, 6330 documents are related to Arsenic therapeutic, and 1276 are about Arsenic poison.

The researchers are from different corners of the globe who have published articles on Arsenic. It is found that the United States of America is on top with 2057 documents followed by China and India with 1778 and 864 documents respectively (**Table 3**).

Table 3: Affiliation of authors into different countries

Sl. No	Name of Country	Arsenic Therapeutics	Arsenic Poison	Total
1	United States	1701	356	2057
2	China	1569	209	1778
3	India	706	158	864
4	Italy	325	50	375
5	France	218	37	255
6	Germany	239	57	296
7	Japan	251	36	287
8	United Kingdom	220	66	286
9	Canada	210	48	258
10	Iran	226	24	250

The study of Arsenic literature reveals that around 96 % of total documents during this period (2008 to 2021) are published in the English language whereas about 4 % of documents are published in other languages like Chinese, French, Spanish, Polish, German, and Japanese (**table 4**).

Table 4: Distribution of documents in different languages

Language	Arsenic Therapeutics	Arsenic Poison	Total	% age
English	6132	1218	7350	96.24
Chinese	132	22	154	2.02
French	15	11	26	0.34
Spanish	14	9	23	0.30
Polish	11	8	19	0.25
German	11	3	14	0.18
Japanese	6	2	8	0.10
Persian, Russian & Turkish	12	5	17	0.22
Czech, Portuguese	6	3	9	0.12
Italian, Malay	4	2	6	0.08
Bulgarian, Greek, Hungarian, Serbian, Slovenian, Ukrainian	6	5	11	0.14
Total	6349	1288	7637	100.00

3. Discussion

3.1 Arsenic as poison

The poisonous effects of Arsenic have been well-known to man for ages. Philosophers of the ancient world, notably Hippocrates (370 B.C.), Theophrastus of Erebus (4th century B.C.), and Pliny the Elder (1st century B.C.), had deep insights into the noxious properties of Arsenic. A vivid description of abdominal colic and similar abdominal discomfort, in miner of metals, has been presented by these philosophers in their scholarly works.[10]The Greek physician Pedanius Dioscorides, creator of the historical pharmacopeia “De Materia Medica”, has described the use of Arsenic in 55 B.C., by the Roman Emperor Nero, to kill his brother Tiberius, to consolidate his position as the Roman Emperor.[11,12] In the Medieval Era, arsenic became very infamous as an ideal homicidal poison. Arsenic was used with increasing frequency, to eliminate persons of the decision-making class in the Medieval Era and the period of Renaissance in Europe.[7] The practice of killing one’s rival with Arsenic poisoning, became so rampant in Renaissance Europe, that two families of the time The Medicis and The Borgias cultivated the “Art of Poisoning” and got contracts to kill one’s troublesome neighbors and potential rivals by using the subtle art of poisoning, with Arsenic.[13] In the middle of the 17th century, cosmetics having Arsenic content, were prepared and sold under the name “Aqua Toffana” by an Italian lady “ GluliaToffana”. These cosmetics were sold with appropriate instructions on their method of application on the intended victim.[12,14] In France during the 17th century, white Arsenic (Arsenic Trioxide) came to be known as “Poudre de succession” or the “Inheritance Powder”.[11] Till about 1850, Arsenic continued to be used in high profile murder cases, and one of the famous cases was a political assassination of Napoleon Bonaparte in the year 1851.[13]According to some works of literature inorganic Arsenic present in

groundwater and some foods, higher than the normal limit is a well-known carcinogen and toxicant.[15,16]

3.2 Development of Analytical Tests to Detect Arsenic

The fact that Arsenic could be put to criminal use with impunity, for so long, was because no reliable tests were available to detect arsenic inside the body, even though initial tests to detect Arsenic was developed in the mid-18th century.

A breakthrough for the detection of Arsenic, came in the year 1832, when James Marsh, a British Chemist developed an analytical method to demonstrate reliable evidence of "Visible Arsenic" to Juries.[13] The Marsh test for Arsenic, which involved, treating the suspected sample in a glass apparatus with Zinc and Sulfuric acid and heating, which would cause collection of a silvery-black substance on the cold ceramic vessel, which was not only specific to arsenic but also as minute as 0.02 mg of arsenic could be detected.[17,18] In the year 1840, the Marsh test was used for the first time when Marie LaFarge of France was trialed for the murder of her husband by the use of arsenic in his food.[13] These historic incidents of murder using Arsenic, though appeals to the gloomy interest of the common man, the murders, never the less provide important insights for advancement of knowledge of Arsenic toxicology. The study of such poisonings indicates the acute effects and target organs in death due to arsenic. These murder cases that were affected by Arsenic poisoning, also helped in developing the analytical methods for arsenic in different biological samples and other media, leading to a better understanding of arsenic metabolism.

3.3 Arsenic in Therapeutics

Though Arsenic is very infamous as a toxic agent in the annals of Medicine, it is also used as an effective therapeutic agent through the ages. It is perhaps because of the inherent toxic nature of Arsenic, certain ailments have been treated by Arsenic. In about 2000 B. C. E, a paste of Arsenic was used for the treatment of ulcers and abscesses by Hippocrates, known as the father of Medicine.[19,20,21,22] Other great physicians like Aristotle and Paracelsus also knew of Arsenic's use as a therapeutic agent.[13,23] Paracelsus was a pioneer in advocating the use of Arsenic for treatment and prepared a balsam using white Arsenic, which was used for the treatment of anthrax, wounds, carbuncles, buboes, and other ulcers.[12,24] Traditionally it has been used by the Chinese as a medicine as far back as 200 B. C. E. According to the Chinese concept, a poison in the body can be neutralized by using another poison.[25]Ayurvedic herbal medicines, originated in India, too contained Lead, Mercury, and Arsenic, and the notion was the "essence of five planets" can help in the preparation of mineral elixir which could offer long-lasting life.[7, 26] A detailed documentation of the use of Arsenic in Medicine started in the latter half of the Eighteenth Century. In 1786 Thomas Fowler discovered Fowler's solution, consisting of 1 percent Potassium Arsenide solution and it was used for the treatment of different diseases like Syphilis, Psoriasis, Chorea, Eczema, Asthma, and Malaria.[25,27] In 1809, Fowler's solution also called "Liquor Mineralis" was accepted in the London Pharmacopeia. In the year 1878, it was found that Fowler's solution helps in decreasing the number of white cells in Chronic Myeloid Leukemia and was used to treat leukemia until the 20th century, that chemotherapy and radiotherapy became the main treatment.[4]

Other Arsenic preparations in use, before the 20th century, were De Valagin's and Donovan's solutions both contained Arsenic compounds as one of their constituents and were used as a therapeutic agent for a similar type of disorders.[9, 11]

Until the year 1940, compounds of Arsenic were the main therapeutic agents for Syphilis before the invention of the antibiotic era with penicillin in the lead.[21]

Syphilis, otherwise called the "Great Pox" was a scourge next only to plague in the middle ages and remained so, till about 1910, when Paul Ehrlich, a German physician discovered a drug "Salvarsan" known as "Magic bullet" for Syphilis treatment, in which Arsenic was one of the main constituents. Salvarsan, chemically called dioxy-diamino-arsenobenzol-dihydrochlorite which is now known as Arsphenamine was the first drug in the series of drugs developed for the treatment of Syphilis. In 1911, Paul Ehrlich developed neoarsphenamine or neo-Salvarsan and by 1920, various Arsenic compounds like neoarsphenamine, arsphenamine, mapharsan, and acetarsole in combination with mercury or bismuth were the main treatment modality for Syphilis that penicillin became the main treatment from year 1943 onwards.[6, 23, 26, 27]

Research on Arsenic poison and Arsenic therapeutics is going on for several decades. All the researchers are interested to examine these things

from their parent branch of health science. SCOPUS database indexed these documents accordingly.

Research documents are published in different forms. Some research papers are published as original research papers, some are published as conference papers, book chapters, and review papers. **Table 3** indicates different types of documents published on Arsenic poisoning and therapeutic uses from 2008 to 2021.

The researchers are from different corners of the globe. It indicates that research on Arsenic is commonly cherished throughout the world. Table 4 indicates the researcher's affiliation with the top 10 countries of the world.

It is found from the SCOPUS database that all the documents indexed during the study period are not published in a common language. Table 5 is showing the different languages in which the documents are published. To compare both aspects of Arsenic research here is an attempt to study different journals in which documents are published in the above-mentioned study period.

4. Conclusion

Arsenic has been a source of constant fascination and has influenced the human psyche since time immemorial, owing to Arsenic's ability to act both as a therapeutic and toxic agent. The continuous focus on Arsenic research, as evidenced by publication in leading journals of the world, bears testimony to Arsenic's enigmatic appeal. A critical study of the publications on Arsenic can open new vistas in Arsenic research, especially among the new enthusiastic young toxicologists; of the world.

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Short communication

Role of Checklists in Medicolegal Death Investigation

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Abstract

Introduction: The essential element of criminal law mandates the offense to be proved beyond reasonable doubt by prosecution and law enforcement. The key approach is to not leave any stone unturned. Investigating agencies and forensic personnel need practice advancement- adopting modern and effective modalities. Although technological advancement is being considered as the mainstay of improvement, it is not the only area. **Medicolegal Aspects:** The overall conviction rate of a country requires upgrading the quality of work of investigating teams handling cases. As is true for all complex processes handled by teams, criminal investigations, and medicolegal autopsies are also prone to human errors at multiple stages. Hence, it is necessary to adopt methods for the improvement of teamwork. One accepted method is the usage of checklists. Here, we discuss the need for checklists in medicolegal death investigations, their utility of different types of checklists in various situations, and provide an example checklist for hanging. **Conclusion:** The introduction of checklists has been found to improve the work standards in high-reliability organizations such as aviation, and nuclear power plants. World Health Organization has recommended checklists in the operation rooms and areas affecting patient safety.

1. Introduction

Oxford dictionary defines a checklist as a list of the things that you must remember to do, to take with you, or to find out.[1] Checklists have gained significance in medical practice to improve patient safety and quality outcome. Since the introduction of checklists in Operating rooms by the World Health Organization, its application has been found relevant in other domains of medical practice also.[2,3]

However, its application in medico-legal practice is still restricted to developed countries. The current state of criminal investigation in India

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needs much improvement and checklists can prove to be an effective tool to improve ground-level teamwork.

2. Checklists:

Why checklist in the Indian system of medico-legal death investigation?

- Complexity leads to adversity.

  The Law of individuality states that "*Every object whether natural or man-made has a unique quality or characteristic in it which is not duplicated in any other object*".[4] The same holds for crime scenes and involved individuals also. Crime investigators may find the modus operandi to be the same, but the individual's response and interaction with the environment varies and its detection requires the dedicated focus of experts. The environment of a crime scene is also disarray -*phones buzzing, next of kin expressing despair, casual trespasser and neighbors peeping out of interest, special effects provided by media, constant pressure of the clock ticking over the head, sense organs overwhelmed with sight and smell of thick air of a dead body*- this creates an ambiance of exasperation for the young investigators. To add on: the interaction with seniors, juniors, colleagues, and other individuals involved in the investigation such as scientists and experts may not always go smoothly. This scenario takes a toll on physical and mental competencies to the extent that even experienced investigators can miss a vital step. The procedure is further complicated as the Chief investigating officer is expected to perform multiple tasks at hand keeping up with the current practice and knowledge.

  Similarly, during an autopsy, the forensic pathologist has to pay attention to the findings in front of him, take photographs, make a rough record of the findings, navigate the distracting straightforward injury and look for more, collect evidence for preservation, make sure the preservatives are added correctly, label them, respond to queries raised by staff and teach the post-graduate and undergraduate students. Though there is an assistant at teaching institutions to help, this luxury is not always present. Post-graduates and undergraduates require constant monitoring and guidance even if they volunteer to help. While steering through the case, a simple routine cardinal step has a likelihood of being skipped and proves to be a vital miss in the death investigation.

- Humans have fallible memory.

  When routine work is being done, the brain plays a trick and makes us skip steps. Similarly, when we try to recollect and pen down what we observed, the observations made commonly also come to the pen easily. Although this fallible memory may be a boon for the victims of crime to counter post-traumatic stress, the same does not apply to the ones solving the crime. In absence of a standardized checklist, professionals often find themselves engulfed in an unwanted urge to re-examine a cardinal finding which may be missed or interpreted wrongly.

- Experience at times gives an edge to miss vital steps.

  Those involved in criminal investigations are well aware that minute steps during the process impact extraordinarily. One such experience of the author pertains to the autopsy examination of a dark-skinned person as a victim of assault. Though the standard practice necessitates incising the back to look for injuries, this step was missed until reminded by a junior at the last minute. The incision in the back revealed multiple tram track contusions. Missing a simple step like this can have a downhill consequence for the victim, society, and profession.

- Removing simple stuff out of the way will help to focus on the hard stuff.

  When specific steps of a case are checked out, then focus can be diverted to the important points- interpretation of findings that may warrant further intervention. For example, a crime scene investigator may look for hidden evidence/material for a special investigation or an autopsy surgeon may proceed with additional dissection which can be of importance.

- Lack of knowledge and the ability to apply it.

  One research study on the increasing acquittal rates in Indian criminal investigation observed that nearly 40% of criminal cases

are lost due to investigation flaws. Practical difficulties such as delay in collection of evidence and inability of 'clue team' to reach districts have been pointed out as common reasons for failure.[5] In India, like many developing countries a significant portion of forensic autopsies and investigations are done by doctors and investigating officers who are neither qualified nor trained to do so.[6,7] This results in a faulty investigation and endless legal deadlocks.

Even if investigating officers and doctors take an interest to gain theoretical knowledge, they fail to apply it or apply it wrongly due to a lack of experience, training, and misguidance by another person who has sat in the same boat for years and never had his/her shambles questioned by the judicial system. The introduction of a standardized checklist may enable untrained individuals to bring out an element of objectivity and standard to the practice.

Types

- **Do-confirm**

  When the chief investigating officer and forensic pathologist are well trained, then a do-confirm type of checklist will be helpful, as here the users are well acquainted with the procedure. They have to read the items in the list and ensure it is done. An example is given in **table 1.**

- **Read-do**

  This type of checklist is for personnel who are untrained or are doing a non-routine procedure. Here every step is explained in order clearly and one just has to read and do it.

Table 1: Do-confirm type checklist for autopsy in a hanging case.

Example Checklist for Autopsy Surgeon In A Case Of Hanging (Do-Confirm type)
Pre-procedure
€ Is history taking complete
€ Review of evidence collected from the crime scene
€ Briefing about the case to the team involved
€ Has the autopsy request and inquest papers been reviewed
€ Has the identification been confirmed by the investigating officer (IO)
€ Any infection risk identified
€ Scale and Measuring tape ready
€ Equipment ready- to preserve and send samples for fiber from neck/ligature material
€ Is there a need for any additional/supportive investigation
During procedure
Before incision
€ Collection of fiber from neck/ligature material
€ Tongue position and evidence of Salivary Dribble
€ Heel to fingertip measurement with upper limb extended above the head
€ Description of Clothes, Ligature mark & Ligature material (if present in situ)
€ Rigor and Hypostasis (location and fixation)
€ Any evidence of physical or sexual abuse
€ Plan for wide and bloodless field for neck dissection
Before closure
€ Neck structures examination
€ Hyoid bone and thyroid cartilage examination
€ Any signs of poisoning/intoxication (requiring preservation of viscera)
Post-procedure
€ Is the body sutured and packed properly
€ Are the evidence collected labeled properly, sealed, and handed over to IO
€ Communication about evidence processing given to IO
€ Body handed over to the IO

What is a Good Checklist?

- Easy to use: Simple sentences, straightforward language, electronic or hardcopy but can be carried and stored with ease.
- To the point: one item in the checklist stick to one simple task.
- Relevant: though the content of the checklist can grossly remain the same across the country, it can be tailored as per the local needs.
- Time savvy: a good checklist should not take more than 90 seconds to read through and acknowledge.
- Tested and reviewed: The checklist created once should be tested in the field repeatedly and inputs from those using it routinely should be taken to update it. Meetings at the local or state

or national level should happen regularly to exchange ideas and update the checklists.

- Strategic: During an investigating process, putting the questions too early and even too late may beat the purpose of the checklist. Hence, a checklist has to be broken into multiple modules (ideally three) and applied at relevant times.

Where can a checklist be used in the medico-legal investigation?

- Autopsy
- Crime scene investigation
- Medico-legal case examinations (wound, drunkenness, age certification, etc.)
- Framing sub-sequent / review opinion
- Weapon examination
- Preparation of investigation summary by law enforcement agencies

Who should implement the checklist?

One may argue that the introduction of checklists in the Indian criminal investigation system requires legal recognition before its acceptance in a uniform manner and that statutory incorporation will be time taking process. However, the practice of a checklist at the grass-root level can go a long way. Here, roles can be identified as:

- Supervision: by a senior officer. For example, the chief investigating officer at the crime scene and the main autopsy surgeon in the mortuary. The implementation of the checklist requires the whole team to pay attention while the items are being read. This task falls in the hands of the senior-most person to pull everyone together and to encourage speaking up of the team members if there is any concern.

Execution: by a trained designated person in the team. This can be a constable at the crime scene and a technician or junior assistant during the autopsy. The one who reads through the checklist also has the responsibility to be a sincere speak-up person. They have to tick only those items that have been confirmed and raise the issue if an item has been neglected.

3. Conclusion:

Checklists remind the minimal necessary steps and make them explicit. They not only offer the possibility of verification but also instill a kind of discipline of higher performance. An apt and effective checklist will reduce human error, ensure completeness, and reduce subjectivity. In the ever-expanding complexities of human endeavors in forensic practice, we can resort to breakdown and simplifying.

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Short communication

The Crime of Bribery in Forensic Medicine

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Key words
Forensic Doctor,
Justice,
Crime of Bribery,
Judiciary.

Abstract

Introduction: This study deals with the issue of the crime of bribery by the forensic doctor, by clarifying the concept of the crime of bribery. Clarifying its pillars represented in the material and moral pillars, and clarifying the penalties stipulated by the legislator, which are imposed on the forensic doctor when he commits this crime or when its pillars are fulfilled. **Medicolegal Aspects:** Because of its impact on judicial decisions, justice decisions, the rights of people, and society, the forensic doctor is an employee and an expert, and therefore the provisions of the Jordanian Penal Code relating to this capacity apply to him, including his criminal responsibility for the crime of bribery, if its elements are available. **Conclusion:** The study concluded that the crime of bribery is one of the most dangerous crimes of corruption, and its severity increases when it is committed by a forensic medical expert such as a forensic doctor.

1. Introduction

Forensic medicine is a medical subspecialty that focuses on determining the cause of death, by examining the body, and the autopsy process is done by the forensic doctor, and these cases are usually done through the investigation of criminal law cases, and the judge often requests a criminal investigation to ascertain the identity of the body. The forensic doctor is the one who searches and investigates cases of deaths and injuries, which occur under mysterious, suspicious, and unusual circumstances. Therefore, in the eyes of criminal justice, the forensic doctor is a technical expert charged with giving the competent court an advisory opinion on issues of a delicate technical nature concerning the victim, whether he is alive or dead. It concerns the accused in terms of his psyche and the soundness of his mind.[1]

There are formal controls for the forensic doctor shows the mental and psychological map, and clarifies the minutes of its affairs before the judiciary in the lawsuits that he is concerned with, so there are formal controls for the forensic doctor's report to assist the judge in achieving criminal justice, as well as ethical controls must be observed by the forensic doctor. And when he violates it, he will be a perpetrator of crimes against the honor of his job. The formal controls are the apparent general description of the case, the description of the tools used in the crime, and the determination of the cause of death in the murders.

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As for the ethical controls, they are sincerity of intent, sincerity of work and performance, which requires accuracy, because the forensic doctor's report depends on the conviction or innocence of the accused in the lawsuits, and it is also the result of the technical expertise that he provides to the judiciary at his request or the request of his representative, as it is an aid and support for the judiciary in passing judicial judgment and then achieving criminal justice. Therefore, he must take all necessary precautions when writing his report. The forensic doctor plays a positive role in the lawsuit, but as a human being who is not infallible, he may fall into the forbidden and commit acts [i] that harm him and harm the truth, justice and the judiciary, so he may commit the following acts. Submitting a false expert report, giving false testimony about his report in the lawsuit, not clarifying the forensic report, forging the documents that were handed over to him, destroying or altering one or more documents he received, disclosing the expert report to one of the litigants before delivering it to the court entrusted with it.

Failure to comply with the court's decision regarding the litigants for the purposes of discussing the expert report submitted by him, requesting a bribe from one of the litigants. Accordingly, we can say that the forensic doctor may commit financial and non-financial crimes that require the punishment stipulated by the law. Therefore, the study will be limited to clarifying the two crimes of bribery and medical secret disclosure, and these two crimes have been given the research because they are crimes that are perceived to occur by the forensic doctor and because of their wide practical application, before the courts.[1]

2. The crime of bribery:

The crime of bribery is considered one of the most serious crimes of corruption, and its severity increases when it is committed by a judicial medical expert such as a forensic doctor, Because of its impact on judicial decisions, justice decisions, the rights of people, and society.[1] The forensic doctor is an employee and an expert, and therefore the provisions of the Jordanian Penal Code relating to this capacity apply to him, including his criminal responsibility for the crime of bribery, if its elements are available. Bribery is defined as a behavioral pattern that leads to a corruption in the performance of the forensic doctor, or an act committed by a public official or a person of a public quality when he trades in his job or takes advantage of the powers granted to him under his job. It is an agreement between two people who are a forensic doctor who asks or accepts money or a promise of it in return for his doing or refraining from doing an act of his job and he is called a bribe-taker., forensic physician. This crime is considered one of the most serious crimes related to money because it affects the most important principles on which public utilities operate. The crime of bribery is two separate and independent crimes, namely, positive bribery, committed by the person in need when he presents the money to the forensic doctor or prepares it and accepts it, and it is called the crime of the briber. A negative bribery committed by the forensic doctor when he asks or takes money or accepts a promise, and it is called the crime of the briber, the reason for the bribery is to do an act of the job, to refrain from doing an act, or to breach the duties of the job. The reason for bribery is the benefit or the promise of it, and it is one of the elements of its material pillar.[2] The penal legislation explicitly stipulates that the forensic physician be punished if he receives a bribe because of his work as an expert in the case, to ensure that he performs his work faithfully and so as not to weaken himself and beg him to accept a bribe from one of the litigants. There must be elements available for the crime of bribery to be committed, which are the moral element, the material element, and the criminal intent.

2.1. The moral element

That bribery is a deliberate crime in which the criminal intent is present in the forensic doctor's direction to request or take a benefit or accept the promise of it, as it is not required for the criminal intent in the crime of bribery to be the will of the forensic doctor directed to implement what was requested of him, but it is sufficient for his will to seize the benefit or the financial amount, with knowledge of the purpose of providing them.[3]

2.2. Criminal intent

The crime of bribery is one of the intentional crimes, for its occurrence, the presence of criminal intent is required by the forensic doctor, so that his will is directed to taking the benefit or the financial amount. The general rule is that the moral element presupposes that the bribe-taker is aware of the work he is performing, that is, he is aware at the time of taking the money that he is taking advantage of his position. Although the legislator was clear about trading in the medical field.

Knowledge: For the criminal intent of the perpetrator to be established, he must be aware of all the elements of the material element of the crime. The bribery forensic doctor must know all the realistic elements extracted from the text of the criminalization of bribery, where the act constitutes a crime punishable by law, since this knowledge is assumed in all cases in application on the basis of the assumption of knowledge of the law, it is not acceptable for the accused forensic doctor to claim that he was ignorant and did not know that the act he had done was considered a crime.

Will: The offender's tendency to buy the forensic doctor's responsibility, i.e., to make him do an action or refrain from doing an act, and on this basis the criminal intent is negated if the briber believes that he is directing his activity to someone other than a forensic doctor. It is one of the temporary crimes for which the criminal intent must be proven, and it does not take a specific time until the crime is completed.[4]

2.3. The material element

The material element of the crime of bribery against the forensic physician is investigated from the actions on which the material element of the crime of passive bribery is based, in requesting, accepting, taking, or receiving.[5]

Request: The request means the affirmative issued by the forensic doctor for the bribery, and it is sufficient once the forensic doctor expresses his will to obtain a sum of money to perform an act or refrain from performing it to achieve the material element of the crime.

Acceptance: It means the acceptance by the forensic doctor of the offer, and the material element of the crime is realized as soon as the acceptance of the forensic doctor meets the person's offer, regardless of the briber's implementation of his promise or not, and it is required that the acceptance be serious and emanating from a conscious will.

Taking or receiving: It means that the forensic doctor receives the thing, that is, he receives the money from the briber.[6]

The Jordanian legislator stipulated in the Jordanian Penal Code that[7] "every employee and every person delegated to a public service, whether by election or appointment, or every person assigned an official mission, such as an arbitrator or expert, who requested or accepted a benefit for himself or for others, to perform an act by virtue of his work was punished by imprisonment for a period not less than two years and a fine equal to the value of what was requested or accepted.[8] We note through this legal text that the legislator expressly stipulates the crime of bribery by the forensic doctor as a judicial expert, and the penalty that must be inflicted on him. The forensic doctor, as an expert, [9] is also barred from being an expert in any other lawsuit for life. this is due to the importance of his work and its danger, so the forensic doctor, as an expert in the case, must do his work with accuracy, honesty, [10] sincerity, impartiality and integrity without taking sides without the other, or accepting or requesting a sum of money for him or for others, or a gift, benefit or promise to him or to others, He may not receive any kind of bid, no matter what, in return for performing the task of expertise, abstaining from performing it, or delaying it. [11] Otherwise, he will be subject to criminal accountability and the imposition of punishment on him. [12]

3.Conclusion

After addressing the issue of bribery by the forensic doctor, the study concluded that the forensic doctor is a technical expert charged with giving the competent court an advisory opinion on issues of a delicate technical nature concerning the victim, whether he is alive or dead. It concerns the accused in terms of his psyche and soundness of mind. The forensic doctor shows the mental and psychological map and clarifies the details of its affairs before the judiciary in the judicial cases that he is concerned with.

The crime of bribery is defined as a behavioral pattern that leads to a corruption in the performance of the forensic doctor, or an act committed by the forensic doctor when he trades in his job or takes advantage of the powers granted to him under his job.

It is an agreement between two people who are an employee who asks or accepts money or a promise of it in return for his doing, doing, or refraining from doing an act of his job. The elements of the crime of bribery are the moral element, the material element, and criminal intent. The penalties imposed on the perpetrator are imprisonment and a fine.

4. Recommendations

Tightening the punishment for the forensic doctor when he commits crimes because of the seriousness of his task on which the performance of

the judiciary depends, and for the courts to investigate the accuracy, justice, and honesty of those they elect to carry out the task of the forensic doctor because it wastes the rights of people.

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Case Report

An Atypical Case of Firearm

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Firearms,
Entry Wound,
Re-Entry Wound,
Exit Wounds

Abstract

A woman was shot at her home at close range by an unknown assailant. The projectile traversed in such a way that it caused entry and exit as well as re-entry and exit**.** Although firing was from close range bullet entered through scapula and exited through axilla and re-entered left arm. Wound of exit was seen on left arm and a laceration was observed on the left forearm. No vital organ was involved.

1. Introduction

Alleged history of firing by unknown person while woman was sleeping at home in early hours of the morning. The woman was admitted to hospital in a conscious state with complaints of pain in back and left upper limb.

2. Clinical Summary

2.1 Local Examination-

a. Wound of entry -left scapular region 1*1 cm, 14 cms from vertebral column and 18 cms from clavicle with surrounding abrasion collar (**Fig. 1**).
b. Wound of exit- left axilla in mid axillary line 1*1 cm
c. Re-entry -flexor(inner) aspect of upper 1/3 of left arm 0.5*0.5 cms
d. Wound of exit -over extensor(outer) aspect of upper 1/3rd of upper left arm, 0.5*0.5 cms in diameter- margins everted (**Fig. 2**).
e. Lacerated wound on left forearm about 0.5*0.5 cms x skin deep (**Fig. 3**).

2.2 Radiological Findings- X-ray Left arm with shoulder and elbow AP/Lateral- 4-5 mm metallic pellet seen embedded in soft tissue of antero lateral of mid arm. Bone normal. USG Chest – Normal, X-ray Chest PA/Right Oblique-Normal

2.3 Management and Outcome of the case- The patient was not operated on as the pellet was very small and not causing any complication. The stay in hospital was uneventful. The woman was managed medically and discharged from the hospital after 4 days.

3. Discussion-

The unlawful use of firearms as weapons of assault continues to increase. In whichever jurisdiction the forensic practitioner practices, he/she will encounter injury and death caused by wide variety of firearms.[1] Firearm injuries are becoming common by the day. In the present case, as per history given by the woman, an intruder barged in to the house when the family was sleeping. The noise broke her sleep. The intruder, who was unknown to her, fired at her. Although firing was from close range bullet entered through scapula and exited through axilla and re-entered left arm. Wound of exit was seen on left arm and a laceration was observed on the left forearm.

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No vital organ was involved. X-ray left arm with shoulder and elbow both AP and lateral view showed metallic pellet embedded in soft tissue of anterolateral aspect of mid-arm. Bone appeared normal. The bullet had traversed from scapula to axilla, to the arm and then forearm. The wound over forearm was superficial. It had not entered the forearm. Although fired from close range the projectile had not caused any major injury.

Figure 1: Firearm wound of entry.

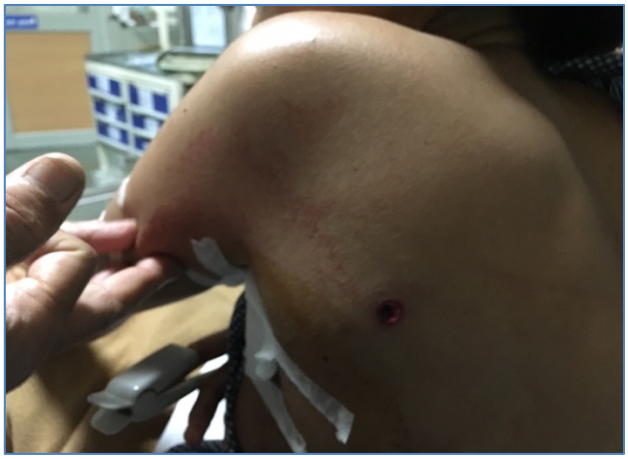

Figure 2: Firearm wound of exit.

Figure 3: Firearm - Lacerated wound over forearm.

Multiple entrances and exits from single shot occur when victim is running or sitting in an unusual position, bullet hits irregular surface of the body e.g., breast, buttocks or bullet strikes the victim in such an orientation that several parts of the body come in its line successively.[2] It may also happen when the person is leaning in an unusual position so that several re-entries and exits take place. Examination of clothing is important in such cases.[3] The woman in this case must have been in an unusual posture to have such a different trajectory of the projectile.

The internal effects of the bullets depend upon the kinetic energy. Low velocity, low energy missiles such as shotgun pellets and some revolver bullets, cause simple mechanical disruption of the tissues in their path.[1] The severity and extent of a wound, however, are determined not by the amount of kinetic energy possessed by a bullet, but rather by the amount of this energy that is lost in the tissue.

The major determinants of the amount of kinetic energy lost by a bullet in the body are:[4]

1. The shape of the bullet
2. The angle of the yaw at the time of impact
3. Any change in the presented area of the bullet in its passage through the body.
4. The construction of the bullet.
5. The biological characteristics of the tissues through which the bullet passes.[4]

The photograph clearly shows abrasion collar around the wound of scapula. The re-entry wound on inner aspect of axilla does not show abrasion collar.

Re-entry wounds occur when a bullet has passed through one part of the body and then re-entered another part. The re-entry wound is usually characterized by a large irregular entrance hole with ragged edges and wide irregular abrasion ring. Re-entry wounds of the axilla caused by missiles that have passed through the arm often have an atypical appearance. Such wounds may range from oval to slit-shaped with a very thin or absent abrasion ring.[3] They often so nearly resemble a wound of exit, that differentiation from an exit wound if considered alone is difficult/nearly impossible. Entry wounds are oval to circular with a punched-out clean appearance to the margins except on palms, soles and elbow. The exception to this is re-entry wounds of axilla and scrotum.[4]

In through and through gunshot wounds, small fragments of metal from the bullet may be deposited along the wound track or in the bone

fractured by the bullet.[3] Usually, cases of firearm injuries are admitted in surgical ward. Forensic faculty and surgical faculty can jointly handle the case. The job of the forensic faculty is accurate documentation of the injuries, collection of evidence and record photographic evidence. In this case, clothes could not be examined as by the time call was received, clothes had been handed over to police. Thus, communication between treating doctor and forensic medicine faculty is essential for better documentation of injuries. The treating doctor should also be aware of the importance of evidence to be preserved.

In the living, all efforts must be directed to saving life but, if at all possible, the emergency medicine specialist, and surgeon, should accurately note the original appearances of the injuries and preferably take good quality images of any entry or exit wounds before surgical cleaning or operative procedures are performed.[1] The presence of forensic practitioner at the time can be helpful in ensuring that appropriate documentation is made, for presentation at a later stage in court.[1]

4. Conclusion

A forensic expert may be needed to aid the surgeon/s when a case of firearm injury is admitted to the hospital. Forensic expert should take help of radiology and other technology available to assess the injury and issue an injury report. It is also the duty of forensic expert to preserve the necessary trace evidence required for ballistic/chemical analysis. Photographs should always be taken as supportive evidence. Access to taking a photograph may be limited in cases where the patient is critical. In such cases photographs should be taken as and when is possible.

Autopsy in cases of firearms is common nowadays. A forensic medicine expert however, may have to deal with firearm cases admitted in the hospital. In fact, when cases of injuries are admitted in surgical or orthopaedic ward a call should also be sent to Forensic Medicine department. Clinical forensic medicine is a neglected sub-specialty of Forensic Medicine.

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Case Report

The Impact of Raman Spectroscopy on Concentration and Purity DNA Amelogenin from Dental Samples

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Abstract

Background: Analysis Laser by Raman spectroscopy is widely used to sex estimation of dental samples. Generally, sex estimation of dental samples can be identified by DNA amelogenin examination, but there is a lack of research on the impact of laser administration on concentration results and DNA purity in sex identification from dental samples. **Aim**: To determine the impact of laser application from Raman spectroscopy on the concentration and purity of DNA amelogenin for sex estimation. **Methods:** The tooth samples came from the same individual, with 1 right tooth and 1 left tooth. Samples were obtained from tooth extraction for orthodontic pretreatment. The tooth sample was cut horizontally on the occlusal surface to the tooth apex, then laser light was applied with a wavelength of 100-3400 cm^{-1}, on the enamel, dentin, and pulp chamber layers. The layers of teeth that had been shot with a laser were powder on each layer and DNA amelogenin analysis was performed. The total is 6 samples. **Results**: Examination of the concentration and purity of amelogenin DNA showed values between 1.57 – 1.87 µn, but the results of PCR analysis showed 1 of 6 did not have the same match in gender identification. **Conclusion**: This preliminary study showed that there was had impact of laser of Raman spectroscopy on the concentration and purity of DNA amelogenin from dental samples, and also there was an impact on gender determination.

1. Introduction

Laser spectroscopy studies provide the essential insight needed to gain insight into the atomic and molecular dimensional world. In particular, Raman spectroscopy is a powerful analytical method that provides detailed and specific information at the molecular level. In terms of its versatility, this method can provide information that maybe below the capabilities of other spectroscopic methods.[1] Raman spectroscopy has useful properties for forensic applications that

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identify body fluids (BFs) that non-invasively characterize a sample using light irradiation and highly selective spectral patterns based on the molecules that make up the sample. Detailed peak assignments show that the BF spectrum has a characteristic spectral pattern that can be interpreted with knowledge of the physiological components.[2] The use of Raman spectroscopy for biomedical applications, including dentistry, has increased significantly .[3] The research of Gamulin (2021) in dental aspect, concluded that sex examination of teeth with Raman spectrometric can be seen on the apex, dentin and enamel using a support vector machine (SVM) and artificial neural network (ANN) with a wavelength of 200-3500 cm−1.[4]

Amelogenin is involved in tooth development early in life. Previously known only from tooth enamel, amelogenin was also found in long bone cells.[5] Band readings in gender identification use amelogenin, according to Pfeiffer and Brenig (2005) if one band identifies the female gender and if two bands identify the male gender.[6] This is also affected based on the base length of bitter melon, male sex has two bands at ~ 1.3 kb and 1.5 kb, while for female gender there is only one band at 1.5 kb.[7] Based on this background, the uses of Laser from Raman Spectrocopy in dentistry can be in the form of sex examination of tooth samples[4], examination of the biological elements of ancient teeth[8], estimation of age from tooth samples[9], Spectrophotometric analysis of burnt tooth color can predict the feasibility of human DNA extraction for identification purposes.[10]

However, there is a lack of evaluation of the laser effect of Raman spectra on the purity of amelogenin DNA from dental samples. The purpose of this study was to determine the impact of laser application from Raman spectroscopy on the concentration and purity of DNA amelogenin for gender identification.

2. Material and Methods

Sample is Premolar teeth from male patient, after extracted tooth to orthodontic treatment. It is premolar right side and left side from lower jaw.

Sample Preparation

Teeth splitting (cutting horizontal), and doing examination on dental layer (enamel, dentin, and pulp). The total sample is 6 from the left and the right teeth.

Raman Spectroscopy

This analysis use Raman Microconfocal Spectrocopy with laser wavelength 100-3400 cm^{-1}, in Laboratory of Analysis and Instrumental, Department of Chemical Engineering, Gadjah Mada University. The function of analysis is to see the micro structural of hidroxyapatite from dental layer (enamel, dentin, and pulp).

Concentration and purity of DNA amelogenin

Analysis of Concentration and purity in Institute of Tropical Diesease Airlangga University

Artificial intelligence (AI)

The data from the Raman Spectroscopy examination were then analyzed using Cemometric. The usefulness of this method is to group a layer of tooth from enamel, dentin and dental pulp. The potential layer to identify gender using the clustering method with the Principal Component Analysis (PCA) and continued with multivariant analysis using artificial intelligence (AI) (K-Means and Pearson Correlation).

3. Result

The laser of Raman Spectroscopy was analysis in the layer of teeth such as enamel, dentin and pulp. Showed in figure 1.

Figure 1: The part of examination of Raman spectroscopy.

The analysis of Raman Microconfocal Spectrocopy showed the result of the raman imagine view. That dentin area was the left and the right teeth have similar condition of the 3D view. Showed in **figure 2**. The result of the spectra from each area sample, showed in **figure 3**. The graphic of spectra showed that pulp area had flat spectra and enamel area had some high spectra. It is mean the area

doesn't have correct similar graphic. But different with dentin area had normal.

The chemometric analysis (Principal component analysis) showed that dentin area had significant clustering area from left and right teeth. Showed in **figure 4.**

Figure 2: The result of the 3D view from different layer of dental sample (enamel, dentin and pulp).

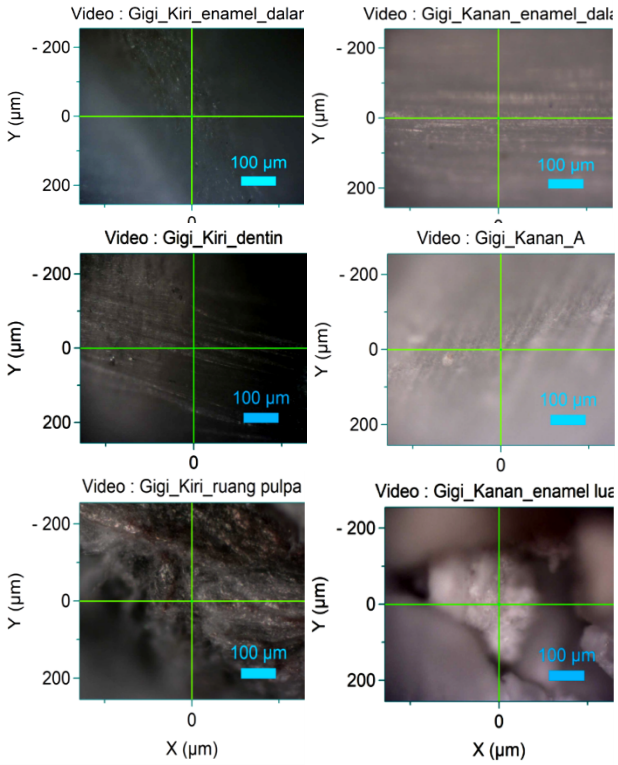
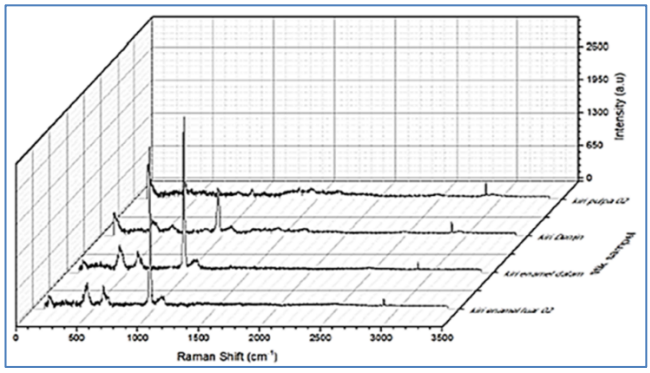
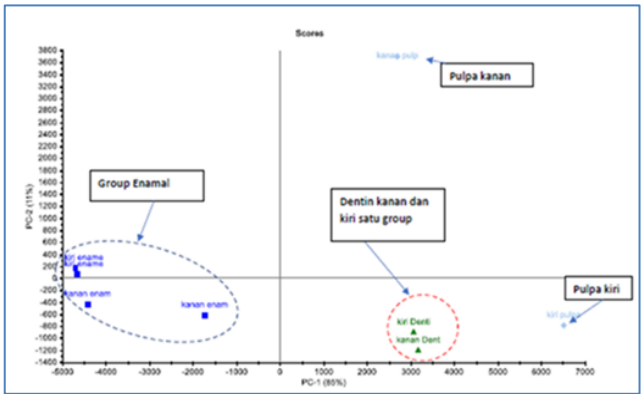


Figure 3: The result of spectra from Raman Microcnfocal spectroscopy.



Concentration of purity DNA showed two sample have less than normal standard. The ratio is appreciably lower (< 1.6). [11] A ratio of *1.8 is generally accepted as ''pure'' for DNA. Statistical analysis data showed that the correlation of Pearson had p > 0,05, it is mean the wavelength had correlation with layer of dental sample.

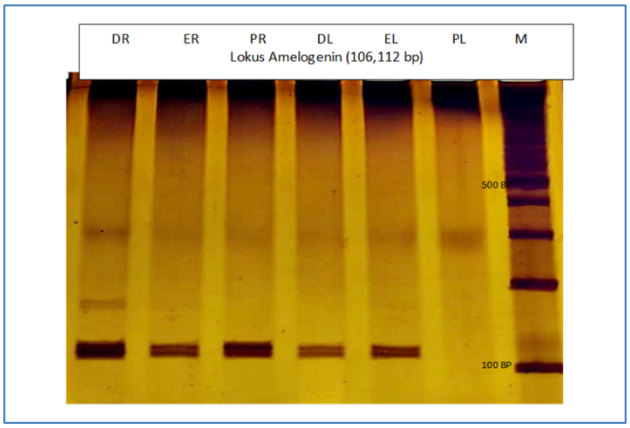
Figure 4: PCA analysis



4. Discussion

The effect of laser of Raman spectra with wavelength 100-3400 cm-1, in this research, shows side effects on dental samples, such as the concentration of purity to analysis DNA use ratio of absorbance at 260 and 280 nm is used to assess DNA purity, showed that area of the enamel layer, dentin left and pulp left was average concentration with of purity 1.83 - 1.87. Meanwhile, the sample of dentin left and pulp right had less accuracy of concentration which is 1.59 and 1.57.

Figure 5: The result of electrophoresis DNA Amelogenin



The results of DNA isolation are said to be pure if the absorbance ratio is at 1.8 – 2.0. The value of DNA purity was calculated by dividing the absorbance value at a wavelength of 260 nm by the absorbance value at a wavelength of 280 nm.[12]

In other conditions, the effect of low or normal DNA purity has an impact on the results of DNA electrophorensis analysis on Amelogenin DNA testing showed a negative result on the left pulp in **figure 5**, which is the dental sample from male patient. But the result of PL showed different thing.

Previous study Pfeiffer and Brenig (2005) if one band identifies the female gender and if two

bands identify the male gender.[6] This is also affected based on basepare length, male sex has two bands at ~1.3 kb and 1.5 kb, while for female gender there is only one band at 1.5 kb.[7]

De Luca (2014) showed the effect of laser of Raman Spectra use sperm sample [13], there was study on non-invasive sex assessment in bovine semen by Raman spectroscopy combined with PCA analysis had impact on quality DNA sperm. [14, 15]

In addition, Raman spectroscopy has detected oxidative DNA damage and mitochondrial damage caused by ultraviolet radiation.[15,16,17]

5. Conclusion

This preliminary study showed that there was had impact of laser of Raman spectroscopy on the concentration and purity of DNA amelogenin from dental samples, and also there was an impact on gender determination.

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Case Report

A Suicide Claimed As A Homicide - Role of Medical Evidence to Untie.

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Abstract

Introduction: Majority of the fatal railway cases are accidental in nature though there are cases of suicide and homicide. Though decapitation or transection of the body at thoraco-abdominal region is common in suicidal cases there can be cases with different patterns of injuries depending on peculiar body posture adopted at that time. **Discussion:** When unusual pattern of injuries are present it becomes very difficult to give opinion about the manner of death. In sensitive cases and when proper history is not available it becomes very tough for the autopsy doctor to give his opinion. There is always a chance error leading to further chaos and miscarriage of justice. In the present case report we discussed about such an unusual death on a rail track. **Conclusion:** Timely intervention by law and medical expert opinion based on scientific findings can prevent heinous social crime.

1. Introduction

Railway related deaths are often reported in India and the incidence is increasing day by day as this constitutes a common mode of public transport system. This increase in incidence is also contributed by factors like rapid urbanization and industrialization. More alarmingly, there has been a spate of Railway Accidents in India, leading to loss of a significant number of human lives.[1] The Railway accidents present with a vast variety of injuries which are often very difficult to assess as to their patterns at the postmortem examination.[2] Though fatal railway deaths are mostly accidental in manner sometimes it could be a case of suicide or homicide also. As bodies are generally grossly mutilated it may pose a great challenge to determine manner of death in such fatal cases. Moreover, in the absence of proper case history or eye witness, it is difficult to distinguish between, accident, suicide or homicide.[3, 4] In the present case report we discussed about such a case of suicide on a rail track.

2. CASE HISTORY:

About 1.7m away from a rail track a dead body of a male about 20 years old was spotted by passerby public. Local police referred the dead body to a nearby government medical college for post mortem examination. The body was of average built of height 173 cm. On external examination rigor mortis was present in lower limb and passed off upper limb.

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Post-mortem lividity was present on the back side of body except on pressure points and it was fix. The mouth was partially open. There was no evidence of bleeding or discharge. The left eye showed subconjunctival haemorrhage in the outer canthus. There were no visible signs of putrefaction. There were grease mark on the front of chest, inner and front aspect of left hand and on the left middle finger on the outer aspect.

External body injuries were as follows:-

Irregular reddish abrasions of about 0.5 to 8.5cm size seen on right shoulder, right arm, left forearm, left fingers and right foot. About 15 x 8 cm x cavity deep laceration present on left nasal, forehead, frontal and parietal region exposing fractured pieces of skull vault, irregularly lacerated duramater and part of cerebellum (**Fig No.1**). Another about 7 x 2cm x bone deep size laceration seen on the back of elbow with surrounding irregular black grease mark (**Fig No.2**). The wound exposes fractured ends of upper part of ulna bone .

Fig No.1: Head Injury Showing Multiple Skull Bone Fragments

Fig No.2: Old Linear Multiple Superficial Scar Marks on Left Hand

Internal body injuries were as follows:-

- Swelling and deformity of left forearm, on dissection there was fracture of radius at its mid-3rd with surrounding reddish contusion.
- Available scalp tissue showed presence of about 6 X 1.5cm size reddish contusion on right parietal region.
- Skull Vault showed presence of 22 X 15cm size comminuted fracture involving the right fronto-parieto-occipital region. There was a fissured fracture about 9cm long in the left parieto-occipital region. Another 7cm long fissured fracture was seen in the left posterior cranial fossa which was in continuous with the vault fracture.
- Duramater was torn irregularly over the right and left fronto-parieto-temporal region. Both the cerebral hemispheres were oozed out from the cranial cavity. Cerebellum and part of brain stem were intact. Cut sections of the available brain matter were pale.

Other than these there was no external or internal injury in the body. The same day the remaining missing brain mater was also collected from the crime scene area and it was examined by the same autopsy doctor.

The cause of death was given as the head injury and the time since death approximately 12 to 24 hours prior to autopsy. However, viscera were preserved for chemical analysis. This was not the end of the case as there was a hue and cry from the relatives as they suspect homicide as this man eloped and tied a nuptial knot with a girl from a higher community. The situation went from bad to worse as communal riot broke out.

3. Court intervention

The matter was filed in the court of law. On the direction of the Madras High Court the dead body was examined independently by two senior Forensic Medicine Professors one of which was one of the authors of this article. There was discordance in opinion and the following points were put forward by the other senior professor:-

1. Usually in railway accidents extensive injuries like multiple lacerations, contusions, abrasions, etc. are seen all over the body.
2. In suicidal deaths complete severing of head from the body or severance of limbs are common.
3. Except the injury over the head and left forearm, no other injuries were seen in other areas of the

body. In head injuries due to speeding train, associated spinal injuries are seen. In this case we have taken X-rays to look for spinal or mandible fractures, we dissected the neck area to check for any bruising, to our surprise there were no sign of injury in the neck

4. If the deceased person was hit by the train by the sides, along with the head injury he would have sustained severe injuries over his shoulder, rib fractures, chest injuries and other injuries on the side of impact will be seen. In this case no such injuries were seen. Since the shoulders are the most protruding part of the body it will definitely show severe injuries. In this case forearm injuries are seen, no shoulder injuries are present.
5. Extensive laceration with fracture of skull were seen but bruising of the scalp was minimal, which was not consistent with the extent of injury.
6. Thus the possibility of accidental or suicidal death theory was challenged by the other senior Forensic Professor.

So, the necessity of a second post mortem examination was felt and the court ordered to conduct a second post mortem examination by a Medical Board of forensic experts.

4. Second autopsy findings:

An autopsy team of Medical Board comprising three experts came from one of the premier institutes located in New Delhi and the second autopsy was conducted on the 8th day after the first autopsy. The Medical Board unanimously concluded that:-

1. The cause of death in this case is the extensive cranio-cerebral damage caused by impact of a heavy blunt object. The head injury as well as other injuries are ante mortem in nature and it will result to instantaneous death. The injuries mentioned could be caused by the impact of a running train.
2. The deceased was having multiple linear scars on inner aspect of left forearm which are hesitation cut marks suggestive of previous suicide attempts/tendencies (Fig No.2). Suicidal tendency is the propensity of a person to have suicidal ideation or to make suicidal attempt.

The Medical Board also further observed that – "It is most likely that since the deceased was under the influence of alcohol at the time of incidence and the ideation of committing suicide, sustaining injuries resulting into death could be possible due to accidental hitting by a moving train."

5. Discussion

In accidents cases head injuries are more common though they are associated with other bodily injuries on different body parts such as lower extremities, abdomen, thorax, upper extremities, neck, etc.[5,6] In suicide cases decapitation and hemi section of body trunks are quite common.[7] So, the present case, by prima facie, must go in favour of an accidental death. But there was no enough other bodily injuries to call it as accidental one.

In his forensic medicine textbooks published throughout the 1920s and 1930s Prof. Milovanovic´ noted: ''suicidal or accidental railway collisions with a person in an upright position are quite similar. However, injuries in individuals lying across the rails are overly characteristic: they are found at the neck, head, legs, and the pelvis; the wounds are parallel, with the scissors-effect of the train wheels and the rails on the body lying across the track. Bound legs, covered eyes, and hands covering the ears all indicate suicide. Covering the ears with the hands results in arm injuries that are contiguous with neck injuries, which may also be typical for suicides''.[7,8]

Individuals who lie across railroad tracks in order to commit suicide hold the palms of their hands against their ears in an effort to avoid the noise produced by the oncoming train. In such cases the arms and shoulders are abducted with the elbows flexed, resulting in contiguous injuries of the neck and arms. However, in the present case the position of the deceased at the time of impact could be partially bending forward so that only the frontal part of the head was smashed forcefully by the prominent portion of the train resulting into the oblique laceration of the scalp along with shattering of the underlying vault and base of the skull, complete severance of the body may not be necessary.

Multiple abrasions, contusions, fractures and lacerations seen on the deceased (though they are not scattered in the whole body) are also possible in a case of railway accident. Laceration & fracture of left arm bones could be due to secondary impact injury. Because of the extensive head injury, death could have occurred instantaneously so scalp contusion was not extensive.

Another angle of possibility of torture and killing by other means and placing the dead by deliberately onto the railway track was also excluded

as there was no evidence of such physical torture. Regarding the question about the absence of neck and spinal cord injury, it is not necessary that there will be always such damages as the head was not stationary. This opinion was consistent with the opinion given by the Medical Board experts. This whole theory was consistent with findings of the crime scene investigation. So, ultimately the possibility of homicide was excluded.

6. Conclusion:

The ugly face of communal hatred and riots due to inter-caste marriage rises up now and then in our society. Sometimes, it may lead to honour killing of their daughter or suicide of the parents. Those who dared for the inter-caste marriage by violating the social norm had to face the consequence in terms of violence, social boycott, family boycott and even death. Timely intervention by law and medical expert opinion based on scientific findings can prevent such heinous social crime.

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