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Journal of Indian Academy of Forensic Medicine (JIAFM)

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Dr. Mukesh Yadav

Professor & HOD

Forensic Medicine & Toxicology,
School of Medical Sciences & Research
Sharda University, Greater Noida, U.P. PIN:
201306

Residence

G-216, Parsvanath Edens,
Alfa-II, Greater Noida, G.B. Nagar,
U.P.-2010308
Ph. No. 0120-2326060,
Mobile No. 09411480753
Email: drmukesh65@yahoo.co.in

Joint Editor

Dr. Akash Deep Aggarwal

Assistant Professor,
Department of Forensic Medicine,
Pt. B.D. Sharma PHGIMS, Rohtak,
Haryana-124001

Residence

H.No. 14, Desi Mehmandari,
Patiala, Punjab
PIN: 147001
Mobile No. 9815652621
Email: toakashdeep@yahoo.com

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From Editor's Desk

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I feel immense pleasure to present before you the third issue of 2010. I assure you about the quality of research papers and quality of printing in future issues. Your valuable suggestions are always encouraging me and I heartily welcome for future suggestions. On behalf of Executive Committee of IAFM for the years 2010-2011, I took resolution to further improve the quality and status of our Journal. We always learn from mistakes and try to improve upon these. I am thankful to the advertisers who have provided additional financial resources for improving the quality of this issue.

Dr. Mukesh Yadav
Editor

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Editor

*Editorial***Discovery Rule and Medical Negligence**

As a General Rule consumer court can reject the complaint of medical negligence if filed after lapse of two years from the date of cause of action under section 24A. The **“Discovery Rule”** evolved by the Courts in United States has been recently applied by the Hon’ble Supreme Court of India in a case decided on 20th October 2010. The patient was employed as a Nurse in Government Hospital, Goa, she had no reason to suspect that gauze might have been left in her abdomen at the time of surgery performed in November, 1993 and the Gujarat State Commission was not at all justified in non suiting her on the premise that the cause of action had accrued in the year 1993 and complaint filed in the year 25.10.2002. [Para 12]

The term cause of action is not defined in the Act of 1986 the same has to be interpreted keeping in view the context in which it has been used in Section 24A (1) and object of the legislation. The question of limitation is a mixed question of law and fact.

Section 24A, Limitation period:

- (1) The District Forum, the State Commission or the National Commission shall not admit a complaint unless it is filed within two years from the date on which the cause of action has arisen.
- (2) Notwithstanding anything contained in sub-section (1), a complaint may be entertained after the period specified in sub-section (1), if the complainant satisfies the District Forum, the State Commission or the National Commission, as the case may be, that he had sufficient cause for not filing the complaint within such period:

Provided that no such complaint shall be entertained unless the National Commission, the State Commission or the District Forum, as the case may be, records its reasons for condoning such delay." [Para 13]

Whether effect of negligence is ‘patent’ or ‘latent’?

- In cases of medical negligence, no straitjacket formula can be applied for determining as to when the cause of action has accrued to the consumer.
- Each case is to be decided on its own facts. If the effect of negligence on the doctor's part or any person associated with him is patent, the cause of action will be deemed to have arisen on the date when the act of negligence was done.
- If, on the other hand, the effect of negligence is latent, then the cause of action will arise on the date when the patient or his representative- complainant discovers the harm/injury caused due to such act or the date when the patient or his representative-complainant could have, by exercise of reasonable diligence discovered the act constituting negligence. [Para 18]

What is the Discovery Rule?

- Where a foreign object is negligently left in a patient's body by a surgeon and the patient is in ignorance of the fact, and consequently of his right of action for malpractice, the cause of action does not accrue until the patient learns of, or in the exercise of reasonable care and diligence should have learned of the presence of such foreign object in his body.

Background of the Discovery Rule:

- The Discovery Rule to which reference has been made was evolved by the Courts in United States because it was found that the claim lodged by the complainants in cases involving acts of medical negligence were getting defeated by strict adherence to the statutes of limitation. [Para 19]

Global Scenario on applicability of the Discovery Rule:

- In Pennsylvania, the Discovery Rule was adopted in *Ayers v. Morgan* case.
- In that case a surgeon had left a sponge in the patient's body when he performed an operation. It was held that the statute of limitation did not begin to run until years later when the presence of the sponge in the patient's body was discovered.
- In West Virginia, the Discovery Rule was applied in *Morgan v. Grace Hospital Inc.* case.
- In that case a piece of sponge had been left in the wound during a surgical operation but its presence in the body did not come to light until 10 years later. The Court rejected the objection of limitation and observed:

"It simply places an undue strain upon common sense, reality, logic and simple justice to say that a cause of action had ‘accrue’ to the plaintiff until the X-ray examination disclosed a foreign object within her abdomen and until she had reasonable basis for believing or reasonable means of ascertaining that the foreign object was within her abdomen as a consequence of the negligent performance of the hysterectomy."

Again, the **Supreme Court** observed:

"We believe that the **'discovery rule'** as stated and applied in cases cited above represents a distinct and marked trend in recent decisions of appellate courts throughout the nation."

Recent application of the Discovery Rule:

- In **Idaho**, the **Discovery Rule** was invoked in **Billings v. Sisters of Mercy of Idaho** case.
- The facts of that case were that the plaintiff underwent a **surgical operation in 1946**. A **sponge was left in the wound when the incision was closed**. The same was **discovered in the patient's body in 1961**. During the **intervening period** the patient sustained considerable suffering, during which she **consulted various physicians**.

Limitations of 'General Rule':

- After reviewing numerous authorities at great length, the **Court cast aside the earlier doctrine**, adopted the **Discovery Rule** and observed:
 "In reality, the **'general rule'** has little to recommend it. It is neither the position of a majority of the jurisdictions nor is it firmly based on **considerations of reason or justice**. We will, therefore, adhere to the **following rule**: where a **foreign object is negligently left in a patient's body by a surgeon and the patient is in ignorance of the fact, and consequently of his right of action for malpractice, the cause of action does not accrue until the patient learns of, or in the exercise of reasonable care and diligence should have learned of the presence of such foreign object in his body.**"
- The facts in **Quinton v. United States** case were that the **wife of the plaintiff was given blood transfusion in a Government hospital in 1956**. In **June, 1959**, the **plaintiff and his wife during the latter's pregnancy discovered that wrong type of blood was given to her in 1956** and as a result she gave birth to a **stillborn child**.
- The Government sought dismissal of the action for damages on the **ground of limitation**. The **Court of Appeals opined** that when a claim accrues under the **Federal Tort Claims Act**, it is governed by **Federal law** and **not by local State law**.
- The Court then held that **the period of limitation does not begin to run until the claimant discovers, or in the exercise of reasonable diligence should have discovered the act constituting the alleged negligence**.
- In **Josephine Flanagan v. Mount Eden General Hospital** LEXSEE case, the application of the rule of **Discovery** was considered in the background of fact that during the course of operation done on **14.7.1958**, **surgical clamps were inserted in the plaintiff's body**. In **1966**, the plaintiff consulted a doctor because she experienced severe pain in the region of her abdomen. The doctor told her that **surgical clamps were discovered by X-ray analysis**. Thereafter, another operation was performed to remove the clamps.
- The defendants sought dismissal of the complaint on the ground that the same was **barred by time**. The Court referred to the **Discovery Rule** and observed:
 "The so-called **discovery rule** employed in foreign object medical malpractice case is in compatible harmony with the purpose for which **Statutes of Limitation** were enacted and strikes a fair balance in the field of medical malpractice. The **unsoundness of the traditional rule**, as applied in the case where an object is discovered in the plaintiff's body, is patent. **"It simply places an undue strain upon common sense, reality, logic and simple justice to say that a cause of action had 'accrued' to the plaintiff until the X-ray examination disclosed a foreign object within her abdomen and until she had reasonable basis for believing or reasonable means of ascertaining that the foreign object was within her abdomen as a consequence of the negligent performance of the operation."**

In the case before SC, the **danger of belated, false or frivolous claims is eliminated**. In addition, plaintiff's claim does not raise questions as to credibility nor does it rest on professional diagnostic judgment or discretion. It rests solely on the presence of a foreign object within her abdomen.

The **policy of insulating defendants from the burden of defending stale claims brought by a party who, with reasonable diligence, could have instituted the action more expeditiously is not a convincing justification for the harsh consequences resulting from applying the same concept of accrual in foreign object cases as is applied in medical treatment cases**.

A clamp, though immersed within the patient's body and undiscovered for a long period of time, retains its identity so that a defendant's ability to defend a "stale" claim is not unduly impaired. Therefore, **where a foreign object has negligently been left in the patient's body, the Statute of Limitations will not begin to run until the patient could have reasonably discovered the malpractice.**" (Emphasis added)

Doctor should make aware of these new developments in the field of medical negligence to protect from potential law suit as well as take reasonable precautions in the interest of patient to avoid his sufferings for which he approached the concerned doctor.

Original research paper

Access of High Technology Based Medical Diagnostic Tool to Convicted Prisoners Lodged in a Typically Large Indian Jail – CT Scan as Case Study

*Dr Munawwar Husain, **Dr Usama B. Ghaffar, ***Dr Jawed Ahmad Usmani, ****Dr Shameem Jahan Rivzi

Abstract

Computed tomography scan of whole body or part of the body is an excellent tool that has elbowed out other radiological procedures demoting their diagnostic importance. However, it is costly to install and operate successfully following the prescribed procedure of equipment maintenance, overhaul and replacement of depleted parts. Keeping this in view, this exercise was contemplated to find out if convicted prisoners lodged in jail are being discriminated at any time by denying CT scan against medical advice. A typically large Indian jail was selected because it would be reflective of similar conditions prevailing in other jails. It was found that although the prescription rate of CT scan was less in prison inmates as compared with the general population, no element of discriminatory nature or prejudice could be detected. Search on internet and other related journals yielded no result on this topic. Hence it was felt that a beginning should be made. In future large sample studies could be taken up for an authoritative work. Such a work would serve the requirement of the government for enacting policies as well as create awareness among the penitentiary officers.

Key Words: CT scan, Convicted prisoners, High technology, Awareness

Introduction:

In India, prisons are literally bursting at their seams due to overcrowding thus exceeding the intake capacity of prisoners. An example is of Tihar Jail Complex [1] at New Delhi, the biggest prison in India. It is illustrative of demoralizing state of penitentiary affairs. Similar conditions, by and large, prevail in district central jails. The root cause is large number of under trials lodged in prisons and the sheer number of pending cases in courts of justice decelerating the process of final dispensation. Since the annual budget of prisons is determined by the allotted capacity of convicted prisoners, the heavy number of under trials stretches the recurring financial allocation to gossamer thinness.

Corresponding Author:

*Dr. Munawwar Husain
Reader & fmr Medical Superintendent
Deptt. of Forensic Medicine
J N Medical College
Aligarh Muslim University
Aligarh 202 002, India
E-mail: husain_uia@yahoo.co.in
Ph.: +91 (0571) 2720038 (Off) /
H/P: +919837314652 / +919997497939
**Assist Professor,
Era Medical College, Lucknow
*** Professor, Abha Medical College,
Kingdom of Saudi Arabia
****Professor and Chairman of the department

The present research work was undertaken to find out whether the prisoners are getting a fair deal when it come to medical treatment. Computed Tomography (CT) scanning was selected as the indicator of medical attention paid to the prisoners because of the following reasons:

- I. It is a specific diagnostic tool that utilizes high technology, and hence involves considerable cost to the patient.
- II. While considering cost-benefit analysis (CBA), CT comes midway to contrast X-ray and ultra sonogram (USG) which are cheaper, and magnetic resonance imaging (MRI) that is three times costlier than CT scan.
- III. CT scan needs referral by qualified and specialized doctors, and hence it indirectly reflect on the attention paid to the incarcerated prisoner. It is a highly focused investigative procedure.
- IV. CT units are costly to install and operate, and hence no prison hospital can afford to have one as huge investment is required to establish the ancillary infrastructure. The patients needing CT scan have to be referred to outside hospital anyway.

A typical large Indian jail on which the study was conducted

Description of Jail:

The prison is spread on an area of 23 acres of land in the heart of the city. Its inner boundary wall is 16 feet high and run for 3979 feet. It has

separate barracks; 29 for male and 1 for female prisoners effectively segregating the sexes. Each barrack has a capacity to accommodate 30-60 people. In addition it has 16 cells initially meant for solitary confinement but now serving as quarantine area. The prison's total capacity is to lodge 1050 prisoners; 1030 males and 20 females. At the time of writing this paper the number of prisoners lodged was 2300, more than half of them under trials.

Hospital Figures:

The hospital staff consists of Resident Medical Officers (02), pharmacists (02), laboratory technician (1), laboratory attendant (1); doctors-on-call includes female gynecologist, medicine and surgery specialists. Their services are generally borrowed from the main central government hospital of the district as and when required.

The hospital is small in terms of admission capacity: 16 beds for male patients and 2 for female patients. 8 beds for males and 2 for females are exclusively earmarked for communicable diseases.

Diagnostic facilities include provision of simple X-ray, laboratory for testing sputum (AFB), blood (haemogram, malaria parasite), urine (routine and microscopic) and stool (for ova, cyst and occult blood). In addition it has an electrocardiographic (ECG) machine. However, its reading and interpretation is done by the medicine doctor-on-call.

Bed occupancy rate hovers around 80% of the total bed capacity throughout the year. Most ailments treated are typhoid, diarrhea, and simple cases of food poisoning, fever and skin eruptions. Serious cases requiring specialized care are referred to higher centers / hospital. Emergency section provides first aid to the patient.

Budgetary Provision for Medical Care to the Inmates:

Few years back the prison was paid @ 0.72 paisa ^(F/N) per patient per day by the State Government. For 1050 capacity this would be Rs 2, 75, 940/- annually. However, the financial position is slightly eased now taking into consideration the spiraling inflation index – including on pharmaceuticals – and presently the prison is paid Rs 15,00,000/- annually which would come to Rs 3.91 per day per inmate. Nevertheless, this increase is 5.43 times higher than the previous one.

Observations and Discussion:

The present study has been conducted in a typical Indian jail which is reflective of more or less similar happenings, malaise and improvisation as in other jails in India. Though access to medical records of the patients was denied much information was obtained from the doctor who was in charge of the management of the hospital. A total of 5 CT scans were recommended during the period from January 2008 to December 2008. Those recommended for CT

belonged to medical domains of neurosurgery, neurology, carcinoma (suspected metastasis) and neglected injuries, though rare in the last case. CT scans were recommended by the specialists who had observed the patient for quite longer period. If this figure of 5 in a year is compared by the CT scans done in a local 1050-bedded medical college hospital the disclosure would be alarming. Total CT scans in the medical college hospital stood at 7512 during the same period. Though it caters to specialties and super specialties the comparison would not be comparable in the wildest of imagination. Nevertheless, for feasibility of study the bed-wise recommendation of CT in medical college hospital would be 7.15 per bed per year (discounting the disease profile of the patient). In that respect on 18 beds of the prison the CT recommendation should be more or less 128 during the same duration.

The population of prison inmates is drawn from the same district; hence it would be expected that they were predisposed to similar ailments and illnesses age-wise as those attending the medical college hospital. But it must not be lost sight of that medical college hospital draws patients from distant places too. Hence the demographic profile changes. Therefore, the population profile in both cases changes drastically and becomes incomparable due to ^{nth} variants.

Being a referral tertiary hospital the medical college hospital gets the referred patients. Mostly they have exhausted other avenues of treatment locally to where they belonged. Hence most of them are far advanced in disease process. Therefore, CT option becomes primary. Comparably, the prison population is mostly under 40s and has lesser predisposition to fall prey to conditions demanding immediate CT scan as a matter of rule. Priorities changes because the first line of radiological diagnostic exposure would be limited to X-ray and USG.

Conclusion:

From the study it was deduced that the prison has not discriminated nor denied the option of CT scanning to prisoners if medically required. Those who really required CT scanning were sent outside the prison for medical referral and investigation keeping the interest of the patient intact. However, the claim by the prison authorities that all expenses were borne by the prison may be taken with a pinch of salt. In few cases this may have been borne by the relatives of the prisoner discreetly. However, whatever be the case this was unambiguously established that referral was quick and prompt and CT scan if advised was followed. This was on the plus side. However, the possibility cannot be gainsaid that doctors may aver from prescribing CT scan because they know that the prison would not support

such medical expenditure. So either the needy most or those who could sponsor the test by their own resources may be taken up for the same.

Suggestions:

1. Pooling of resources must be done.
2. Since health is human right extended by the State irrevocably, transfer of serious patients to the hospital equipped with necessary equipment must be done. For this purpose and in accordance with the above legal instrument establishment of a large well-equipped hospital may be considered as an extension of penitentiary complex. It may accommodate patients from other prisons. It should arguably be a state-of-the-art affair. Not only CT scan, other diagnostic and treatment facilities too, may be centralized making it a composite facility center for the jail inmates. This hospital would cater to prison population of local area as well as other prisons located within a perimeter of 100 kilometers or more. In the meantime the medical

allocation of budget should be increased. Since investigation costs are high separate head of accounts may be created within the broader medical expenditure exclusively meant for the purpose of investigation.

3. A large study is needed with wider terms of reference that could pin-point other deficiencies in order to formulate a policy conducive with the prison environment and beneficial to the inmates.
4. There is dearth of such type of focused studies which if properly pursued would definitely lead to amelioration of pathetic conditions in prisons. Therefore, such academic ventures must be encouraged.

References:

1. <http://tiharprisons.nic.in/html/profile.htm>

Acknowledgement:

Thanks to all the jail staff who co-operated in the study.

Original research paper

Fatal Road Traffic Accidents among Young Children

*Harnam Singh, **A. D. Aggarwal

Abstract

Fatal road traffic accidents in childhood constitute a significant public health problem. Young children are extremely vulnerable to such injuries which are vastly preventable. 59 cases of fatal road traffic accidents in children aged below 16 years, autopsied during 1 year period were studied. Males accounted for 83.1% cases with male-female ratio of 4.9. The most common age group involved was 13-16 years. The most frequent victims of road traffic accidents were pedestrians (61%) followed by cyclists (13.6%). More than half of the cases occurred in winter season and majority occurred at 12-4 PM. Children themselves were at fault in majority of cases. Head injury alone was fatal in 72.9% cases. None of the victim received any treatment or first-aid at the site of accident. 72.9% of victims died within 6 hrs of accident. The study highlights the pattern of fatalities due to road accidents in children and suggests suitable preventive measures to reduce burden of childhood mortality due to road accidents.

Key Words: Road Traffic Accidents, Children, Injury, Fatal.

Introduction:

In many Countries around the world, injuries are the leading cause of death. Approximately 20% of all unintentional deaths worldwide occur in children under 15 years old and are among 10 leading causes of death. Road accidents account for 21% of all death in this age group. [1] 0-14 year children constitute 30.4% of total population in our country. Accidental death of children accounts for 6.7% of total such death out of which 36.3% are due to road accidents. [2] Road Traffic injuries are a leading cause of death in children. Pedestrian are 30 times more involved in accidents as compared to cyclists and car occupants [3].

Road accidents accounted for 55% of all accidental death in children and in almost all of these, the unsafe behavior of child was considered to be at fault. [4] These road accident deaths occur in healthy children who might have been expected to have had productive lives and cause immeasurable distress and guilt to the parents and other parties involved. So the prevention of accidents in children is being increasingly recognized as an important public health issue.

Corresponding Author:

Harnam Singh

*Associate Professor,

Forensic Medicine,

Muzaffarnagar Medical College,

Muzaffarnagar, U.P.

Email: drharnam71@gmail.com

**Assistant Professor, Forensic Medicine,

PGIMS, Rohtak

Material & Methods:

All the children under 16 years of age were included in study, which died due to road accidents over one year period.

During 1 year 450 cases of road accidents were brought for postmortem examination. Out of these 59 cases were below 16 years of age. These cases were thoroughly studied for age and sex distribution, place, time and cause of accident, pattern and distribution of injuries, fatal injuries and cause of accident. The history was taken from relatives, friends, and police inquest report and hospital records. The data thus obtained was analyzed statistically.

Observations:

In one year study period 59 children aged less than 16 years died due to road accidents out of 450 cases (13.1%) out of which 83.1% were males and 16.9% were females. The commonest age group involved was 13-16 years (30.5%) followed by 9-12 years (27.1%) and 6-8 years (20.4%) respectively. (Table - 1)

There were no fatal accidents before one year of age and after that the incidence increased as the age group increased. The national and state highways accounted for 55.9% of all cases followed by village roads (23.8%). (Table-2)

Pedestrians (61%) were the commonest group of road users killed followed by cyclists (13.6%) (Table - 3) 54.2% of fatal accidents occurred in winter season (Table - 4). The majority of accidents occurred between 12-2 PM (27.1%) followed by 2-4 PM (18.6%) and 8-10 AM (15.3%). No accident occurred between 10 PM to 6 AM. (Table - 5) Trucks and buses were responsible for 40% of fatal accident followed by cars and jeeps

(30.5%) (Table - 6) Hit & Run type of accidents occurred 59.3% cases followed by run over accidents in 18.6% cases (Table-7). Children were themselves at fault in majority of cases like negligent road crossing (22%), playing on road, (16.9%) and cycling without helmet (13.6%).(Table-8)

None of the victim received any treatment or first-aid at the site of accident. 16.9% cases died on spot and only 1.7% cases reached hospital with in 15 min of accident where as majority reached with in 15-30 min (18.6%) followed by 30-45 min (15.3%). (Table-9)

43 (72.9%) patients died within six hrs of accidents out of which 10 (16.9%) died on spot, six (10.2%) with in 0.5-1 hrs and 23 (40%) with in 1-6 hrs. Only two (3.4%) patients survived for more than 14 days. The longest survival period was 26 days 20 hrs in a pedestrian who died due to subdural effusion and compression of brain. (Table-10)

The commonest site injured was head and face (84.7%) followed by lower limbs (76.3%) and upper limbs (72.9%). Multiple injuries are a rule in road traffic accidents. In total there were 189 major injuries in 59 cases i.e. injury per case was 3.2. (Table-11)

Head injury was fatal in 72.9% cases followed by abdominal (30.5%) and chest injuries (28.7%). There were 87 fatal injuries in 59 cases that is fatal injury/case was 1.47 (Table-12)

Hemorrhage and shock was leading cause of death accounting for 37.3% deaths followed by laceration of brain and intracranial bleed in 22% cases each. (Table-13)

Discussion:

Road traffic accidents are a major cause of childhood motility. After one year of age as the age group advances, the incidence of fatal accidents increases. Males outnumbered females in ratio of 5:1. [4]

Pedestrians and cyclist are the common group injured. [3, 4, 5, 6, 7] Majority of fatal accidents occurred during winter season. Children were at fault in majority of cases. They were either playing on the road or crossing the roads, unsupervised by adults. The cyclists were not wearing any protection helmets.[4,5,8] None of the injured received any treatment or first aid at the site of accident.16.9% cases died on the spot and only 1.7% reached hospital with in 15 minutes of accident. 3/4th of these death occurred with in first 6 hour. [9]

Multiple injuries are a rule in road accidents. Major injury per case was 3.2 and fatal injury per case was 1.47. Head injuries alone were cause of fatalities in majority of cases (72.9%) [4, 8, 10]

Road accidents are most common cause of death in children over one year of age. So the prevention of injury to children remains high priority

for society. So the preventive measures should be directed towards improving the road safety for children, increased supervision of children by adults and the provision of safe play areas away from the traffic. [11]

Conclusion:

Fatal road accidents are a major cause of childhood mortality up to 16 years of age involving mainly males. Children are themselves at fault in majority of cases. To prevent these early childhood deaths, children should be educated about traffic rules. They should be separated from high-speed highways and safe playgrounds should be developed for their recreation. The cyclists should have proper training and should be encouraged to obey traffic rules.

Wearing of safety helmets should be made compulsory even for the cyclists. Smaller children should not be left unattended by parents near the roads. Special restraining devices should be installed in cars and buses. Walking should be encouraged in children rather than cycling for good health and safe journey.

Table No. 1: Age & Sex Distribution

Age Group (Years)	Male No. (%)	Female No. (%)	Total No. (%)
0-1	0 (0)	0 (0)	0 (0)
2-3	3 (5.1)	0 (0)	3 (5.1)
4-5	6 (10.2)	4 (6.8)	10 (16.9)
6-8	9 (15.3)	3 (5.1)	12 (20.4)
9-12	13 (22)	3 (5.1)	16 (27.1)
13-16	18 (30.5)	0 (0)	18 (30.5)
Total (N=59)	49 (83.1)	10 (16.9)	59 (100)

Table No. 2: Place of Accident

Place	No.	%
National Highway	16	27.1
State Highway	17	28.7
City Road	9	15.3
Village Road	14	23.8
Approach Road	3	5.1
Total (N=59)	59	100

Table No. 3: Type of Road User Killed

Type of Road User	No.	%
Pedestrian	36	61.0
Cyclist	8	13.6
Ride Motor Cycle	6	10.2
Cars Jeep	2	3.4
Passenger Bus	4	6.8
Others	3	5.1
Total (N=59)	59	100

Table No. 7: Type of Accident

Type of Accident	No.	%
Hit & Run	35	59.3
Run Over	11	18.6
Head on	3	5.1
Fall from bus	4	6.8
Over turn & Skidding	4	6.8
Others	2	3.4
Total (N=59)	59	100

Table No. 4: Seasonal Variation

Seasons	No.	%
Winter Seasons	32	54.2
Summer Seasons	19	32.2
Raining Seasons	8	13.6
Total (N=59)	59	100

Table No. 5: Time of Accident

Time of Accident	No.	%
6-8 A.M	3	5.1
8-10 A.M	9	15.3
10-12 A.M	7	11.9
12-2 P.M	16	27.1
2-4 P.M	11	18.6
4-6 P.M	6	10.2
6-8 P.M	6	10.2
8-10 P.M	1	1.7
10P.M. - 6 A.M	0	0
Total (N=59)	59	100

Table No. 6: Vehicles Responsible for Accident

Responsible Vehicles	No.	%
Trucks & Buses	23	40.0
Cars & Jeeps	18	30.5
Tractor	7	11.9
Two wheelers	6	10.2
Others	5	8.5
Total (N=59)	59	100

Table No. 8: Cause of Accident

Cause of Accident	No.	%
Negligent Road Crossing	13	22.0
Playing on Road	10	16.9
Negligent Cycling	8	13.6
Negligent Driving	8	13.6
Over Speeding	4	6.8
Poor Vision/Fog	3	5.1
Standing on Doors/Scoters	7	11.9
Others	6	10.2
Total (N=59)	59	100

Table No. 9: Hospital Survival Period

Time to reach Hospital	No.	%
<15 Min	1	1.7
15-30 Min	11	18.6
30-45 Min	9	15.3
45-60 Min	6	10.2
1-1.5 hrs	9	15.3
1.5-2 hrs	2	3.4
2-2.5 hrs	7	11.9
>3 hrs	4	6.8
Spot Death	10	16.9
Total (N=59)	59	100

Table No. 10: Survival Period

Survival Period	No.	%
0-0.5 hrs	14	23.8
0.5-1 hrs	6	10.2
1-6 hrs	23	40.0
6-12 hrs	3	5.1
12-24 hrs	1	1.7
24-48 hrs	4	6.8
48-72 hrs	1	1.7
3-5 days	3	5.1
5-7 days	0	0
7-14 days	2	3.4
>14 days	2	3.4
Total (N=59)	59	100

Table No. 11: Site of Injury

Site of Injury	No.	%
Head & Face	50	84.7
Neck	3	5.1
Thorax	26	44.1
Abdomen & Pelvis	22	37.3
Upper limb	43	72.9
Lower limb	45	76.3
Total (N=59)	189	Injury /Case =3.2

Table No. 12: Fatal Injuries

Site of Fatal injury	No.	%
Head	43	72.9
Cervical Spine	4	6.8
Chest	17	28.7
Abdomen	18	30.5
Pelvis	3	5.1
Lower limb	2	3.4
Total (N=59)	87	Injury /Case =1.47

Table No. 13: Cause of Death

Cause of Death	No.	%
Hemorrhage & Shock	22	37.3
Laceration of Brain	13	22.0
Intracranial Bleed	13	22.0
Compression of Brain	6	10.2
Respiratory Failure	4	6.8
Rupture of Heart	1	1.7
Total (N=59)	59	100

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Original research paper

Application of Victims' Fingernails in Forensic DNA Analysis

*Kamoun Arwa, *Mahfoudh Nadia, **Ayadi Adnene, **Hammemi Zouheir, **Maatoug Samir, **Makni Hafedh

Abstract

DNA extracted from the victims' fingernails may assist in the identification of the aggressor. Fingernails were collected from 8 victims, and were subjected to DNA extraction using the Kit « Tissue and Hair Extraction Kit (Promega) ».

All samples were typed for 15 autosomal short tandem repeats and for amelogenin using the Kit « Powerplex TM16 system (Promega) » and the ABI Prism 310 DNA sequencer. The profiles obtained were compared with those achieved by similar typing of victims' and suspects' blood.

In two Forensic investigations, mixed genotypes were detected in DNA extracted from the nails: Alleles originating from the victim were coamplified with other alleles that matched the suspect's genotypic profile. This indicated that victims' fingernails contained biological material (blood, epithelial cells) originating from the suspect.

Our results confirmed the usefulness of the nails as a specimen for forensic identification of the aggressor.

Keywords: Fingernails, DNA, Victim, STR, Promega, Genotypic Profile, Fingernails, Hair, Tissue

Introduction:

DNA analysis has proven to be a valuable technique for human identification and for the resolution of criminal disputes. Human nail material has been identified as a potential source of biological material for Forensic DNA testing [1, 2, 3].

Fingernail clippings collected from victims in assault cases, principally sexual cases, are occasionally sent to Forensic laboratories as a possible source of DNA originating from the perpetrator [4].

The aim of the present study was to optimize the extraction conditions using the Kit DNA IQ™ system (Promega) in order to identify a foreign profile in victims' fingernails possibly originating from the perpetrator.

Materials and Methods:

Extraction of DNA

Within 8 forensic caseworks, we received the fingernail clipping of 10 victims of murder (7 males and 3 females).

Corresponding Author:

*Dr Kamoun Arwa

Hôpital Hédi Chaker, Route El Ain Km 0.5, 3029

Sfax, Tunisia

E-mail : arwakamoun@yahoo.fr

Tel: 216 98652824, Fax: 216 74248622

** Professor

Service de médecine légale,

EPS Habib Bourguiba,

3029, Sfax, Tunisia

Blood collected from the 10 victims and from 13 suspects, and bloodstains sampled from the crime scenes. Samples were stored at -20°C until DNA extraction.

DNA extraction from blood was carried out by salting out technique.

Bloodstains and fingernails were extracted with DNA IQ™ system according to the protocol described by Promega [5]:

For bloodstains, 150µl of lysis buffer was added and incubated for 30 mn at 70°C. Lysis buffer and sample were then transferred to a DNA IQ Spin Basket seated in a 1.5ml microcentrifuge tube and Centrifuged at room temperature for 2 minutes at maximum speed.

DNA was purified by adding 7µl resin. After washing and drying of the resin, DNA was eluted in 50µl of elution buffer. The nail clippings received no treatment before extraction.

DNA extraction from nail clippings was carried out by a modification of the protocol described above. In order to minimize the quantity of endogenous DNA recovered, digestion was done at room temperature and not at 70°C for a short period of time ranging from 1 minute to 10 minutes, mixing was done by a gentle pipetting and not by vortexing. DNA purification and elution steps were not modified.

Short Tandem Repeat Amplification And Typing:

The DNA samples (1ng) were amplified using the powerplex 16 Kit following the manufacturer's recommendations. The amplified

products were analyzed using an ABI Prism 310 Genetic Analyzer according to the manufacturer's recommended protocol.

Initial fragment sizing was performed by the GeneScan Software (Applied Biosystems). Allele calling was performed by Promega's PowerTyper™ 16 macro operating within the genotyper® software program (Applied Biosystems).

Genetic profiles obtained from the nail clippings were compared to those typed from blood samples.

Results:

In the 1st Forensic casework, the victim was a man. The nail clippings digestion was carried out at room temperature for 10 mn. Genetic profile analysis revealed evidence for the presence of DNA from the offender in fingernail clippings of the victim's hands, with allele signal intensities 3 times lower than those of the victim [figure 1].

In the second investigation, the victim was a woman. Victim's nails were soaked in the lysis buffer for only 2 mn at room temperature. Amplification with the powerplex 16™ system showed a foreign male genetic profile which could be assigned to the perpetrator [figure 2].

In the other caseworks, fingernails collected from 8 victims were digested for only 1mn at room temperature. Genetic profiles typed were identical to those obtained from the blood nail donors.

In one investigation, genetic profiles retrieved from 2 bloodstains matched the profile of one suspect, providing hence evidence for his culpability [figure 3].

Discussion:

DNA Identification is often useful in forensic investigation, since it could originate from the perpetrator, particularly when the sample is taken from the victim cadaver. Indeed, sexual assaults or homicides are often associated with multiple actions of aggression and defence which may lead to transfer of DNA containing material: skin epithelial cells, blood. Therefore, in relevant cases, the analysis is focused on fingernail clippings or on debris scraped from underneath nails. [4] Several experimental studies aimed to develop techniques for foreign DNA extraction from nails of volunteers having scratched other subjects.

Oz et al used phenol/chloroform for the extraction of DNA from the entire fingernail clippings. [6] Amplification of 4 autosomal STRs (short tandem repeats) produced a genetic profile identical to that typed from the buccal swabs of the same volunteers. They concluded that the routine fingernail clippings would not contribute essential information in forensic casework. In fact, when digesting the entire nails, endogenous DNA would be relatively abundant and thus preferentially amplified.

When studying the resolving power of the powerplex 16™ system, Krenke et al found that only 17% of minor alleles could be detected at a ratio of 1:19. [7]

Gangitano et al optimized a non organic DNA extraction procedure for fingernail clippings after scratching. [8]

DNA samples were typed for an STR locus residing on the Y chromosome: DYS19. The success rate of typing of the scratched person was 64%. This strategy based on the identification of haplotypic markers could be useful only for the exclusion of male suspects.

Wiegand et al reported that a foreign profile could be obtained from debris scraped from underneath nails if removal of particles was carried out with sufficient care. [9]

Cline et al developed a technique for isolating and purifying foreign DNA in fingernail clippings [10]: human test nails were heavily coated with mouse liver and allowed to dry several days. A one hour H₂O/EDTA (ethylenediaminetetraacetic acid) soak of contaminated nail clippings released only exogenous DNA. The presence or absence of each species DNA was confirmed through mitochondrial DNA amplification using PCR sites conserved in all mammals.

To date, genetic identification of foreign DNA in fingernail clippings was successful in 2 cases. In the 1st report, debris from the fingernails of the suspect were scraped out with a plastic spatula and extracted with Chelex 100. Amplification with the pentaplex kit genRES MPX revealed alleles at all loci which could be assigned to the victim. [11]

In the 2nd case, a 2 years old micro-bloodstain under the fingernails of a victim was scraped. A mixed DNA sample from both the victim and the scraped person was recovered. [9]

In our report, we extracted DNA from the entire fingernail clippings of 10 victims by DNA IQ™ system. We used mild digestion conditions (shorter incubation time, room temperature, gentle mixing) in order to minimize victim's epithelial cells' lysis. We succeeded to identify a foreign DNA pattern from fingernail clippings in 2 cases. In the other caseworks, failure to identify additional alleles could be attributed to the absence of foreign biological material in the victims' fingernails.

Conclusion:

Our study underlines the value of the genetic analysis of fingernails in forensic investigations. In fact, victims' fingernails may contain biological material which could possibly originate from the perpetrator: body fluids scratched epithelial cells. Digestion conditions must be optimized to minimize extraction of victim's DNA.

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Original research paper

A Two-year Burns Fatality Study

*Rahul Chawla, **Ashok Chanana, **Hukumat Rai, ***A. D. Aggarwal, ****Harnam Singh,
*****Gaurav Sharma

Abstract

A severe burn injury is the most devastating injury a person can sustain and yet hope to survive. It is a common catastrophe today as burn injury cases are one of the common emergencies admitted to any hospital. There are several social, economic, cultural and psychological factors interplaying which influence the reporting, treatment, management and if the patient dies the further investigations. As the etiological factors of burn injuries vary considerably in different communities, careful analysis of the epidemiological features in every community is needed before a sound prevention programme can be planned and implemented. When stratified by age, more females were found in most age groups. Most burns were noted in the age group of 21-30 years. 56% cases who suffered burns were housewives. 26% females had 91-100% burns. Smell of kerosene was present in 4% cases. Maximum burns were of 3rd degree with 28% males and 54% females. Head & neck were involved in 94% cases. Extremities were involved in all cases.

Key Words: Burns, Fatal, Fire, Dowry, Death

Introduction:

Fire has been known to mankind for about 400,000 years. Although the use of fire was known to ancient man, it is probably the potential fury of an unharnessed fire that made man bow before it. India has an ancient culture where fire was worshiped since the civilization started. Along with water (jal), air (vayu), earth (prithvi), fire (agni) is perceived as one of the four basic components of universe. [1]

Burns constitute a major cause of death and morbidity whatever reason may be, in the world and in this country too. Burns always have posed a threat to the sensitive human body. An accurate estimate of incidence of burns is going to be difficult to obtain for the huge and diversely composed population of this country.

The loads of overpopulation, illiteracy, poor standards of safety at home and in the industry further add to overwhelming rise in the burn incidents. As everywhere else, the modes of sustaining burn injuries in India are the same i.e. flames, scalds, electrical and thermal. The most common cause of flame burns is accident. [1]

Undoubtedly a severe burn is the most devastating injury a person can sustain and yet hope to survive. In the United States, there are approximately 2 million thermal injuries every year and 130,000 of them necessitate hospital admission. Approximately 10,000 to 12,000 of these individuals die as a result of thermal injury annually. [2]

Material and Methods:

The study consisted of 50 cases alleged to have died of burns and brought to mortuary attached to the Department of Forensic Medicine and Toxicology, Government Medical College, Amritsar from May 2004 to July 2005.

All the 50 cases were first thoroughly examined for noting demographic details and other relevant observations. The information was collected from accompanying relatives, hospital records, and police papers to ascertain the incidence, manner and circumstances of burns. The external and internal findings of burns on autopsy were noted along with the examination of clothes.

Observations:

The present medico-legal study of burns in 50 cases was conducted on dead bodies brought in the Department of Forensic Medicine & Toxicology,

Corresponding Author:

*Assistant Professor,
Forensic Medicine, MM Institute of Medical
Sciences & Research, Mullana
E-mail: drrahulchawla9@gmail.com

**Additional Professor
Govt. Medical College, Amritsar
***Assistant Professor
Pt.B.D.Sharma PGIMS, Amritsar
****Associate Professor
Medical College, Muzaffarnagar
*****Associate Professor
Katari Medical College, Guntur

Govt. Medical College, Amritsar with effect from May 2004 to July 2005.

Age and sex wise distribution of burns is depicted in table no. 1 and figures I & II. Out of 50 study cases, 36% cases belonged to males which included one case of eunuch who was a castrated male. For all practical purposes, this case was discussed as a male in the study. 64% cases belonged to females.

The maximum incidence of burn injuries in males were noted in the age group of 21-30 years i.e. 12% and minimum cases were reported in the age group of 1-10 years i.e. 2% and no case was observed in the category of 0-1 years. The maximum incidence of burn injury in females was noted in the age group of 21-30 years i.e. 52% and minimum cases were reported in age group of above 60 years and no case was reported in the age group 0-1 years. The minimum age to suffer burns was 2 years and maximum age was 64 years.

56% cases who suffered burns were housewives and 6% females were labourer. In males, 16% were labourer, 8% were businessmen, 6% were doing private jobs and 2% were students. In females, 4% were students. (As shown in table no. 3 and figure no. IV).

Maximum percentage of burns was seen in females as compared to males in 26% cases. In males, maximum, 10% cases, suffered burns to the extent of 0-50%, followed by 8% cases suffering burns to the extent of 81-90%. In females, maximum, 26% cases fell in the category of 91-100%. Equal numbers of cases, 6% each, were charred. (As shown in table no. 7 and figure no. V).

72% cases were non-smokers and non alcoholics. 4% females were only bidi smokers. 2% males were only alcoholic. 22% males were both smokers and alcoholics. (Table no. 4).

In 78% cases, bodies were devoid of clothes and in 22% cases, burnt clothes were intact. Smell of kerosene was present in 4% cases. (Table no. 5).

1st degree burns were suffered by 6% cases in male and 8% cases in females. 2nd degree burns were seen only in females in 4% cases. Maximum burns were of 3rd degree in which 28% males and 54% females sustained burns. (Table no. 6)

Head & neck were involved in 94% cases and spared in 6% cases. Chest & abdomen were involved in 92% cases and spared in 8% cases. Extremities were involved in 100% cases. Genitalia were involved in 50% cases. (As per table no. 8)

Table 2: Area Wise Incidence and Distribution of Burns

Area	No.	%
Rural	14	28%
Urban	36	72%
Total	50	100%

Table 1: Age and Sex Wise Distribution of Burns

Age (Years)	Males	Females	Total
	No. (%)	No. (%)	No. (%)
0-1	0 (0)	0 (0)	0 (0)
1-10	1 (2)	2 (4)	3 (6)
11-20	2 (4)	4 (8)	6 (12)
21-30	6 (12)	20 (40)	26 (52)
31-40	3 (6)	3 (6)	6 (12)
41-50	4 (8)	1 (2)	5 (10)
51-60	2 (4)	1 (2)	3 (6)
> 60	0 (0)	1 (2)	1 (2)
Total	17 (36)	32 (64)	50 (100)

Figure I: Sex Wise Distribution of Burns

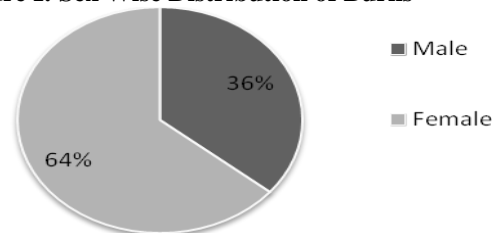


Figure II: Age and Sex Wise Distribution of Burns

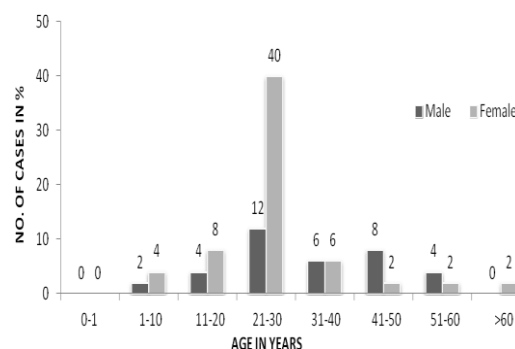


Figure III: Area wise Distribution of Burns

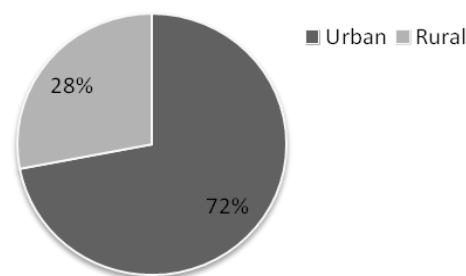
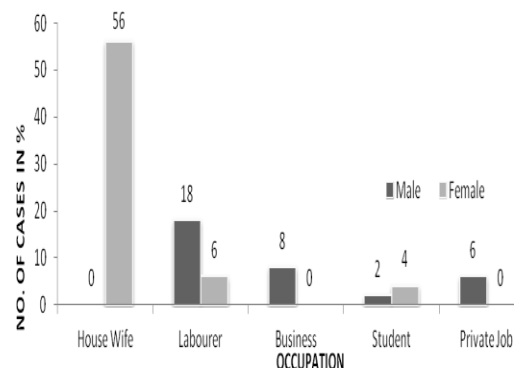


Table 3: Incidence and Distribution of Occupation of Burn Cases

Occupation	Male	Female
	No. (%)	No. (%)
House wife	0 (0)	28 (56)
Labourer	9 (18)	3 (6)
Business	4 (8)	0 (0)
Student	1 (2)	2 (4)
Private job	3 (6)	0 (0)

Figure IV: Incidence and Distribution of Occupation of Burn Cases**Table 4: Incidence and Distribution of Addictions in Burn Cases.**

Addictions	Male No. (%)	Female No. (%)
Smoking	0 (0)	2 (4)
Alcoholism	1(2)	0 (0)
Both	11(22)	0 (0)
None	36(72)	0 (0)

Table 5: Incidence and Condition of Clothing in Burn Cases

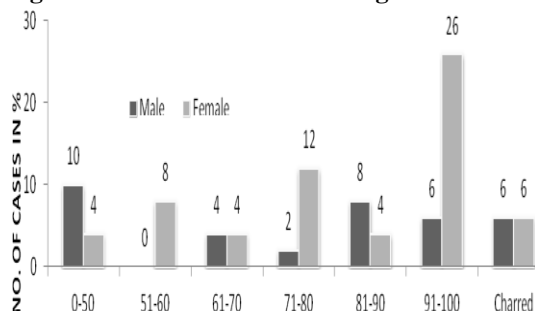
Condition Of Cloths	No.	%
Clothes present & burnt	11	22%
Clothes not present	39	78%

Table 6: Incidence and Distribution of Degrees of Burns

Type	Male No. (%)	Female No. (%)
1 st degree	3 (6)	4 (8)
2 nd degree	0 (0)	2 (4)
3 rd degree	14 (28)	27 (54)
Total	17 (34)	33 (66)

Table 7: Incidence of Percentage of Burns

Extent	Male No. (%)	Female No. (%)
0-50%	5 (10)	2 (4)
51-60%	0 (0)	4 (8)
61-70%	2 (4)	2 (4)
71-80%	1 (2)	6 (12)
81-90%	4(8)	2 (4)
91-100%	3(6)	13 (26)
Charred	3 (6)	3 (6)

Figure V: Incidence of Percentage of Burns**Table 8: Incidence and Distribution of Burns on the Body**

Body Regions	Involved No. (%)	Spared No. (%)
Head & Neck	47 (94)	3 (6)
Chest & Abdomen	46 (92)	4 (8)
Extremities	50 (100)	0 (0)
Genitalia	25 (50)	25 (50)

Table 9: Incidence and Distribution of Alleged Causes of Burn Cases

Alleged Causes	Male	Female	Total
Stove burst	6	13	19
Clothes caught fire from gas while working	0	2	2
Clothes caught fire from stove while working	0	4	4
While saving victims of cylinder blast	0	1	1
Cylinder blast	4	1	5
Clothes caught fire from candle	0	1	1
Suicidal burns by kerosene	0	2	2
Burnt by husband	0	2	2
Burnt by in laws	0	1	1
Burnt by a known person	0	1	1
To conceal crime	1	1	2
Gas leakage	0	1	1
Fall into fire	1	0	1
Blast of machine while working	1	0	1
Factory fire	1	0	1
House fire	2	2	4
Fall of burning cigarette in to bed while asleep	2	0	2

Discussion:

Age and sex wise distribution:

Out of 50 cases of burns, females predominates males. 64% cases belonged to females and 36% were males. Male to female ratio was 1:1.77. (Table no.1 and Figures I & II) Aggarwal and Chandra [3] observed 67 cases belonging to female category out of 100 cases of burns. Females were affected more than the males. Doshi [4] observed 157 females and 143 males in his study of 300 cases with male to female ratio of 1:1.17. Ganguly [5] observed 58.34% cases belonged to female category as compared to 41.66% males. Sinha et al [6] observed that females outnumbered males in the ratio of 1.25:1. Haralkar and Rayate [7] observed 239 females and 104 males in total of 343 cases with male to female ratio of 1:2.30. Naralwar and Meshram [8] found 64% females and 36% males suffered with 1.76 times more frequent involvement of females.

The present study is in unison with all these studies, because female become victim of domestic fire. In the home, either it is stove burst, gas leakage, or wearing loose clothes which are more vulnerable to catch fire. The maximum cases of burns were seen in the age group of 21-30 years comprising of 52% cases out of which 12% were males and 40% were females. In males, the maximum incidence of burns

was seen in age group of 21-30 years comprising of 12% cases followed by 41-50 years comprising of 8% cases. In the age group of 31-40 years, 6% cases were reported. In the category of 11-20 years and 51-60 years, 4% cases were reported in each respectively. 2% cases were observed in the category of 1-10 years. No case was reported in the category of 0-10 years and above 60 years. In females, the maximum incidence of 40% cases was observed in the age group of 31-40 years followed by 8% cases in the age group of 11-20 years. 6% and 4% cases each were observed in the age group of 31-40 years and 1-10 years respectively. 2% cases each were observed in the age group of 41-50 years, 51-60 years and above 60 years respectively. No case was reported in the age group of 0-10 years.

Doshi [4] found male to female ratio of 1:0.88 in age group of below 15 years and 1:1.17 in age group of 15-25 years. Sinha et al [6] found the boys were affected more than the girls, while in the next group; subsequently females dominated males probably due to their engagement in cooking in kitchen. In 3rd decade, there was not much difference in sex incidence. Sharma et al [9] observed that out of 110 cases, 33 belonged to 0-10 years, 28 in 21-30 years, 12 in 31-40 years, 3 in 41-50 years, 4 in 51-60 years and 3 in 61-70 years. Aggarwal and Chandra [3] observed 31 deaths in age group of 11-30 years and 13 deaths in 31 to 40 years. Majority of them belonged to 2nd and 3rd decade i.e. 67 cases. Females were double the number of males and were in their 2nd and 3rd decade. Haralkar and Rayate [7] found the maximum number of burn cases i.e. 156 (45.48%) belonged to age group between 15 and 25 years. Minimum number of patients i.e. 61 (17.28%) were in the age group between 35-45 years.

The present study is in consistence with the studies of above mentioned authors in respect to preponderance of female sex and age groups due to involvement of females in kitchen work, even in younger age and early marriages in society, clothing pattern, few suicidal and dowry deaths are also reported in this age.

Area-wise distribution:

In present study, urban habitat comprising of 72% cases predominately the rural habitat in 28% cases. (Table 2 and Figure III) However, Sinha et al [6] observed high incidence in rural habitat. Haralkar and Rayate [7] observed the rural preponderance probably due to style of living and low socio-economic status. Use of shegadi, chulah, stove for cooking was seen more in rural than in urban areas. Punjab is a developed state and has lot of industry. There is great rush of migratory population in the urban areas who still use stoves in the kitchen and majority of cases reported belong to poor socioeconomic strata females catching fire.

Occupation:

In the present study, housewives predominated comprising of 56% cases other occupations in females, 6% cases of laborers and 4% cases were students. In males, the category of laborers comprising of 18% cases predominated followed by 6% cases of private jobs, 8% case of businessmen. (Table 3 and Figure IV) Aggarwal and Chandra [3] observed that all the females of 3rd decade and some of 2nd decade were housewives. Haralkar and Rayate [7] observed in their study of 343 burn cases admitted at General Hospital, Solapur, that 49.85% were housewives, 6.2% agri-labourers, 10.2% non agri-labourers, 3.5% own business and unemployed 11.08% and doing no work were 18.06%. The present study was in consistence with studies of above mentioned authors due to involvement of females in the kitchen work.

Addiction:

In the present study 4% females were bidi smokers. In males 22% were both smokers and alcoholics and 2% were alcoholics (Table 4). Despite high rates of addiction in this part of country, only 22% males were both smokers and alcoholics and 2% were alcoholics. 4% females were bidi smokers. The alleged cause of burns as a result of fall of burning cigarette into bed while asleep was only 2 cases out of 50 study cases. None of the case showed the presence of alcohol on autopsy. In the study of Leth et al [10], 51% of house fire deaths were due to tobacco smoking, often in combination with alcohol intoxication or handicap. Merley and Baker [11] observed that more than half of the deaths resulted from cigarette ignited fires though 39% of people who died in such fires were not cigarette smokers themselves. Gormsen et al [12] in 169 autopsy cases found that more than half of fire victims had alcohol exceeding 0.05%. The present study was not in consistence to the studies in western world. In the study of Parks et al [13] falling asleep while smoking was one of the major etiologic factor and substance abuse were seen in 25% cases. In the current study, though domestic fire dominated in female victims, but fire due to alcohol or smoking cigarettes was negligible. This was due to Punjabi culture, where addiction to these agents is negligible.

Clothing and accelerant:

In the present study, body was devoid of clothings in 78% cases and in 22% cases burnt clothes were intact. Smell of kerosene was present in 4% cases. (Table 5) Sukhai et al [14] observed the use of accelerant in 76.8% cases and paraffin was preferred. In the study of Parks et al [13], gasoline was the commonest solvent involved in burn fatalities. Betz et al [15] observed in 18 out of 21 cases, use of gasoline as accelerant. Current study also points out use of kerosene and its detection only

in 4% cases as majority had been treated in the hospital and wounds were cleaned and in other cases, fire was due to domestic gas or factory fire and there were hardly any clothes for evidence of combustible material.

Degree of burns:

In the present study, maximum burns were of 3rd degree (Wilson) in which 28% males and 54% females sustained burns. (Table 6) Betz et al [15] the predominance of 3rd and 4th degree burns in his 21 cases study. Stefan [16] in his study observed that the depth of burns has no relation with the fatality, rather burns of 2nd and 3rd degrees of 57.3% body surface survived more than 16 days.

Percentage of burns:

In the present study, maximum percentage of burns, 32% cases were in the category of 91-100%. Only 14% cases had sustained less than 50% burns. (Table 7 and Figure V). In the study of Aggarwal and Chandra [3], percentage of burns was up to 25% in 3 cases, between 25-50% in 32 cases, between 50-75% in 23 cases and was more than 75% of surface area in 42 cases. Maximum deaths due to burns were because of surface area involved in the burn injury. Sukhai et al [14] observed the mean age burn surface area of 63.3% leading to death irrespective of depth. Betz et al [15] in his study of suicidal cases, the extent of burns ranged from 50% to 100% of body surface. Similar observations were seen in the current study as observed by Sukhai et al [14], Betz et al [15]. It is also concluded that it is the percentage of body surface area which decides death due to burns. Minimum percentage of area leading to burn death in the present study was 50%.

Distribution of burns:

In the present study, extremities were involved in 100% cases, followed by head and neck in 94% cases, chest and abdomen in 92% cases, genitalia in 50% cases. (Table 8) Cases in which percentage of burns was above 90% involving head, neck, trunk or extremities died within 24 hours. In the study conducted by Datey et al [17], it was observed that maximum cases had burns involving limbs and trunk, next in order was involvement of head, face & neck and genitalia. McIndoe [18] found that burns of the trunk and head were more serious to life than burns of extremities and burns of the flexures and external genitalia carried a bad prognosis, if not to life then to health. Similar observations were observed in the current study.

Alleged causes of Burns:

In the present study, alleged cause of death was stove burst in 6% males and 13% females. (Table 9) Suicidal burns by kerosene were seen only in 2% cases all of which were females. In the study of 100 cases of Aggarwal and Chandra [3], commonest mode of committing suicide was by

sprinkling kerosene oil over the body and setting them to fire. In 11 cases who committed suicide, 8 cases were of females, out of which in 2 cases, illness and domestic quarrel were responsible for this act and 3 cases were males. In rest 6 cases the motive was not known. In the present study, 4 cases resulted from house fire.

Aggarwal and Chandra noted 2 out of 100 cases where jhuggi caught fire accidentally. In the present study 1 case of a female where the body was burnt after killing by poisoning and 1 case of a male where the body was burnt after killing by ligature strangulation. Suarez-Penarando [19] studied two cases of homicidal ligature strangulation with extensive burning of bodies. Haralkar and Rayate [7], in his study observed that burns were more common in housewives than other occupation because housewives were more exposed to injury prone environment while cooking. Cooking at floor level, use of kerosene pressure stove, wearing of loose clothes such as sarees, dupattas made them more prone for burn injuries. Narlawar and Meshram [8] observed that kerosene stove flames was major cause of burn due to which females burned 2.04 times more frequently than males. Domestic fire was the main reason of burn injuries.

Conclusions:

Despite the modernization, the domestic fire is the major cause of burns with maximum involvement of females and the stove burst, being the main cause. Dowry deaths, curse to our so-called modern society, are still prevalent, in spite of stringent laws and amendments in the acts. As this problem of thermal deaths persists in our country, the government along with various working groups and bodies need to come together with more sincere efforts so as to minimize burn mortality and also to prevent and reduce their incidence.

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Original research paper

Computed Tomographic Studies on Ossification Status of Medial Epiphysis of Clavicle: Effect of Slice Thickness and Dose Distribution

*Kaur Gurdeep, *Khandelwal N., **Jasuja O.P.

Abstract

The accuracy of technique adopted for Forensic age diagnostics of young adults and adolescents especially in case of livings lies in the standardization of the technical parameters used. The emerging radiological techniques, when used in standardized way may minimize the possibilities of misinterpretation, as it has been practically shown in present study. CT scans of 100 live subjects were performed on 16-slice (Siemen's Sensation 16) CT scan machine and the volumetric data acquired was reconstructed into five separate sets of slice thickness for each one of the subjects included in the study and the ossification status for each set of slice thickness was determined for all the subjects separately. The results are almost identical while evaluating ossification stages from 1 and 2 mm thick slice data but the differences are found in the ossification stages when evaluated using 3 mm, 5mm and 7mm slice thickness as compared those found in 1 and 2mm slice thickness. It was concluded that by increasing slice thickness the rate of error-nous interpretation are also increasing.

Thus, the minimum reliable thickness to produce high resolution scans in order to get maximum accuracy is 2 mm for staging medial clavicular ossification from CT scan and the reconstruction should be done using kernel (filter) B60F at window setting osteo (1500/450HU).

Key Words: Forensic, ossification, Clavicle, Computed Tomography, Slice Thickness, Dose Distribution

Introduction:

The demand of estimating age of adolescents and young adults has increased in the recent years due to the increasing cross border migration [1]. Age estimation in cadavers, human remains and living individuals is generally needed to solve the issues with significant legal and social ramifications for individual as well as for the community. The accuracy of the technique to be used for age estimation especially in case of living individuals is of utmost importance in both the situations criminal as well as civil. The newer radiological techniques proved invaluable inventions of modern era for diagnostic purpose, may also be used for age diagnostics in forensic context.

The proper way of using these techniques has reduced the possibilities of misinterpretation to the minimum and raised the accuracy level of the results to the maximum.

The current state of forensic age estimation of living subjects is mainly considered for the purpose of criminal prosecution [2]. Forensic age estimation in living adolescents and young adults undergoing criminal proceedings is generally performed to determine whether the defendant of questionable age has reached the age of criminal responsibility and whether general criminal law of adults can be applied[3].

In most countries the age threshold of legal relevance ranges between 14 to 21 years of age [4]. When it is necessary to prove that the subject has attained the age of 21 years, an additional x ray examination or CT scan of clavicle is recommended along with the recommendation of the "Study Group On Forensic Age Diagnostics", which includes physical examination of the suspect, an x ray of left hand and dental examination and orthopantomogram to know about the dental status.

Clavicular Epiphyseal ossification is must in case it is necessary to prove the proband has reached the criminal liability threshold of 21 years, as the other system on which the development analysis is based are fully matured by this time[5]. If bone

Corresponding Author:

**Professor of Forensic Science,
Department of Forensic Science,
Punjabi University, Patiala 147002, India
Email: opjasuja@gmail.com

*Department of Radiodiagnosis & Imaging,
PGIMER, Chandigarh, India

*Research student

development of hand has been completed, an additional radiological examination of the clavicles should be realized. [6]

Kreitner et al. stated that the ossification status of medial extremity of clavicle can easily be assessed by computed tomography as conventional radiographs which were the basis of analysis in some comprehensive studies are sub optimal because of the over lapping of the ribs, vertebrae and mediastinal shadows. Interpretation of the stages of medial epiphyseal development is even prevented in some cases. Conventional tomography is time consuming and lack clarity. Computed tomography eliminates all these problems. [7]

Schulze et al [8] has reliably determined the ossification status of medial epiphysis of clavicle in 556 cases, aged between 15 to 30 years of age using the classification of stages used by Schmeling et al. [9]. He discussed that partial volume effect in CT using thicker slice was possible explanation of early visualization of stage 5 (21 years) in his study as compared to 26 years in the study of Schmeling et al. and established the effect of slice thickness on staging the ossification status. Mulher et al [10] has determined the ossification stages for different slice thickness 1mm, 3mm, 5mm and 7mm separately in each one of 40 subjects included in the study to prove that inadequate choice of slice thickness can lead to misinterpretation of ossification status.

Schulze et al [11] suggested the use of reconstruction kernel (filter) suitable for osseous structure and to view the scan in bone window to study the status of ossification of medial epiphysis of clavicle for better visualization.

The method of clavicle examination also appeared to be significant. For the age interval in which mature clavicles have been observed, the predicted probability of being mature clavicles is greater when X-rays or CT scans are used instead of dry bone specimens. Inappropriate slice thickness of CT scan can affect age diagnosis, as an almost completely fused clavicle may be diagnosed as being mature when details are lost due to greater thickness. [12]

Present study is aimed to study the chances of interpretation errors while defining the ossification stages of medial epiphysis of clavicle due to technical parameters selected for scanning and how does the resolution affect the results. The slice thickness is an important parameter of CT scanning which depends on the choice of pitch ratio in helical CT, which in turn influences z-axis resolutions. The choice of higher pitch ratio value therefore reduces spatial resolution performance [13]. The radiation dose (as expressed in CTDI vol) is inversely proportional to pitch.

The trade off in increasing pitch is an increase in effective slice thickness, which in turn

results in increased volume averaging and reduced image signal (contrast between object to be detected and background)[14]. Thus the slice thickness depending upon the choice of pitch ratio value in turn influences both image quality as well as dose distribution to the patient and suboptimal quality scans may lead to interpretation problem while doing staging to define ossification status, but the dose distribution to the patient is correspondingly increased to produce scans of optimal quality at less slice thickness to increase contrast to noise ratio in the resultant CT image. [13, 14]

Materials and Methods:

CT scans of 100 live subjects (55 males and 45 females) falling in the age group of 12 years to 30 years, originally performed for their diagnostic purpose as contrast enhanced CT chest, neck angiography, pulmonary angiography and bronchial artery angiography on 16 slice (Siemen's Sensation 16) CT Scan machine, retrospectively analyzed to find out the ossification status of bilateral medial clavicular epiphyses at different slice thickness.

The CT examination of all the patients were performed acquiring volumetric data using technical parameters:

KVp - 120; MA - 140/150; Rotation time - 0.5sec; Pitch - 1.15; slice collimation- 16 x 0.75; FOV 294 mm; Matrix 512 x 512. The volumetric data acquired from spiral CT scans performed using above mentioned parameters reconstructed into axial scans of slice thickness - 1mm, 2mm, 3mm, 5mm and 7 mm using kernel B-60 (filter suitable for osseous structures) at window width / window level 1500 / 450 H.U. (osteo).

The respective ossification stage was determined corresponding to each slice thickness separately for both side in case of all the subjects involved, using following classification criteria. [8]

- Stage I: Ossification centre not ossified.
- Stage II: Ossification centre ossified but epiphyseal cartilage not ossified.
- Stage III: Epiphyseal cartilage partially ossified. (Fused)
- Stage IV: Epiphyseal cartilage completely ossified, but epiphyseal scar is still visualized.
- Stage V: Epiphyseal scar is no longer visible.

The radiation dose distributed to the patient as calculated by the dosimeter inhibited in the scanner itself while performing the examination was CTDIvol = 11.54 mGy.

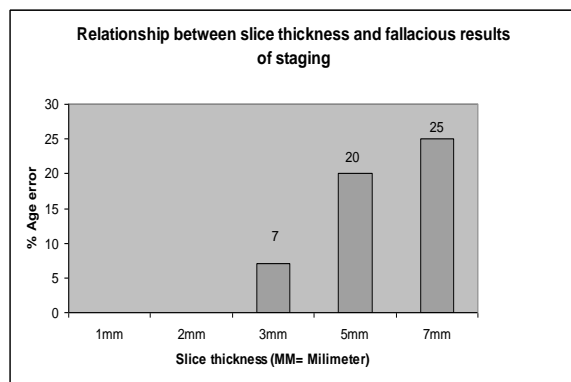
Results:

All CT scan images obtained after reconstruction at different slice thickness permit the evaluation of ossification status. Following results show the difference in the ossification stages of the

same subject at different slice thickness. Results are almost identical while evaluating ossification status from 1 and 2 mm but the differences was found in results between 1 and 3 mm slice thickness in about 7 cases out of 100 patients CT scans. The stages were found different in 5 mm slice thickness as compared to the stages defined from 1 and 2 mm slice thickness in 20 samples among the sample size of 100 patients and staging interpreting the ossification stages using 7 mm slice thickness exhibited different results in 25 cases out of 100 cases.

Relationship of slice thickness and rate of error in determination of ossification stage

Slice Thickness	% error
1mm	0
2mm	0
3mm	7
5mm	20
7mm	25



With the increase of slice thickness of CT scan, the %age of fallacious results increases i.e. at 1mm and 2mm there is no difference and at 3mm is 7%, 5mm is 20% and at 7mm is 25% i.e. with increase of slice thickness, the percentage of fallacious results increases.

Discussion:

Computed tomography is advantageous as it allows imaging of medial epiphysis of clavicle without overlapping. Kreitner et al.[6] examined 380 CT scans of patients aged 20-30years. Slice thickness was 8mm in 202 cases, 5mm in 88 cases, 4mm in 54 cases and 1,2,3mm in 36 cases. They recommended ideal slice thickness of 3mm for imaging of sterno-clavicular joint using pitch factor 1.3 to 1.7 and 3 mm reconstruction increments and table speed of 4 to 5 mm per second. Though they did not mentioned quantum of error, while various slice thickness was used.

Schulz et al. [7] examined CT scans of 629 patients aged between 15 and 30 years and evaluated the medial epiphyseal cartilage of clavicles. The slice thickness of the scan suitable for the evaluation considered in this study were 7mm in 546 cases, 5

mm in 2 cases, 3 mm in 4 cases, 2mm in 1 case and 1 mm in 3 cases. The question, how does the slice thickness affect the interpretation of the ossification stages corresponding to the age intervals, the authors advised to be examined in the further study but in their opinion in order to achieve best possible results and ensure maximum accuracy in age estimation practice, the slice thickness of 1 mm is most ideal to perform CT scan.

The findings of present study are in conformance with this and found that 1mm and 2mm slice thickness of CT scan images give the best results without any error for the purpose of defining medial clavicular ossification stages. Muhler et al. [9] determined ossification stages of 40 live subjects at different slice thickness reconstructing the data acquired into CT imaged of 1, 3, 5 and 7 mm thick slices and found different stages while assessing at different slice thickness.

They concluded the slice thickness has a crucial impact on the evaluation of clavicular ossification status found that even the slice thickness of 1 and 3mm led to different results in one case; the ossification status was also different in three cases using slice thickness of 3 and 5 mm for staging and same differences were encountered for slice thickness of 5 and 7 mm in another three cases and suggested in the end to use slice thickness of 1mm for CT examination of clavicle to evaluate the ossification stages for forensic age estimation purpose.

In order to ensure a maximum of accuracy in forensic age estimation practice, it is recommended to perform thin-slice CT scans. Thus thin-slice multidetector CT images of the individuals aged between 10 and 35 years were analyzed successfully in 502 cases using the classification criteria of staging used by Schmeling et al. [8] in a retrospective study by Kellinghaus et al.[15] and found that the findings of their study were in line with those from the only CT based studies on clavicle ,except from the fact that stage 5 first occurred at the age of 26, which is 5 years later as compared to the other studies by CT ,but with thick slices(7mm). This vast difference assumed to occur due to partial volume effect with thick-slice CT images by a visual deception of the epiphyseal scar occurring with stage 4.

The present study found that the results defining the ossification status at different slice thickness were different in 25 cases among the sample size of 100 live subjects.

This difference in results depending upon slice thickness was mainly caused by partial volume effect and decreased resolution using greater slice thickness. The resolution along longitudinal axis is inversely proportional to the slice thickness, as the slice thickness increases the resolution will be decreased, which apparently partly or fully masks the fine

anatomical structures like cartilaginous epiphyseal plate creating confusion between stage 2 and 1 or epiphyseal scar creating confusion between stage 4 and 5. Some time it was difficult to clarify whether the epiphyseal plate has been fused completely or not yet appeared while defining the stage from 5 or 7 mm thick slice.

Conclusions:

CT scan images in a large sample size of bilateral clavicles of 100 live subjects were studied to find the effect of the slice thickness and found that it has crucial impact on the evaluation of clavicular ossification status, because this is one of the main parameter affecting the special resolution of CT scan, specifically longitudinal axis. Even the slice thickness of 1 and 3 mm led to different ossification stages in 8 cases.

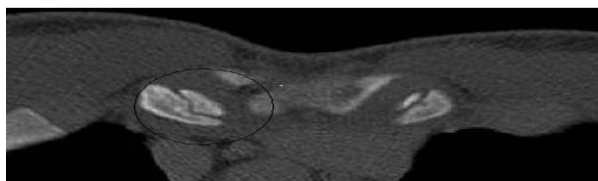
In all the cases the ossification stages defined using 1 and 2 mm slice thickness has been found identical. Therefore we recommend that a slice thickness 1 or 2 mm should be used for CT examination of clavicle to evaluate the ossification stage for Forensic age estimation factor to ensure maximum accuracy and reliability in results. The slice thickness of 2mm is rather beneficial to the subject as, volume dose (CTDI vol) is reduced while using technical parameters for acquiring minimum slice thickness of 2mm as compared to the technical parameters used in order to get 1mm minimum reconstructed slice thickness. The CTDI vol (CT dose index) was equal to 10.50 mGy for 2 mm (min) slice thickness and CTDI vol has been increased to 11.54 mGy for 1mm (min) reconstructed slice thickness in our scanner 16-row MDCT (Siemens Sensation 16).

Thus 1 or 2 mm is the only reliable thickness to produce high resolution scans in order to

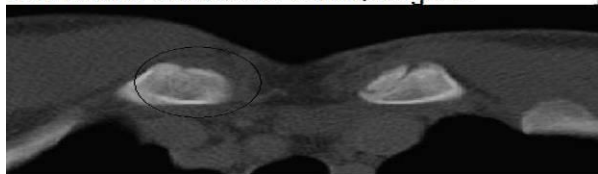
get maximum accuracy in the results and reconstruction should be done using kernel (filter) B60f at window.

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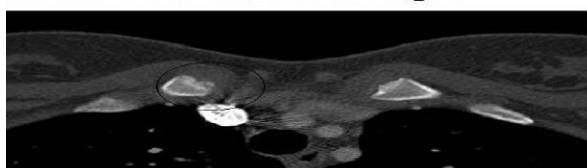
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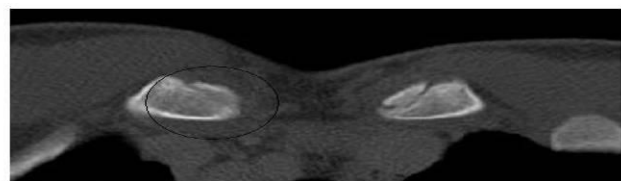
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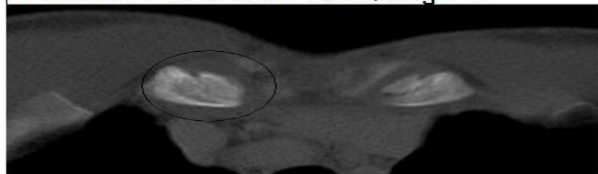
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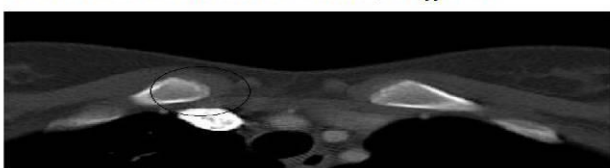
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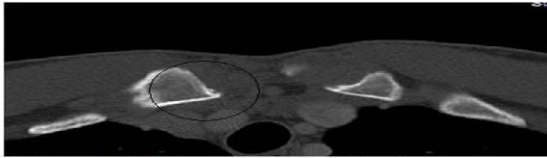
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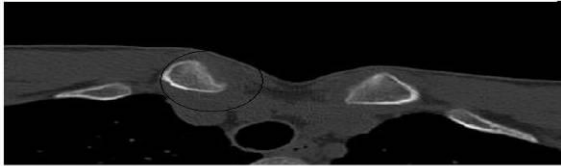
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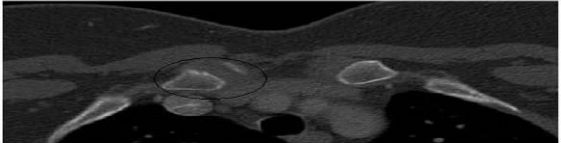
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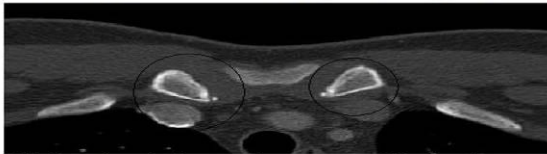
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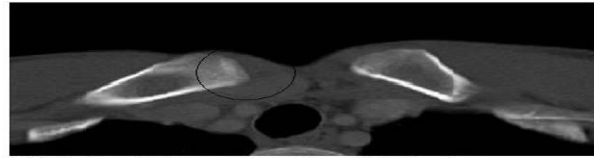
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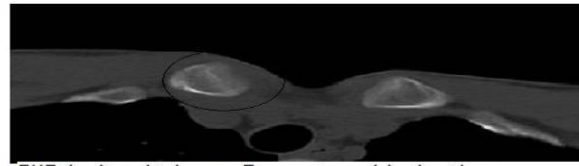
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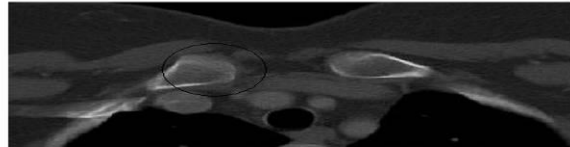
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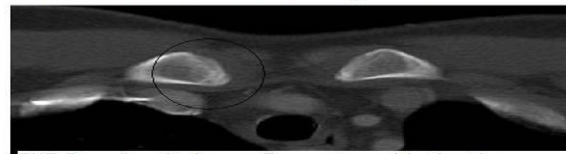
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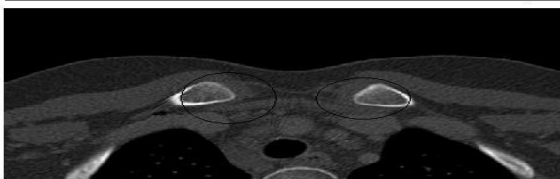
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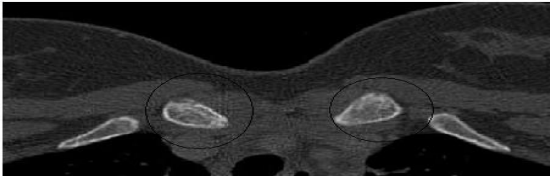
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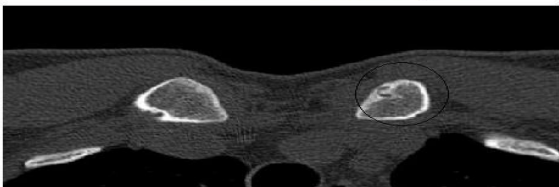
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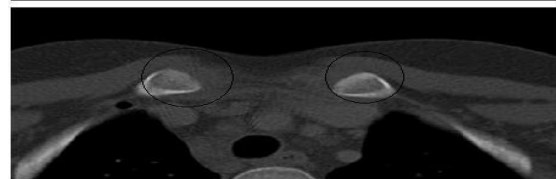
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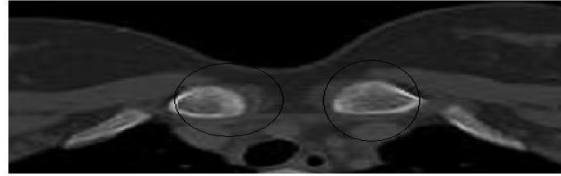
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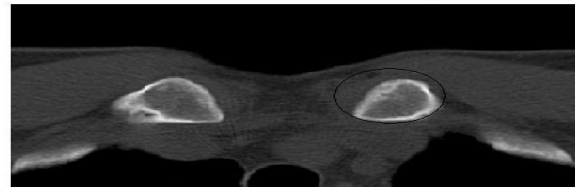
SUB 9,slice thickness-1mm,stage-3(L)



SUB 7. slice thickness-5mm. stage-4



SUB 8,slice thickness-7mm,stage-4



SUB 9,slice thickness-5mm,stage-4(L)

Original research paper

The Profile of Age in cases of Victims of Sexual Offence

*Dr. Chandresh Tailor, **Dr. Ganesh Govekar, ***Dr. Gaurang Patel, ****Dr. Dharmesh Silajiya

Abstract

Sexual assault on female subjects is a global health & human right issue. The problem has legal as well health related bearing. Female victims, often young girls are the worst sufferers of crime like rape, kidnapping and trafficking etc... To prove this type of crime, age estimation is most important. The ages of relevance to criminal liability ranges between 14 and 18 years in most countries. In the present study 141 cases were studied for age estimation in cases of victims of sexual assault cases at Dept. of Forensic Medicine & Toxicology, Govt. Medical College, Surat. In accordance with the updated recommendations for age estimation, a physical examination with determination of anthropometric measures, inspection of signs of sexual maturation, dental examination and X- ray examination were carried out. Surprisingly we found that appearance and fusion of ossification centers and 3rd molar eruption were occurred in few cases at earlier age as contrary to that mentioned in standard literatures.

Key Words: Sexual Assault, Victims, Age Estimation, Rape

Introduction:

Estimation of human age is a procedure adopted by anthropologists, archaeologists and forensic scientists. Age is one of the essential factors in establishing the identity of an individual and also in law, the crime and punishment is entirely based on the age of a person. In the modern society, the crimes against the children are increasing. According to Aggrwal MI & Pathak IC (1957) [1], epiphysis of bones unites during particular age periods which are remarkably constant for a particular epiphysis. This is possible due to complex but dependable system by which the osseous framework of the body develops, grows & matures. Epiphysis of the bones unites at a particular age and this is helpful in age determination. Determination of age is helpful in both civil and criminal cases. In the living, age determination is the most important issue to the court and to the common citizen as well.

Age determination is also important while taking consent or in cases relating to juvenile offenders, rape, kidnapping, employment in Government establishments, competency as a witness, attainment of majority, marriage, fixation of criminal responsibility, etc. Extensive work on the determination of age of epiphyseal union has been carried out in different states of India as well as abroad and from the finding of various workers, it is evident that there is not only difference in the age of epiphyseal union in India and abroad, but also in the different states of India. These differences may be on account of varying genetic and epigenetic factors like climatic, economic and dietetic conditions. Among many factors used for age estimation, none has withstood the test of time which necessitates the continuous work on this vital issue by the medico legalists. The present study was undertaken retrospectively for determination of age in cases of victims of sexual offence coming particularly to the Forensic Medicine & Toxicology Dept. for age determination.

Material & Method:

The cases of victims of sexual assaults registered under Sec. 376 IPC, Sec.361 IPC, and Sec. 362 IPC, Sec. 366 IPC, Sec. 377 IPC were brought for estimation of age to the Of Forensic Medicine & Toxicology department, Govt. Medical College & New Civil Hospital, Surat. Total 141 cases of victims of sexual offences were studied which were of period from January 2006 to June 2009. The age estimation was done first by general emblem. In the general emblem, general information of victim was taken i.e.

Corresponding Author:

*Assistant Professor

Dept. of Forensic Medicine & Toxicology,
Govt. Medical College & New Civil Hospital
Surat- 395001, Gujarat

E-mail Address: chand8494@yahoo.co.in

Mobile. No.09909914952

**Professor and Head

***Tutor

****Associate Professor

Dept. of Forensic Medicine & Toxicology,
B.J.Medical College, Ahmadabad, Gujarat

name, age, sex, residence, education, occupation, requested by, brought by, date, place & time of examination. The age was asked from the victim of sexual offence which was verified either by parents who come along with the victim or from birth proof. Proper written consent for age estimation was taken from the victim & signature was taken. Patients were examined in the presence of female witness, & signature of witness was also taken. Two Identification marks of victim were noted & history of case was also recorded.

The determination of age of victim was done on the basis of:

1. **Physical examination:** in which general examination was done by measuring height, weight, signs of puberty, like development of pubic hair, Axillary hair, development of breast, onset of menarche.
2. **Dental examination** in which total no of teeth, type of teeth, presence of 3rd molar and space for 3rd molar was noted down.
3. **Radiological Examination** in which appearance & fusion of various bony centers was noted. The X-ray performed was simple machine X-ray and it was read by us. The opinion of radiologist was not taken into consideration.

The data thus collected was analysed using Epi-6 software. The result obtained was matched with the data of the standard textbooks and recent scientific literatures.

Observations:

It was observed that the maximum percentages of the victims are in the age group of 14-17 yrs (i.e. 71.6%), the mean age being 16 yr. Among these 80.9% were from urban population and almost all (99%) were educated. Almost half (48.9%) were engaged in household work and about one quarter (23.4%) were students in different grades. The history of runaway with the friend, colleague or known person, mostly consented or on abetment was common in almost all the cases were brought for age estimation in the department.

Out of a total of 141 cases, 57 (40%) spent some hours, but did not stayed for whole day, 58 cases (42%) stayed together for several days, while 26 (18%) lived together for several months after which either they came back by themselves or were brought by police, after complaint lodged by their parents.

The fact of having sexual intercourse was furnished by 68.7% while they stay together. Sexual activity with the partners was mostly in the age group of 14-17 years. The indulgence in sexual activity was even observed in the age of 9 years ranging upwards up to the age of 23 years. In majority of the cases

83.7% sexual activity took place with mutual consent.

Secondary sexual characteristics:

1. Pubic hair: stage 1-5: starting at 11 yrs and completed at 15 yrs.
2. Axillary hair: Appearing at the age of 14-15 yrs.
3. Breast development: starting at 11 yrs and completed at 15 yrs.

No discrepancy was observed in above mentioned criterion on matching these data with the standard literature [3, 6-13].

Dental examination:

Eruption of third molar is very irregular. The usual age mentioned in literature for its eruption is 17-25 years.

This holds true in the present study also, but we do depend a lot on its eruption or non eruption to fix the age. In the present study comprising the age ranging between 09 to 23 years; 52 (36.8%) cases were between 17-23 years of age, which reflects that out of 141 cases examined, 125 (88.6%) did not have their third molar erupted. It was also observed that the third molar was seen erupted as early as in 16 yrs and it was even seen absent in the age of 23 years.

Radiological examination - Ossification centers':

Acromion process of Scapula: Age of fusion is 17 – 18 years.

The fusion of tip of acromion process of scapula was observed as early as at 14 yrs of age in more than a quarter (26.6%) of cases. It was seen united in 61% at 15 yrs, in 82% at 16 yrs & in 86% at 17 yrs of age. It was also observed that it was not fused in 13.88% of cases even at the age of 17 yrs.

Head of Humerus: head, greater & lesser tubercle fuses with shaft at 19 yrs.

The fusion of head of Humerus with the shaft was observed as early as, at the age of 14 yrs and also as not fused, as late at 20 yrs of age. It was observed that it was fused at the age of 14 yrs in 13% of cases, 11.4% at 15 yrs, 20% at 16 yrs, 36% at 17 yrs, 43% at 18 yrs, 80% at 19 yrs and 33% at 20 yrs of age.

Medial Epicondyle of Humerus: Age of fusion 14-16 years.

The fusion of medial Epicondyle was observed in nearly half (45.45%) of the cases at age of 13 years. In 86% cases at 14 yrs, 97% at 15 yrs and in all cases of 16 & 17 years.

Upper end of radius and ulna: Age of fusion 16-17 years.

The fusion of upper end of radius and ulna at elbow joint was observed in greater percentage at quite early age and it differed with what was quoted in contemporary literature. It was observed to be

fused in 54% at the age of 13 years, 80% at age 14 yrs and 93% at the age of 15 years.

Lower end of radius and ulna: Age of fusion 18-19 years.

Similar findings were observed in the fusion of lower end of radius and ulna. Fusion of lower end was reported even at the early age of 14 years in 13% cases. It increased to 35% at the age of 15 years, 55% at the age of 16 years, 58% at the age of 17 years and surprisingly low percentage (57%) of fusion was observed at the stated age, i.e. 18 years. On an average in 46% the fusion was observed in the cases examined in the age group of 14 to 18 years.

Iliac crest: Age of Appearance 14 years. Fusion occurs at age of 18-20 years.

Below 13 yrs of age, iliac crest was not appeared seen in 100% cases. Between 14-18 yrs age in 95% cases iliac crest appeared but not fused. After 19 yrs of age iliac crest fuses in all cases.

Tri-radiate cartilage: Age of fusion 14-15 years.

Tri-radiate cartilage was seen to be fused in 45% of the cases in the age of 13 years, whereas it was found fused in 73% subjects of age 14 years, which is the age at which it fuses as per the available literatures. [3, 6-13] In rest i.e. in 27% cases of that age group it was observed un-fused. Similarly in the age of 15 years, that is the upper limit of age of fusion, it was observed fused only in 87% of cases.

Ischial tuberosity: Age of Appearance 15-16 years and of fusion 20-22 years.

It was said to be more appropriate to consider the appearance of ossification than fusion while estimating age by radiological findings. Here appearance of centre for Ischial tuberosity was observed in half of the case at early age i.e. 12 years, 27% at age 13 yrs and 45% at the age of 14 years. More importantly it was found that the centre has not appeared in one quarter of the cases at the age of 15 years which is the prescribed age of appearance mentioned in standard literature. [3, 6-13]

Head of Femur: Age of fusion 17-18 years.

Following the trend of observation of fusion of ossification centers at early age, contrary to what is mentioned in literatures [3, 6-13] pertaining to Indian population, head of femur was found fused in two-third of the cases at very early age of 14 years. At 15 years it was found in 58% of cases and at 16 years in 65.5% of cases. In the prescribed age of fusion, i.e. at 17-18 years it was observed to be fused in 86% of cases and not in hundred percent.

Few (9.2%) of the subjects (alleged victims of sexual assault) furnished proof of age, in the form of birth certificates issued by registering authorities or school leaving certificates. The documentary proof failed to match with the age estimated on the basis of considering physical and secondary sexual growth, dental examination and Radiological Examination In 25% Of Cases, Which Is Alarming.

Discussion:

Third molar erupts in the age group of 17-25 yrs, as Per the standard literature [3, 6-13] In our study third molar was seen erupted even at the age of 16 yrs in 3% of case and at the age of 15 yrs in 10 % of cases. Modi⁶ claimed that third molar erupted even in 14 yrs & 15 yrs of age. Sahay[6] found third molar erupted between 15-16 yrs. Lall and Townsend[5] found third molar erupted even at the age of 15-16 yrs. Therefore stage of eruption should be noted during examination. In some rare cases third molar may not appear until the advanced adult age. It may appear even after 50 yrs of age.

According to Modi [6], owing to variation in climatic, dietetic, hereditary and other factors affecting the people of the different states of India, it cannot be reasonably expected to formulate a uniform standard for the determination of the age of the union of epiphysis for the whole of India.

In our study acromian process of scapula is fused in 80% of cases at the age of 17 yrs. Some cases show fusion even at the age of 15 and 16 yr. According to Galsraun study [6] acromian process fused in female at the age group of 13-16 yrs. According to Pillai study [6] and Flecker study [6] it shows fusion at the age of 17-18 yrs.

In our study we have observed that head of Humerus fuses with shaft at the age of 19 yrs in 80% of cases. While at the age of 20 yrs it fuses only in 33% cases, remaining 67% of case show partial fusion. We have also observed that it shows fusion even at the age of 14 yrs and 15 yrs in few cases. According to Galstraun study [6] and Pillai study [6] it shows fusion at the age of 14-16 yrs. According to Basu & Basu [6] study it shows fusion at the age of 16-17 yrs. According to Hepworth study it shows fusion at the age of 17-18 yrs. According to Davies & Parson [6] it fuses at the age of 19-21 yrs.

In our study we have observed that Medial Epicondyle of Humerus shows fusion in all cases at the age of 16-17 yrs. It was observed similar to Galstraun study [6], Basu & Basu study [6], Hepworth Study [2], lall & Nut Study, Pillai Study [6], Flecker study [6] and Franklin study [6]. According to Davies & Parson study [6] it shows fusion at the age of 20 yrs.

In our study we observed that upper end of Radius & Ulna fuses at the earlier age contrary to standard literature. According to Galstraun [6] it shows fusion at the age of 14-15 yrs., according to Basu & Basu study [6] and Hepworth study [2] it shows fusion at the age of 13-14 yrs. Similarly it was also observed with Flecker study [6], Davies & Parson study [6] & Franklin study. [6]

Similarly lower end of Radius & Ulna shows fusion in early age i.e. 14-15 yrs in few cases. After

16 yrs it shows fusion in increasing order. The Pillai study [6] shows fusion between 14-18 yrs of age.

There was no difference observed regarding fusion of Iliac Crest, Triradiate Cartilage as compared with various studies.

The Ischial Tuberosity appears at the early age i.e. 14 & 15 yrs in few cases. The Galstraun study [6] also shows appearance of Ischial Tuberosity in early age i.e. 14-16 yrs.

The Head of Femur found to be fused in early age i.e. 14-16 yrs. The Galstraun study [6] shows Head of Femur fused at 14-15 yrs of age. The Basu & Basu study [6] shows fusion at 13-14 yrs of age. The Hepaworth study [2] shows fusion at 15-17 yrs of age. The Pillai & Flecker [6] study shows fusion at 14 yrs of age.

Retrospective study on 114 girls by William Bilkey Ch. Sangma et al [14] found that at the age of 16 yrs epiphysis around the elbow joint, at the age of 18 yrs the epiphysis around the wrist joint, at the age of 17 yrs epiphysis around the knee joint, and at the age of 21 yrs epiphysis around the pelvic joint are completely fused. In our study we found that as age increases i.e. from 14-17 yrs epiphysis around the elbow joint shows fusion in increasing order. Around the 16-17 yrs of age in all cases epiphysis around the elbow joint fuses.

Conclusion:

In the present study we can see that the fusion of ossification centers were occurring at the early age also in comparison to mentioned in various standard literatures. That's why precise age estimation is more important in various medico legal issues. In criminal cases some innocent may get punishment and the real accuse may be released, so there is need to update the data by taking a bigger sample size in living so that the result obtained may become dependable for the medico legal expert.

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Table 1
Age Wise Distribution of Cases

Age alleged	Frequency	Percent
9	1	0.7%
12	2	1.4%
13	11	7.8%
14	15	10.6%
15	31	22.0%
16	29	20.6%
17	36	25.5%
18	7	5.0%
19	5	3.5%
20	3	2.1%
23	1	0.7%
Total	141	100.0%

Table 2
Area Wise Distribution of Cases

Area	Frequency	Percent
Rural	27	19.1%
Urban	114	80.9%
Total	141	100.0%

Table 3
Regarding Consent Present or Not

Consent	Frequency	Percent
Absent	23	16.3%
Present	118	83.7%
Total	141	100.0%

Table 4
Frequency and Percentage Wise Distribution of Days Stayed

Days Stayed	Frequency	Percentage
Several Days	58	42%
Several Months	26	18 %
Nil	57	40 %
Total	141	100 %

Table 5
Comparison of Age corresponding with Proof with Proof of Age

		Age Corresponding With Proof		
Proof of Age	nil	No	Yes	TOTAL
Absent	128	0	0	128
Present	0	3	10	13
TOTAL	128	3	10	141

Table 6
Comparative study of age of appearance of ossification centre

Sr. No.	Examination Dental/ Radiological	Eruption/Ossification	As Per the Standard Literature & Scientific Material (Age in Yrs)	In Our Study	
				Also Found at the Early Age (In Yrs. with percentage)	Age as Per Literature (In Yrs. with Percentage)
1.	Dental Examination	Age of Eruption	17-25	14(7%), 15(10%) 16(3%)	17(3%), 18(14%)
2.	Acromian Process of Scapula	Age of Fusion	17-18	14(26.6%), 15(61%), 16(82%)	17(86%)
3.	Head of Humerus	Age of Fusion	19	14(13%), 15(11.4%) 16(20%), 17(36%), 18(43%)	19(80%)
4.	Medial Epicondyle of Humerus	Age of Fusion	14-16	13(45.45%), 14(86%), 15(97%)	16 & 17(100%)
5.	Upper end of Radius & Ulna	Age of Fusion	16-17	13(54%), 14(80%), 15(93%)	16&17(100%)
6.	Lower end of Radius & Ulna	Age of Fusion	18-19	14(13%), 15(35%), 16(55%), 17(58%)	18 & 19(100%)
7.	Iliac Crest	Age of Appearance	14	-	14(100%)
8.	Iliac Crest	Age of Fusion	18-20	-	18-20(100%)
9.	Tri Radiate Cartilage	Age of Fusion	14-15	13(45%), 14(73%)	15(87%)
10.	Ischial Tuberosity	Age of Appearance	15-16	12(50%), 13(27%), 14(45%)	15(75%)
11.	Ischial Tuberosity	Age of Fusion	20-22	-	20-22(100%)
12.	Head of Femur	Age of Fusion	17-18	14(66%), 15(58%), 16(66%)	17-18(86%)

Original research paper

Ultrasonographical Age Estimation from Fetal Biparietal Diameter

*Garg A, **Pathak N, ***Gorea RK, ****Mohan P

Abstract

In a wide variety of circumstances of feticide, fetal age determination is important for identification. This is an important identification feature in postmortem cases. There are many different parameters to determine the age from fetus. But actual problem arises, when the body of fetus is either mutilated or decomposed. The data of femur length and other variables at various gestational ages can be used for age estimation of fetus at autopsy. But at time of autopsy each bone may or may not be present for autopsy. So, this study of ultrasonic fetal biparietal diameter was done to collect data, which can be utilized to ascertain the age of fetus in autopsy cases particularly in the Punjab region. This regional data can also be used to determine gestation age, if exact last menstrual period date is not known in antenatal cases of this region or to develop charts for ultrasound dating of pregnancy based on bi-parietal diameter and, second, to derive reference curves for normal fetal growth based on bi-parietal diameter.

Key Words: Age Determination, Bi-Parietal Diameter, Ultrasonography, Gestational Age, Pregnancy, Ante Natal

Introduction:

Measurement of various fetal body parts is known as fetal biometry. Ultrasonography is done in every ante natal case for measurement of various fetal parts. If the exact date of LMP is known then it can be useful in correlating the bi-parietal diameter with gestational age.

During fetal autopsy, all the parameters for identification, may or may not be available particularly when body is decomposed or mutilated and sometimes only few bones are available. Then there is no other option except to find out the age from bones. Measurement of length of bone and diameters at autopsy is very easy, less time consuming and a cheaper way of finding out the age of the fetus. In many cases we may not have all the bones. If skull is present then we can measure bi-parietal diameter and by doing this study, we are able to provide data in form of charts to solve such cases.

Review of literature:

No single parameter is sufficient in giving accurate fetal age ultrasonographically. Few useful measurements in the fetus are femur length, length of kidney [1], abdominal circumference and head circumference. [2]

Corresponding Author:

*Assistant Professor,
Department of Forensic Medicine
E mail: anil9637@yahoo.com
Mobile: +919872402904

** Associate Professor, Obstetric & Gynecology
*** Professor & Head, Forensic Medicine
**** Professor & Head, Obstetric & Gynecology
Gian Sagar Medical College, Patiala,
Punjab, India, 140601

If more than one parameter is taken in determining the age of fetus, it is considered better as reliance is not kept on one parameter. [2]

Measurement of kidney length is useful between 24th to 38th weeks. [1] Femur length and BPD have more value prior to 36 weeks but after 36 weeks head circumference and femur length has more value [2]. Length of femur is also better parameter as compared to BPD for determination of age of fetus in the third trimester. [3] Bi-parietal diameter measurement is in less common use after 20 weeks of gestation. Measurements of bi-parietal diameter also help in determination of age of fetus.

The bi-parietal diameter and femur length correlated equally well with gestational age. However, the bi-parietal diameter was more than twice as sensitive as the femur length to variation in fetal growth. Femur length had a larger error associated with its measurement. [4]

It is well established that ultrasound measurement of femur length and bi-parietal diameter are comparably accurate estimators of gestational age when obtained in the first half of pregnancy. Both estimators, however, become less accurate later in pregnancy. [5]

It is well known that ethnicity has a significant influence on fetal biometry. [6, 7]

The correlation coefficient of gestational age versus fetal femur length is statistically greater than that of the gestational age versus fetal biparietal diameter. [8]

Measurement of the fetal femur appears to be a reliable method for assessing gestational age, which can compensate for the limitations of the BPD method. [9]

Material and Method:

The antenatal cases coming to Gian Sagar Medical College for routine Ultrasonography during pregnancy will be studied for bi-parietal diameter. This is a random case study. A total of 271 cases were taken. Only those cases had been taken where there was no mistake for last menstrual period (LMP). Consent of every volunteer was taken. Cases with fetal congenital and developmental abnormalities were excluded. During Ultrasonography, fetal bi-parietal diameter was noted. LMP of these cases was recorded. We had prepared a graph from the available data. Then this graph will be utilized to solve the cases of age determination in medico legal cases.

Result:

With the help of ultrasonic examination of these volunteer cases, the measured bi-parietal diameter is presented in tabulated form.

Chart No. 1 shows location based distribution of cases taken in this study depicted that most of the cases belong to Punjab state.

Chart No. 2 shows age wise distribution of cases taken in this study.

Bi-parietal Diameter:

Table No. 1 shows the tabulated form of bi-parietal diameter at different lunar months of gestational months while Chart No. 3 is showing its graphical representation. According to present study, average bi-parietal diameter of skull at 4th lunar month of pregnancy is 30.63 mm and maximum at 10th lunar month is 87.43 mm.

Table No. 2 shows the tabulated form of biparietal diameter at different weeks of gestational age while chart 4 is showing its graphical representation. According to present study, minimum biparietal diameter of skull at 14 weeks of pregnancy is 28.30 mm and maximum at 39 week is 93.08 mm.

Discussion:

We had prepared the charts or graphs from the available ultrasonic data of biparietal diameter especially for Punjab region. Trend line was also drawn. These trend line and graphs of biparietal diameter obtained ultrasonically can be used to determine the age of fetus brought for autopsy. The expected date of delivery can also be calculated by using these charts or graphs by getting gestation age from biparietal diameter obtained from ultrasound in antenatal cases where last menstrual period is not known. These charts are more useful in Punjab region population as these are directly produced from local population. On the whole, if one variable is known, we can calculate the other variable from these graphs and trend line.

Good curves in the graphs were obtained when horizontal axis becomes lunar month gestational age [10].

Conclusion:

Our new set of reference chart and table for fetal biometric measurements in reference to biparietal diameter is ready for Punjabi population group.

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Chart -1
Location Wise Distribution of Cases

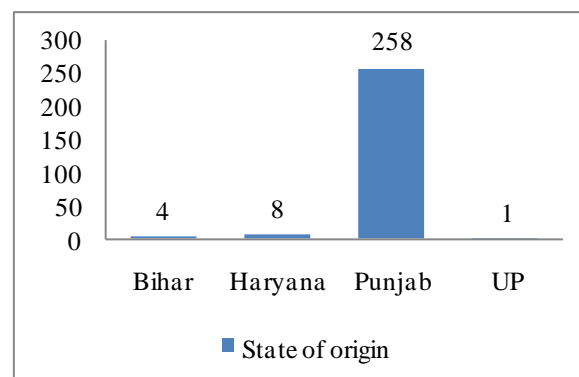


Chart No. 2
Showing Age Wise Distribution of Case

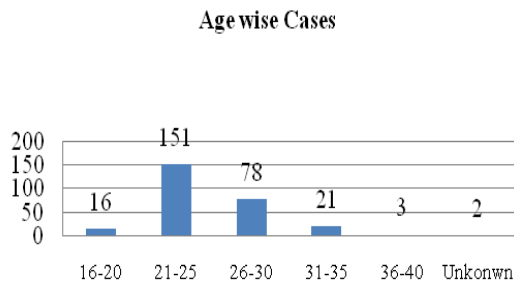


Table-1
Showing Average Biparietal Diameter in Relation to Lunar Months of Pregnancy

Gestational Age (lunar months)	Average length(mm)
4	30.63
5	41.76
6	53.93
7	63.65
8	76.50
9	83.21
10	87.43

Chart-3
Showing Average Bi-parietal Diameter in Relation to Lunar Months of Pregnancy

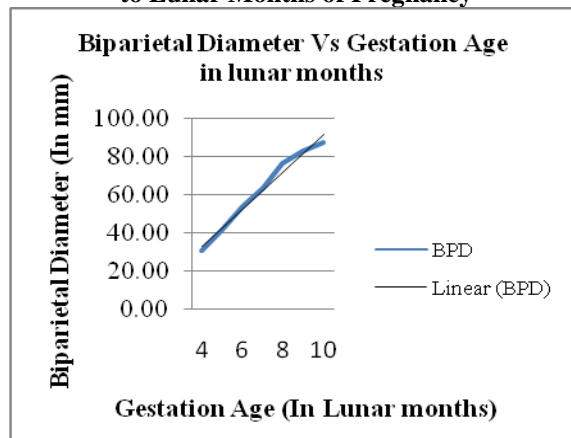
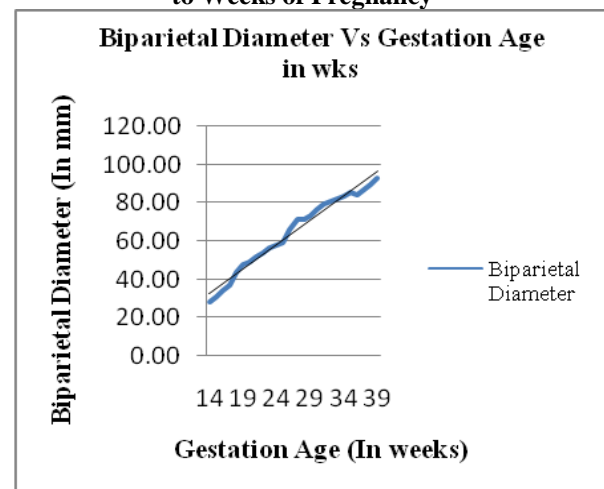


Table- 2
Showing Average Bi-parietal Diameter in Relation to Weeks of Pregnancy

Gestational Age (in wks)	Average BPD (In mm)	Gestational Age (in wks)	Average BPD (In mm)
14	28.30	27	71.73
15	31.10	28	71.44
16	34.68	29	73.63
17	36.98	30	76.65
18	43.73	31	79.88
19	48.03	32	80.91
20	49.20	33	82.52
21	51.68	34	83.31
22	53.65	35	85.77
23	56.88	36	84.12
24	58.24	37	86.94
25	59.47	38	89.69
26	66.12	39	93.08

Chart-4
Showing Average Bi-parietal Diameter in Relation to Weeks of Pregnancy



Original research paper

Analysis of Railway Fatalities in Central India

* Ramesh Nanaji Wasnik

Abstract

A two year retrospective study of railway related fatal cases has been carried out in the Department of Forensic Medicine & Toxicology, Indira Gandhi Government Medical College, Nagpur. Railway fatality cases were stand for 5.99% (Total 173) of all autopsies (n=2888) conducted during the period of January 2001 to December 2002. The fatalities were predominantly seen in the males. Male to female ratio was 8.62:1. The maximum numbers of victims were in the age group of 20-49 years (n= 120 cases, 69.34%). Majority of victims died on the spot (96.53%). Maximum number of railway fatalities were accidental (91.32 %) followed by the suicidal (8.68 %) in nature, whereas none of the homicidal railway fatalities noted. Crush injuries were found mostly over lower limbs followed by the upper limb then over the face and head. Maximum victims (84.38 %) died due to hemorrhage and shock following injuries to the vital organs.

Key Words: Train Accident, Railway Fatalities, Safety, Fatal train Injuries, India

Introduction:

The injuries and deaths due to accidents are inescapable in the modern way of living. The accidental deaths are mostly due to the road traffic accidents but the deaths due to railway fatalities are also not negligible, especially in the areas where railway traffic is higher. A train accident is defined as a "collision, derailment, or any other event involving the operation of on-track equipments." Train accidents can cause devastating damages and personal injuries including the death of the person. Trains are frequently involved in accidents that critically injured passengers and innocent bystanders. These accidents are indeed disastrous and catastrophic due to the speed that trains travel. Indeed, a train accident can definitely result in loss of one's life or his or her property as well.

Nagpur is an important city as well as an industrial town and the second capital of State of Maharashtra. It is situated in the central part of India. As per the sensex 2001, the population of Nagpur city was 20,51,320 and that of Nagpur district was 40,51,444, of which the peoples residing in urban area were 64.36 and in rural area were 35.64 % respectively, these areas are connected very well by the railway network. Nagpur has rapid growth in educational establishments, roads, buildings, business, energy infrastructure, industrialization and of course population during last 25 years.

There is also increase in the Gross National Product (GNP) and improvement in the standard of living. Being the heart of India, many national railway routes pass through the Nagpur railway station, joining the various states around it. Nagpur station is having the heavy burden of transportation of the passengers and goods as well; therefore the incidences of railway fatalities and mishaps are also higher at this junction. Most of the reported cases of railway deaths were either directly hit by the train or recovered in the vicinity of the railway tracks.

Fatal railway injury is characterized by extensive disruption of more than one body region. Hence, to properly understand the epidemiology of railway deaths and the pattern of injuries produced, a retrospective analytical study has been undertaken.

Material and Methods:

The present retrospective study of 173 fatal cases of train accident has been carried out in the Department of Forensic Medicine and Toxicology, Indira Gandhi Medical College, Nagpur for a period of two years from Jan 2001 to Dec 2002. The data was obtained from police papers (Requisition and inquest Panchnama) regarding information on age, sex, and supposed manner of death, pertinent history and autopsy report.

It was verified from the friends and relatives of deceased. The age, sex, types of injuries, pattern and distribution of fatal injuries were noted. All the data thus collected were analyzed and findings are presented in this paper.

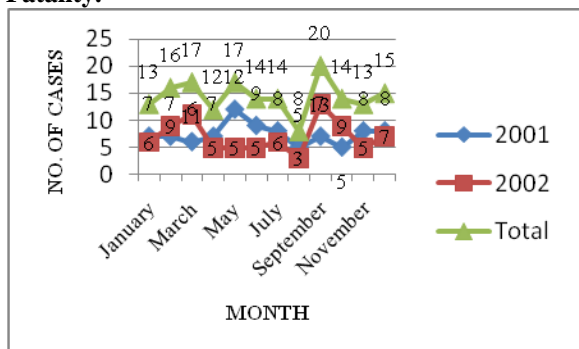
Observation:

Out of 2888 medico-legal autopsies conducted during the period of two years from January 2001 to December 2002, 173 cases (5.99%) were due to train accidents.

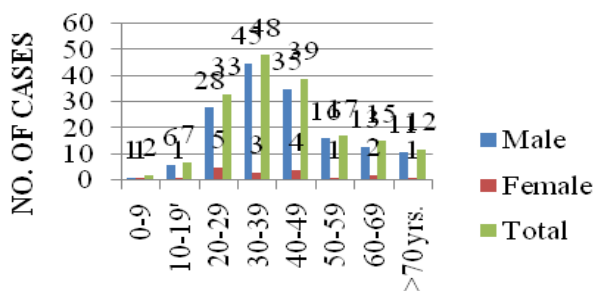
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*Assistant Professor

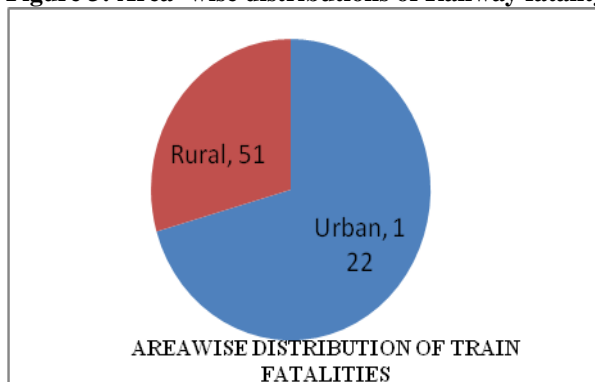
Department of Forensic Medicine
Chennai Medical College & Research Centre
Irungalur, Trichy-621105 Tamilnadu
E-mail Id: rameshwasnik@rediffmail.com

Figure1: Month Wise Distribution of Railway Fatality.

Fatalities by rail occur throughout the year but uniformity was not observed in the victims of railway accidents. However, the fatalities were equivalently seen in all the seasons i.e. in summer season 60 cases (34.68 %), rainy season 54 cases (31.21 %) and in winter season 59 cases (34.10 %).

Figure 2: Age and sex wise distribution of Railway fatality.**AGE GROUP**

The above table shows that the fatalities by the railways were predominantly seen in the males 155 cases (89.59%) as compared to females i.e. 18 cases (10.40%). Male to female ratio was 8.62:1. The maximum numbers of victims were found to be in the age group of 20-49 age groups i.e. 120 cases (69.34%).

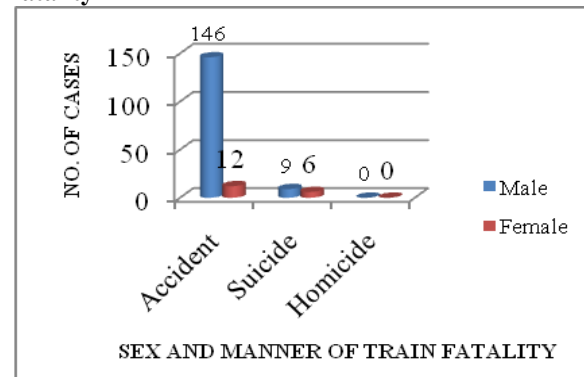
Figure 3: Area- wise distributions of Railway fatality

There were 122 cases (70.52%) cases from urban area while 51 cases (29.48%) cases were from rural area.

Table 1: Cases brought from

Victims	No. of cases	%
Spot	167	96.53
Ward/ Casualty	6	3.46
Total	173	100

From the above table was clearly evident that majority of victims died on the spot 96.53% because of sustaining severe type of injuries, insufficient ambulance services.

Figure 4: Gender and manner of death in Railway fatality

Accidental railway fatalities were the commonest accounting to the 158 (91.32 %) cases, while the suicide seen in only 15 (8.68 %) cases whereas none of the homicidal cases were recorded.

Injuries sustained in railway fatality shows that the crush injuries were found mostly over lower limbs (n=105), followed by the upper limb (n=102), face and head (n=72) and least in the perineum and posterior aspect of thorax. Crush injury to the neck in the form of decapitation was observed in 27 cases. The crush separation of the trunk from the body was seen in 31 cases.

Table 3: Thoracic and abdominal organ involvement in fatal railway accident

Organ	Type of injury		
THORAX	Contusion	Crush/ Laceration	%
Lungs	46	79	11.35
Heart	7	9	88.65
ABDOMEN			
Liver	10	71	41.75
Spleen	5	49	27.83
Kidney	15	44	30.41
Stomach	Perforation		
	18		
	37		
Intestines			
Bladder	23		

Crush laceration and the contusion to the lung were seen in most of the cases compare to the heart. Injury to lungs was seen in the 88.65 % cases whereas injury to the heart accounts only in 11.35 %

cases. Liver injury was observed in 41.75 % followed by the kidneys (27.83 %) and the spleen (30.41 %).

Table 4: Cause of death in railway fatalities

Cause of Death	Cases	%
Injuries to the Vital organs	112	64.73
Head injury	26	15.02
Shock and Haemorrhage	34	19.65
Septicaemia	1	0.05
Total	173	100

Maximum numbers of fatalities were due to injuries to vital organs i.e. 112 (64.73 %). Shock and hemorrhage accounts for 34 (19.65 %) alone and head injury in 26 (15.02 %) cases.

Discussion:

Out of 2888 medico-legal autopsies, 173 cases (5.99%) were due to railway fatality. The incidence of railway deaths is far lower in this area compare to the others [1, 2]. It was observed that the fatal train accidents occurred throughout the year without any uniformity and seasonal variation. Railway fatalities were 60 (34.68 %) in summer season, 54 (31.21 %) in rainy season and in winter season 59 (34.10 %).

Fatalities by the railway were predominantly seen in the male in 155 cases (89.59%) as compared to female 18 cases (10.40%). Male to female ratio was 8.62:1. The male predominance over female was due to the fact that most of the outstation activities are usually carried out by the males. Males outnumbering females in railway fatalities have also been observed by other. [1, 3-8] The maximum numbers of victims were found to be in the age group of 20-49 age groups i.e. 120 cases (69.34%); similar findings were observed by the others. [1, 3-5, 7-10] The passengers on the train, specially males of these age group takes the risk to get boarding in the running train, hanging on to the doors, windows or side bars and travelling on the roof getting injured by low over-bridges, tunnels, also leaning out of the windows of a running train when the trains are overcrowded. Males are doing most of the laborers work along the rail tracks (Gagman), try to cross the rail lines while the train was nearby, takes risk to walk along the railway track, etc are the reasons to get succumb to the train fatalities specially by the male.

There were 122 cases (70.52%) from urban areas while 51 cases (29.48%) were from rural area. Railway fatalities were predominantly seen in the urban area as train transportation is the cheapest mode; urban people adopt it to make to and fro to their outstation working places. The factors which are responsible for higher incidences of railway fatalities are a) in the urban area peoples residing in slum area usually goes nearby the railway tracks to attend their natural calls b) walks along the railway track as the short cut to reach the destination early disregarding the railway safety rules, c) encroachment of the

platforms by the people for business and other purposes. The reasons behind the lower incidence of railway fatalities in rural areas are that most of the villages are either far away or not connected with the railway stations and tracks. The people only occasionally avail the transport facility because in such villages the major way of transport is by bullock cart or by bus etc, hence reflecting the lower incidence of railway fatalities in rural areas.

Study clearly shows that majority of victims died on the spot because of sustaining severe type of injuries, insufficient ambulance services, which is in agreement with others study. [1, 6, 8, 9, 11]

Accidental railway fatality was the commonest manner than others accounting to 91.32 % cases while the suicide seen in only 8.68 % cases whereas none of the homicidal cases recorded in the railway fatalities, these are consistent with the finding of various studies. [1, 2, 4, 5, 7-10] The accidental railway fatalities are due to the fall from the running train, while boarding a running train, while going hanging on the doors etc mostly done by the males; dashed by a passing train while walking or crossing along the railway tracks, shunting accidents, collisions or derailment etc.

Injuries sustained by the train showed that crush injuries were found mostly over lower limbs followed by the upper limb, face and head, neck regions and then the thorax and abdomen. Crush injury to the neck was observed in the 27 cases. The fractures to the lower and upper limbs with the disarticulation were the commonest one followed by head and face. The crush separation of the trunk from the body was seen in 31 cases whereas the multiple fractures to the ribs were commonly seen due to effect of shearing and grinding force from the rotating train wheels. Most of the injuries sustained were abrasions and contused abrasions followed by the laceration and the fracture of limbs and then the decapitation, similar findings were observed by some observant [4, 9]. The study clearly revealed that head was injured in most of the cases followed by upper limb, neck, lower limb & trunk in descending order. [1, 8, 9] The other injuries were due to the primary and secondary impact. The primary impact injuries are related to the head and arms, chest, trunk as it is usually get struck from the side, which are usually multiple and extensive and the secondary injuries are due to been thrown down and run over resulting in the crushing and deep injuries. [9]

Concerning the thoraco-abdominal organ involvement, the crush laceration and the contusion to the lung was seen in most of the cases compared to the heart. Reason is that lung is the superficial organ than the heart and occupies maximum area of the thoracic cavity / rib cage. Most of the parts of the heart are retro-sternal therefore lungs are more vulnerable to injury as compare to heart. The majority of serious

injuries to the chest occurred from forced compression by the crush effect of the wheels of the trains. Abdominal injuries are sustained following the primary and secondary impact resulting in grave injuries to the abdominal viscera.

Maximum numbers of fatalities were due to injuries to vital organs 64.73 %, Shock and hemorrhage alone in 19.65 %, head injury in 26 (15.02 %) cases and in only one case septicemia was the cause of death. Maximum fatalities (84.38 %) were due to hemorrhage and shock following injuries by the train to the different vital parts of the body and the crush amputation of the limbs, decapitation causing hemorrhage and shock. Similar finding was observed by. [2, 4-6]

Conclusion:

Most of the railway fatalities were accidental in nature and in the bread earning age group particularly among the males. The increasing number of population, overcrowding in the trains, reckless and careless behaviour of the passengers, pedestrians and the train drivers towards safety norms are the constant causes of railway fatalities. The high levels of the railway fatalities make a strong case for the necessary accident control interventions. Public as well as the railway authorities must take some measures to bring down these fatalities. People must follow some easy set of laws like do not travel on footboard, do not enter or get down from running trains, do not try to cross the level crossing gate when it is closed, be alert and reduce your speed while approaching railway unmanned level crossing, never guess the speed of the train and adhere to the set norms of railway safety to curb this menace. The railway authority must take some steps to prevent the

accidents by acknowledging the safety engineering, training and awareness among staff, attentive surveillance, high quality maintenance and strict law enforcement.

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Table 2
Types of injuries in train victims

Anatomical Site	Abrasion	Contused abrasion	Lacerated Wound	Contusion	#/Crush/ amputation/decapitation
Head & face	4	35	85	10	72
Neck	2	4	6	3	27
Thorax anterior	2	36	9	6	40
Thorax posterior	3	13	4	3	17
Abdomen anterior	4	16	3	6	31
Abdomen posterior	6	11	9	1	22
Upper limb	12	37	21	4	102
Lower limb	16	37	39	3	105
Perineum region	8	1	5	0	17

Original research paper

Custodial Deaths - An Overview of the Prevailing Healthcare Scenario

*Y S Bansal, **Murali G, ***Dalbir Singh

Abstract

Preventing torture in custody and ensuring strict compliance of its guidelines in custodial deaths is one of the important agenda on the NHRC's list. Sudden and unexpected death in custody is commonly associated with allegations of torture against law enforcement agencies. Delay in providing basic medical care is one of the commonest allegations by the relatives against jail authorities. In this study we analysed the pattern of custodial deaths that had been brought to the mortuary at PGIMER, Chandigarh for medico legal autopsy and have suggested few preventive measures to reduce the morbidity as well as mortality among prisoners. Ninety custodial deaths that occurred while undergoing treatment in PGIMER, Chandigarh in the last decade were analysed, based on various factors such as age, sex, treatment protocol, etc. Of these, 95% were males and 5% were females; Sixty three percent cases were reported from the Punjab zone, 27% from Haryana, 7% from Chandigarh, 2% from Uttar Pradesh and 1% from Himachal Pradesh. Eighty nine percent deaths were attributed to natural causes, while 11% cases were due to unnatural causes, mostly suicides.

Key Words- Custodial death, Human Rights, Natural disease, Jail, prisoners

Background:

The motto of the National Human Rights Commission is "*Sarve Bhavantu Sukhinah*". Happiness and health for all is sought to be achieved through a rights-based regime where respect for human beings and their dignity is cardinal. President's assent to the Protection of Human Rights Act was a major breakthrough in this direction. Section 3 of the Act provides for the setting up of the National Human Rights Commission (NHRC) and Section 21 provides for the setting up of various States Commissions (SHRC). [1]

As per the Oxford dictionary custody means "protective care or guardianship of someone or something". In the legal parlance Custody is defined as any point in time when a person's freedom of movement has been denied by law enforcement agencies, such as during transport prior to booking, or during arrest, prosecution, sentencing, and correctional confinement. [2] All over the world, especially in developing countries like ours Custodial death is one of the key sensitive issues with respect to human rights violation.

Sudden and unexpected death in custody is commonly associated with allegations of police misconduct, media speculation, rumours, and intense community concern. It is also recognized that law enforcement misdemeanours do occur, hence thorough and objective investigation by the Forensic Pathologist is crucial to provide indisputable facts regarding the cause of death.[3] As per the NHRC guidelines, all custodial deaths are to be reported within 24 hrs and post-mortem examination is to be conducted by a panel of doctors & videography has been made mandatory. NHRC Report from 2001-02 to 2006-7 showed an increase in custodial deaths all over India.[4] Though majority of the cases in custody die due to natural causes, but issues such as negligence in medical aid or improper healthcare facilities cannot be ruled out. This study is an attempt to see the pattern of custodial deaths in North West Chandigarh zone of India so as to bring awareness among law enforcement agencies for better care of prisoners.

Materials and Methods:

This is a retrospective analysis of 90 cases of custodial deaths that have occurred in the last decade during their treatment in PGIMER Chandigarh, who had previously received treatment either in the respective jail hospitals or peripheral health centres. The post-mortem examination of these cases was conducted in the mortuary of the institute as per the guidelines laid out by National Human Rights Commission. Relevant information was gathered from post-mortem reports and medical record files. Causes of death were categorized under

Corresponding Author:

*Associate Professor

Department of Forensic Medicine,

PGIMER, Chandigarh 160012

Ph-0172-2755209

E-mail: yogender_bansal@rediffmail.com

**Junior Resident

***Addl Prof & Head

natural (disease process) and unnatural (suicides/accidents/homicides). Factors such as sex, age, place of occurrence, treatment protocols, past medical history, allegations of foul play/negligence, etc were taken into account while analysing the sequence of the events leading to death in these cases.

Results:

A total of 90 cases of custodial death were analyzed. Out of these, 85 were males (95%) and 5 were females (5%), the eldest prisoner was 85 years old & the youngest was of 16 years. (Fig-1) Sixty three percent cases were reported from the Punjab zone, 27% from Haryana, 7% from Chandigarh, 2% from Uttar Pradesh and 1% from Himachal Pradesh. (Fig-2) Natural causes accounted for 80 (89%) deaths, whereas 10 (11%) cases were of unnatural causes. [Fig-3] Among the natural causes, 51% cases had single organ system involvement, majority being pulmonary; while 49% cases had multiple system involvement. HIV was diagnosed in 9 cases (11%), out of which 6 cases were reported from Punjab jails and 3 from Haryana jails. All the HIV cases were in the age group of 22-35 yrs. Two cases were diagnosed to be Hepatitis B positive. Among the unnatural deaths, suicides constituted 60% cases, mainly fall from height (3 cases), followed by poisoning (2 cases) and one due to suicidal hanging. Majority of homicidal cases were due to trauma (3 cases). Homicidal burn in judicial custody was reported in one case.

Discussion:

Premature death of persons in custody is always tragic. The legal authorities are bound by the law to provide adequate necessary amenities to ensure the health and safety of persons in their custody, including timely medical assistance, and treating the inmates in a humane manner. Majority of the cases studied died due to natural causes, which is in accordance with global scenario. [5][6] A study in Ontario showed 41% natural deaths whereas a study in California showed that natural causes constituted 62% of the custodial deaths. [2][5] Suicidal cases were more in the west as compared to our country. They were mostly due to poisoning and hanging. In the present study, natural causes constituted 89% of the custodial deaths which is similar to the observations made by the NHRC that some 80 per cent of the deaths that occurred in custody were attributable to causes such as illness and old age. The remaining 20% occurred for a variety of reasons including, in certain cases, illness aggravated by medical negligence, violence between prisoners, or suicide. It is these latter cases that have exercised the Commission over the years, requiring it to issue specific directions in respect of individual cases of such deaths. [7] Eleven percent of the natural deaths were HIV positive; however history regarding their

disease status was not available. Majority of the deaths were due to pulmonary involvement, mostly Tuberculosis. Two cases were HBV positive. Proper history was not available in the suicides/ homicides. However, it has come to light that of the suicides, 3 were due to fall, two were of poisoning and one was of hanging. All these cases of suicide, point to negligence on the part of person who was in charge of their custody at that relevant point of time. Aluminium phosphide with ethyl alcohol was detected in both the cases of poisoning. How the inmates were able to procure poison and alcohol inside the jail premises was not known. It is these kind of cases which raises suspicion of foul play by the jail authorities.

The law commission has observed: [8]

“Even if the police record the arrest and custody of a victim, a death in the police station is made to look like a suicide or accident and the body is disposed off quickly, with the connivance of a doctor. Records are manipulated to shield the police personals responsible. The local politicians and warlords join the conspiracy. The relatives & friends of the victim are unable to seek justice because of fear, poverty and ignorance. Police atrocities and custodial violence have become so much part of our lives that films and novels have recently made them staple themes.”

It was observed that proper records pertaining to their medical illnesses, medical treatment, history of any addiction, etc were not available. Many cases had a history of opium and alcohol addiction. Some may have contracted illness during confinement while many cases had pre-existing illnesses. In a few of the cases, allegations of negligence were made against jail authorities, including non deliverance of timely medical assistance.

In one of the cases put before the NHRC where there was an allegation of death due to delay in the provision of timely medical aid, the Commission held that the person appeared to have died because of the denial of timely medical aid, which showed gross negligence on the part of the jail prison superintendent. [9]

The Article 21, which is one of the luminary provisions in the Constitution of India, also lays emphasis on the fact that no person shall be deprived of his life and personal liberty except according to the procedure established by law.

Even the convicts, under-trials, detainees, and other prisoners in custody cannot be denied this precious right.

Our study was limited by the lack of standard data available in the records, it was found that though inquest proceedings in all custodial deaths were supposed to be conducted under 176 CrPC, [10] but the investigating officer was heavily

dependent on jail authorities for the relevant information.

Suggestions & Conclusion:

When the state takes away a person's liberty, it assumes full responsibility for protecting their human rights. The most fundamental of these is the right to life. Each year, however, many people die in custody. Though majority of these deaths are due to natural causes, but improper medical facilities could be an important aggravating factor. Providing healthcare facilities, equivalent to that available in the community is one of the most important remedial measures. The provision of adequate treatment for HIV, communicable diseases, drug and alcohol addiction in detention is essential in order to protect the rights to life. Proper awareness among jail authorities and prisoners in such cases can prevent further spread of infection among the inmates.

Developing good practice standards on training; reviewing recommendations from NHRC,

and monitoring progress in their implementation are some of the steps in a positive direction. Systemic measures to improve prison conditions, collecting and sharing information on deaths in custody; and commissioning research and implementation of the recommendations by the Government, should be undertaken. The views of the Commission for better maintenance and running of prisons, better trained and more dedicated staff, including medical staff, and de-crowding of prisons are few of the important suggestions to be followed.

Factors such as timely medical diagnosis and treatment, facilities for quarantine in communicable diseases are few of the important issues relating to the healthcare of the individuals in custody. Strictly following guidelines & slight modification in the already laid down procedures, as well as compliance among jail authorities will go a long way reducing the morbidity and mortality among prisoners.

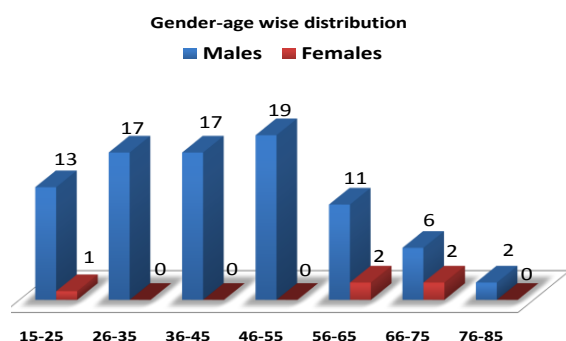
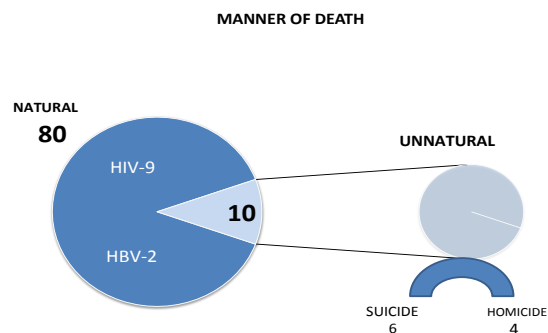
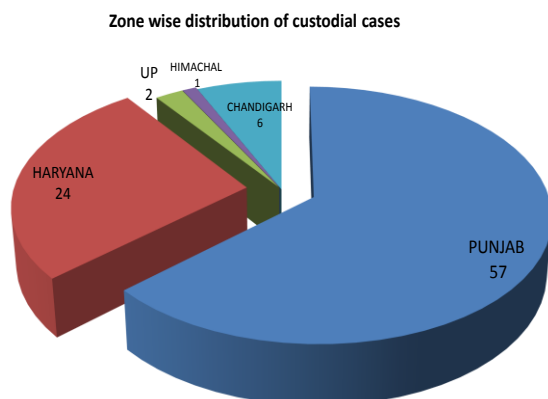


Figure 1



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Original research paper

A Study on Appraisal of Effectiveness of the MCCD Scheme

*Dr. Swapnil S Agarwal, **Dr. Vijay Kumar A G, ***Dr. Lavlesh Kumar, ****Dr. Binay K Bastia, *****Dr. Krishnadutt H Chavali

Abstract

Medical Certification of Cause of Death [MCCD] scheme was proposed by WHO as an imperative tool to obtain scientific and reliable information in terms of causes of mortality. It was accepted by the Government of India with suitable incorporations made in The Registration of Births and Deaths Act, 1969[1]. A cross sectional study was done with an objective to appraise the completeness and accuracy in filling up of these certificates as per the prescribed guidelines and subsequently assess the success of the MCCD training scheme. Information was collected on the various components of the cause of death certificate in all cases brought for autopsy over a period of two year and statistical analysis done. Results of the study reflected that there was a conflict of opinion and understanding as to the meaning of the terms 'causes of death', 'modes of death', and 'manners of death' among the doctors. Extra effort needs to be put forth to educate and generate awareness regarding complete and accurate filling of the forms and to make them understand the very purpose of MCCD scheme, else it won't serve the very purpose for which it was introduced. Also the lacunae in the scheme that exist need to be addressed.

Key Words: Medical Certification of Cause of Death, WHO

Introduction:

Mortality statistics are quite essential for the welfare of the community, health planning, management of health programs, for control measures in preventing spread of epidemic, to build up scientific database for medical research, to know the impact of health services, to evaluate health indicators like infant mortality rate [IMR], maternal mortality rate [MMR] etc. and to find out magnitude of emerging and re-emerging diseases.

Therefore, every physician has become obligated to issue a cause of death certificate in the unfortunate death of his patient. Incomplete or inaccurate entry in these certificates poses difficulty in obtaining reliable information pertaining to causes of mortality. To overcome this, Medical certification of cause of death [MCCD] scheme was introduced; which is basically a part of International Statistical Classification of Diseases [ICD] and health related problems formulated by WHO.

Corresponding Author:

*Associate Professor & I/C HOD,
Department of Forensic Medicine & Toxicology,
Pramukhswami Medical College, Karamsad
Anand, Gujarat, INDIA 388325
E-mail: medicolegalhelpline@hotmail.com
**KLE Academy of Higher Education,
J N Medical College, Belgaum
, * SBKS Medical Institute & RC,
Piparia, Vadodara
***** GMC, Chandigarh

The purpose is to permit systematic recording, analysis, interpretation and comparison of morbidity and mortality data collected in different countries or areas at different times. [2]

Therefore, the Government of India has made a provision in the Registration of Births and Deaths Act, 1969 [India] for certification by the registered medical practitioner who has attended the deceased during his last illness. [1]

To ensure correct and proper filling up of these forms, the Government is currently covering this scheme in phased manner to include medical practitioners at primary, secondary and tertiary levels. It is also being included in the MBBS curriculum so that budding medical practitioners will be well versed on this issue.

There is no provision for the concerned officials to appraise the efficacy of the training program. We conducted a literature search through PUBMED, Medline and various Indian public health journals to know the impact of the awareness scheme. Surprisingly, literature pertaining to the effectiveness of this awareness program is scant and virtually non-existent. Hence, we conducted a survey to find out the effectiveness of the program by studying the various components of the cause of death certificate, certified by the doctors who have already been trained under the scheme.

Material & Methods:

We carried out the study at a tertiary hospital attached to a medical college. Being a teaching hospital, all the concerned doctors were

covered by the government launched awareness program.

Cause of death certificate issued in all medico legal cases (N=296) that were subjected to autopsy during the year 2008 and 2009 were included. These cases had been treated at the same hospital before autopsy. Cause of death certificates issued by treating physician, along with the history and treatment records were studied and analyzed to evaluate the accuracy and entirety in filling up of the forms as per the prescribed guidelines. We compared the cause of death from records with the autopsy findings.

Results:

We studied a total of 296 certificates, out of which 207 were male deaths and 89 were female deaths. The analytical outcome of the study revealed that preliminary components of the certificate viz. full name, age, sex, address were correctly entered in all the cases. Immediate cause of death was mentioned in all the cases but 291[98%] cases had a medical terminology. In rest 5 cases, 4 had written brought dead while in 1 case, it was written as 'sent for postmortem examination'. Terms used to describe modes of death like cardiac arrest, cardiac shock, sudden cardiac failure, respiratory failure, respiratory paralysis, respiratory arrest etc. that should have been avoided, were mentioned in 254 [86%] cases. The cause of death includes any disease or injury responsible to initiate a chain of events incompatible with life resulting in death of a person. [3] It was mentioned in 14% of the cases only. Part II was filled in all the cases. Interval between onset and terminal event of various conditions mentioned was written in 80 [37%] cases. Manner of death was indicated in 166 cases [56%]. Out of 89 female cases, particulars were filled in 54 [60%] cases only.

The doctor certifying death is required to put his signature, mention his/her full name & designation along with date and preferably should use his/her seal bearing registration number, at the bottom of the certificate. All the certificates bear signature but only 10 (3%) certificates had the seal with registration number of the physician. The last part of the certificate was detached and handed over to the relatives in all the cases.

Discussion:

In the present study we found that the doctors are finding it difficult to correctly fill the immediate cause of death. Only 14% could correctly fill this column. Astonishingly, 86% of the doctors are confused between the terms 'cause of death' and 'modes of death'. The differences are explicitly mentioned in textbooks and literature and are covered extensively in the 2nd MBBS curricula. Although the MCCD guideline specifically mentions that, 'the

cause of death should not be confused with the modes of death'; the dilemma still persists.

One of the reasons may be that the treating physicians refer the textbooks on medicine, surgery and the allied subjects that do not mention the difference. The text books that mention these differences are mostly forensic medicine textbook, that are taught in the 2nd phase of MBBS curricula.

Another reason may be the indifferent attitude towards filling up of these forms, which the treating physicians feel that, this is unnecessary. This may also be the reason why the doctors ignore or omit to put their seal with registration number in the death certificate. Guidelines of the MCCD as well as 'Indian Medical Council (Professional conduct, etiquette, and ethics) Regulation 2002.[4], insist that every medical certificate including the cause of death certificate should bear the seal of the doctor which should bear the registration number. It will be foolish to argue that the doctors in a teaching hospital are ignorant of these basic guidelines. On the contrary, it may be concluded that there is a general indifference among the physicians towards certain guidelines that are imposed upon them against their wishes.

Another area of concern is failure to mention the interval between onset and terminal event of death. The MCCD guidelines do not mention what is exactly meant by onset of the illness. Furthermore, as the tertiary health centers mostly deal with the cases which are either referred from some primary health centers or treated at other hospitals, the 'onset of terminal illnesses, sometimes becomes blurred. Many times, the patients are admitted in their terminal stage of the disease. Therefore it is very difficult to pinpoint this interval. Hence the guidelines should explicitly define this interval, and for different hospitals as well as different disease conditions. Other minor areas that need to be addressed are the manners of death, which again is sometimes confused with modes of death or causes of death. In case of female deaths, if the lady is not in the child bearing age, the importance loses its ground. However as a part of the routine the doctors should meticulously fill all the columns as per the guidelines.

Conclusion:

The MCCD scheme is an important step in regularizing and maintaining uniformity of issuing the cause of death certificate by medical practitioners. However our study revealed that there is a conflict of opinion as to the meaning of the terms 'causes of death', 'modes of death', and 'manners of death'. The section on Interval between onset and terminal events needs to be redefined for different settings to ensure a proper and genuine filling up of these certificates. Extra effort needs to be put forth towards awareness regarding complete and accurate filling of the forms. If it is not done, it won't serve the purpose

of being an important tool to obtain scientific and reliable information in terms of causes of mortality.

Also the lacunae in the scheme that exist need to be addressed.

The findings of the study are as follows:

Total number of cases studied (n= 296)	Correctly filled	Incorrectly filled
Immediate cause of death mentioned	291[98%] had medical terminologies	5[2%] had something else
Modes of death mentioned as immediate cause of death	42 [14%] had real cause of death	254 [86%] had modes of death
Interval between onset and terminal event	80 [37%]	216 [63%]
Manner of death	166 [56%]	130 [44%]
Data with regards to female deaths [n= 89]	54 [60%]	35 [40%]
Seal of the doctor containing registration no.	10 [3%]	286 [97%]

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Original research paper

Determination of Sex from Adult Sternum by Discriminant Function Analysis on Autopsy Sample of Indian Bengali Population: A New Approach

*Dr. Partha Pratim Mukhopadhyay

Abstract

Sex determination from skeletal remains is well studied and extensively documented subject. The sternum has drawn considerable attention in Forensic and anthropological studies. Morphological variants of sternum are well documented. The present study was designed to examine the sexual dimorphism of adult sternum in a population specific autopsy sample using discriminant function analysis on 70 adult bones (35 male and 35 female). It was observed that the sternum exhibited sexual dimorphism in the study population (Indian Bengali). The following discriminant function was obtained: $DF = .86 * Ws + 1.04 * WM4 + .77 * PCL - 25.03$. Overall 100 % of the cases could be correctly classified in to the two sexes from the three predictors [width of supra sternal notch (Ws), Width of sternum at level of 4th rib (WM4) and posterior curved length of sternum (PCL)] in the model. Cross-validated results showed correct classification in 100% cases. The results of this preliminary study show that sternum exhibit considerable sexual dimorphism and these variables contribute to discrimination between the two sexes in the study population. This investigation also reiterates that discriminant functions are population specific. Sexing of adult human sternum is thus possible with reasonable accuracy using the discriminant function on a sample obtained from the said population by this approach using a linear combination of new parameters.

Key Words: Forensic Anthropology, Human Identification, Sternum, Sex Determination, Discriminant Function Analysis

Introduction:

Sex determination from skeletal remains is well studied and extensively documented subject of research. The sternum is an elongated, flattened bone, forming the middle portion of the anterior chest. Its upper end supports the clavicles, and its margins articulate with the cartilages of the first seven pairs of ribs. The human sternum consists of three parts, named from above downward, the manubrium, the body, and the xiphoid process.

Like several skeletal remains the sternum also present population- specific morphometric features. Racial differences are prominent as shown by studies as early as Hyrtl's and Ashleys [1]. The sternum has drawn considerable attention in studies related to sexual dimorphism [2, 3, 4, 5] and application in estimation of stature. [6]

This further warranted population-based studies on sternum. Another study [7] focused on sex-based morphometry of the sternum in Maharashtrian population of India.

The present study was designed to identify these morphological features (predictors) and examine the sexual dimorphism of adult sternum in a population specific sample applying linear discriminant function analysis. The purpose was to examine how a combination of these newer variables discriminated between the two sexes in a population specific sample (Indian Bengali). The variables used in the present series were new and taken from direct measurement at autopsy in wet bone sample.

Method:

A study on autopsy cases was conducted at the mortuary of the department of Forensic Medicine, Burdwan Medical College, Burdwan, West Bengal, India. Thirty-five consecutive cases of unnatural deaths in adult male subjects (above 18 years of age) were examined (at autopsy) by the author. The sternum of those subjects (fresh bodies) were dissected and removed from the thoracic cage. Cases with observable deformity, injuries over chest wall and fractured sternum were excluded. All the cases were examined (autopsy) within 24 hour of death. Subsequently healthy sternum of 35 consecutive female subjects were included from the

Corresponding Author:

*Associate Professor.

Department of Forensic and State Medicine
Burdwan Medical College, West Bengal
India, Pin -713104

BMC Doctors' Quarters

Flat No 6 Block 1, Baburbag, Burdwan, West Bengal, India, Pin -713104

E-mail: drpartha99md@gmail.com

routine forensic autopsy cases using the same method and criteria. The sample thus obtained comprised of 70 sterna (35 male and 35 female).

At complete Forensic autopsy the sternum in all the cases were carefully dissected using a standard linear midline incision. The clavicles were disarticulated from the sternum. The sternal margins that articulate with the cartilages of the first seven pairs of ribs were carefully cut so that the body could be measured with precision. Direct measurements were taken by technical quality divider, metallic (steel) graduated scale and tailors tape with readings up to one mm. Three readings were taken and average of the results was recorded. All measurements were taken keeping the bone on flat surface in anatomical positions. The following measurements were taken.

- (1) Width of supra sternal notch (Ws).
- (2) Width of sternum at level of 4th rib (WM4).
- (3) Posterior curved length of sternum (PCL)

Metric data was summarized as mean and standard deviations. Discriminant function analysis was done to examine the dimorphism in sternum and how the variables could correctly assign the bones to the proper sex. Statistical analysis was done using SPSS software version 10.0 for windows. Two-tailed P value of less than 0.05 was considered significant.

Results:

The present study sample comprised of equal number of male and female intact adult sterna. The sample size was 70. The summary of univariate and multivariate analysis seen from Table 1. It was observed that the sternum was larger in males regarding all the three variables namely width of supra sternal notch (Ws), Width of sternum at level of 4th rib (WM4) and posterior curved length of sternum (PCL). The results showed that the mean posterior curved length of male and female sternum was 22.4 ± 1.01 cm and 17.92 ± 0.98 cm, respectively. The mean width of the male and female mesosternum at the level of 4th rib was $5.3 \pm .31$ cm and $4.4 \pm .33$ cm respectively. The width of the suprasternal notch of manubrium for male and females was $5.71 \pm .39$ cm and $4.79 \pm .31$ cm, respectively.

Table 2 shows the results of the statistical test of normality of the distribution of the variables. We performed One-Sample Kolmogorov-Smirnov Test to examine the normality. All the three variables were normally distributed thus fulfilling the assumptions and requirement of discriminant function analysis

A direct discriminant function analysis was performed using three variables as predictors of sex of sternum. All the variables were entered together. The Predictors were width of supra sternal notch (Ws), width of sternum at level of 4th rib (WM4) and posterior curved length of sternum (PCL). The classification groups were male and female. One

discriminant function was calculated with Wilks' Lambda equal to .125 chi square (χ^2) equal to 138.41, degree of freedom 3 and P value of .000. Because P value was less than .05, we could say that the model was a good fit for the data. The following Discriminant Function (DF) was obtained:

$$DF = .86 * Ws + 1.04 * WM4 + .77 * PCL - 25.03$$

The standardized canonical coefficients and the structure weights (pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions) reveal that all of the three variables contributed to the multivariate effect (Table 4). The best predictor for distinguishing between male and female sternum was the posterior curved length of sternum (PCL).

The Cut Score was 0 [Calculated from group centroid (Table 5) by obtaining the arithmetic mean of the values]. The group centroids indicate the unstandardized canonical discriminant functions evaluated at group means. Cases where the D F score was less than 0 the sternum female. For values of discriminant score above 0, the sterna were male. Overall as well as at individual level 100 % of the sample was correctly classified into their group by this model. (Table 6) In cross validation each case is classified by the functions derived from all cases other than that case. Cross-validated results also showed 100 % of the cases correctly classified by this tri variable model. (Fig1)

Discussion:

Earlier works have shown that metric analysis of the sternum is a helpful technique in the sex determination of a skeleton. [1,2] A study [3] on 400 North Indian sterna showed that the combined length of the manubrium and mesosternum was more than 140 mm. the sternum was male, and if less than 131 mm. it was female. The same study also concluded that length of the manubrium, manubrium-corpus index, width of the first or third sternebra or their index, were not found to be useful in sexing a given sternum while using multivariate analysis the probability of correctly identifying the sex of a sternum was over 85%.

The anthropometric measurements of the sterna in the present series (Indian, Bengali) are comparable with those of studies [3, 4, 5,] on sterna from North Indian and South Indian population. Sexual dimorphism in the sternum has also been investigated in Nigerian population using the morphometric variables. [8]

The present work consisted of direct measurement of the sternum in autopsy cases. Discriminant function analysis is used to determine which continuous variables discriminate between two or more naturally occurring groups. In this study the method of discriminant function analysis was used to evaluate how those three variables [width of supra

sternal notch (Ws), width of sternum at level of 4th rib (WM4) and posterior curved length of sternum (PCL)] can discriminate between male and female sternum. The present sample was homogenous as to sex. In its natural position the inclination of the sternum is oblique from above, downward and forward. It is slightly convex in front and concave behind. So we considered the posterior curved length of sternum as one of the variables in the present investigation.

The analysis showed that this model could correctly classify overall 100% of original grouped cases. The posterior curved length of sternum was the best predictor of sex. This result in this population specific (Indian Bengali) sample is better than those of other Indian studies [3, 4] where 70 to 85 percent correct classification was possible using the manubrium length, length of body and width of body as predictors. The present results are also more accurate than studies from South India [5, 7] where sternal index was examined for classification of sex.

This further asserts our contention that morphometry and sexual dimorphism in adult human sternum is population and race specific. Discriminant functions too are population specific as found in the present investigation.

Mutilated or grossly decomposed human remains can be examined by applying this method of sex determination from morphometry. We believe that direct measurement in autopsy cases is more accurate and reliable than other works of morphometry with radiography and digital measurement. No correction factors for measurement (distance of x-ray film and orientation) were needed.

The present work was conducted with direct measurement of only three variables. Further research with a larger study design and more number of measurable variables should be done to discriminate between male and female sternum in Indian Bengali population. Morphological variations related to race and population can be worked out using population-based studies.

This is a humble attempt at studying the sexual dimorphism in adult sternum in Indian Bengali population and the application of linear discriminant function analysis to estimate sex using three newer variables. The Present approach in Indian Bengali population is new as we have used (a) direct measurement at autopsy in wet bones (b) the linear combination of posterior curved length, width of supra sternal notch and width of sternum at level of 4th rib that have not been used as predictors

in earlier works (c) the measurement techniques are simple, easy to perform and repeatable.

Only one shortcoming of the present work is the presence of soft tissue in the sternal sample that might have influenced the morphometry.

This however was uniform and minimal specially in measuring the curved length of the posterior aspect of sternum. The results of this preliminary study show that sternum exhibit considerable sexual dimorphism and these variables contribute to discrimination between the two sexes in the study population. It may be concluded that sexing of adult human sternum is thus possible with high accuracy using the discriminant function on a sample obtained from the said population taking these three variables.

The accuracy of discriminant function was 100% in both groups, proving that this can be used to distinguish males from females in a statistically significant manner thus overcoming the difficulty of application of sternal index and other methods. The two variables namely width of supra sternal notch (Ws) and width of sternum at level of 4th rib (WM4) can also be successfully used in fragmentary remains of sternum as in many cases of forensic interest the entire bone might not be available. This technical aspect of sexing of human sternum can be of immense help in human identification.

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Table 1
Descriptive Statistics

Variable	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance	Kurtosis	
					Statistic	Std. Error			Statistic	Std. Error
WS	70	2.20	4.20	6.40	5.2500	6.936E-02	.5803	.337	-.844	.566
WM4	70	2.70	3.60	6.30	4.8500	6.659E-02	.5571	.310	-.407	.566
PCL	70	10.40	15.60	26.00	20.2114	.2993	2.5043	6.271	-1.255	.566

Table 2
One-Sample Kolmogorov-Smirnov Test

	Ws	WM4	PCL
N	70	70	70
Normal Parameters	Mean	5.2500	4.8500
	Std. D.	.5803	.5571
Most Extreme Differences	Absolute	.083	.135
	Positive	.083	.093
	Negative	-.071	-.135
Kolmogorov-Smirnov Z	.694	1.127	1.287
Asymp. Sig. (2-tailed)	.721	.158	.073
Test distribution is Normal.			

Table 3

Sex		Mean	S D
Male	Width of suprasternal notch (Ws)	5.7086	.3936
	Width of sternum at level of 4 th rib (WM4)	5.3000	.3144
	Posterior curved length (PCL)	22.4943	1.0091
Female	Width of suprasternal notch (Ws)	4.7914	.3091
	Width of sternum at level of 4 th rib (WM4)	4.4000	.3378
	Posterior curved length (PCL)	17.9286	.9898

Table 4

Variable	Canonical Discriminant Function Coefficients	Standardized Canonical Discriminant Function Coefficients	Structure Matrix
Ms	.858	.304	.496
WM4	1.038	.339	.528
PCL	.767	.766	.875
Constant	-25.032		

Tests of Equality of Group Means

	Wilks' Lambda	F	df1	df2	Sig.
Width of supra sternal notch (Ws)	.366	117.556	1	68	.000
Width of sternum at level of 4 th rib (WM4)	.338	133.135	1	68	.000
Posterior curved length (PCL)	.157	365.175	1	68	.000

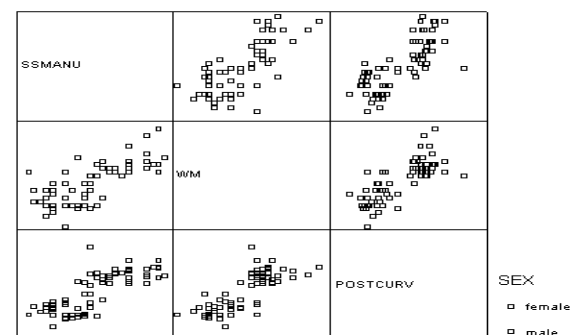
Table 5
Unstandardized Canonical Discriminant Functions Evaluated At Group Means

Sex	Functions at Group Centroids
Male	2.611
Female	-2.611

Table 6
Classification Table

		Sex	Male	Female	Total
Original	Count	Male	35	0	35
		Female	0	35	35
	%	Male	100.0	0	100.0
		Female	0	100.0	100.0
Cross-validated	Count	Male	35	0	35
		Female	0	35	35
	%	Male	100.00	0	100.0
		Female	0	100.0	100.0

Figure No. 1
Scatter plot showing the variables discriminating the male and female sternum
[SSMANU= width of suprasternal notch, WM= width of srernum at level of 4th rib; POSTCURV= posterior curved length of sternum]



Original research paper

Estimation of Stature by Percutaneous Measurements of Distal Half of Upper Limb (Forearm & Hand)

*Kumar Amit, ** Srivastava A. K., *** Verma A.K.

Abstract

Determination of stature from skeletal / dismembered remains is not new for Forensic Experts. In this study efforts are made to reconstruct stature from distal half of upper limb (forearm & hand), for which standing height and distance between tips of olecranon process and middle finger of right and left arms are measured in 100 adult male and female students of 19 -25 years of age. These measurements are analyzed statistically to establish relation between stature and forearm and hand in form of regression equation and multiplication factor.

Regression equations are derived separately for both the sexes by using formula $y - \bar{y} = byx(x - \bar{x})$ i.e. $y = \pi \frac{\delta y}{\delta x}(x - \bar{x}) - \bar{y}$ and calculated as $y = 2.42x + 56.64$ for males and $2.29x + 60.3$ for females, *wherey* stands for standing height and *x* for combined length of forearm & hand. By putting the value of *x* in different situations statures are calculated and compared with the corresponding real standing height and these were close (+/- 3 cm) in most of the cases.

Multiplication factors are also calculated in the study and these are 3.67 for male and 3.73 for female but their results are less compatible with regression equations.

Key Words: Stature, Dismembered Remain, Regression Equation, Multiplication Factor

Introduction:

Stature is one of the important criteria for establishing identification of unknown person/dead body. It is usually measured as standing height of the individual but evaluation of stature is difficult when dead bodies are mutilated, burnt or skeletonized.

Reconstruction of stature from skeletal / dismembered remains is not new for Anthropologists / Forensic experts. A number of multiplication factors and regression equations have been developed to reconstruct stature from long bone throughout the world (1-6). But estimation of stature in mutilated bodies especially from their bones is a tedious and time consuming process which involves cleaning and preparing of bones.

Even then the result may be quite erroneous because of considerable statistical differences between the lengths of fresh and dry bones (7). Percutaneous measurements of different parts of body especially of upper and lower extremities and their relation with stature may be the correct solution for mutilated remains. Rough estimation of stature from parts of upper & lower limbs is used since years as stature is supposed to be equal to the length between the tips of middle fingers of both arms when they are fully extended (8). Stature can also be calculated from one arm by multiplying the whole length with two and add 34 cm for chest or from distal half of upper limb (from tip of olecranon process to tip of middle finger) by multiplying with 19/5 (9). Recently Forensic experts/ anthropologists are trying to develop appropriate formulae/ regression equations for stature from per-cutaneous measurements of different parts of upper & lower limbs (10-13).

The study "estimation of stature by per-cutaneous measurements of distal half of the upper limb (forearms & hands)" is an effort to establish correlation between distal half of the upper limb and stature. This enables doctors/ autopsy surgeons to establish stature in mutilated bodies especially when forearm & hand is intact and most of the other parts are damaged.

Materials and Methods:

200 healthy students (100 males and 100 females) of Subharti Medical College Meerut between 19-25 years of age were selected for this

Corresponding Author:

*Assistant professor,
Department of Forensic Medicine,
Subharti Medical College,
Delhi-Hardwar bye-pass road,
Meerut, U.P.-250002
Mob. No. 09456612562
E-mail: dramit1995@rediffmail.com
**Professor & Head,
*** Associate Professor,
CSM Medical University, Lucknow, U.P.

study irrespective of their caste, religion, dietary habits & socio-economic status. Students having significant growth disorders, deformities, bony anomalies & fracture of forearm & hand are excluded to rule out any gross anomaly in reconstruction of stature.

For reconstruction of stature from forearm and hand standing heights of all the selected students are measured on stadiometer without shoes, as distance between standing surface to the highest point on the head in mid-sagittal plane. Combined lengths of forearm & hand are measured as distance between the tips of olecranon process and the middle finger by sliding caliper.

These measurements are compiled on master chart and also on excel format. The mean & standard deviation of standing height and combined length of forearms & hand of right & left arms and from their average are derived on computer from which their correlation coefficient with standing height are calculated.

Regression equations for stature are derived from right and left distal halves of upper limbs and the average of both limbs separately in male & female by using the formula:

$$y - \bar{y} = byx(x - \bar{x}) = \pi \frac{\delta y}{\delta x} (x - \bar{x})y = \pi \frac{\delta y}{\delta x} (x - \bar{x}) - \bar{y}$$

Where y = Standing height (stature)

\bar{y} = Average (mean) of standing heights

x = Combined length of forearm & hand

\bar{x} = Average (mean) of Combined length of forearm & hand

π = Co-relation coefficient between standing height & combined length of forearm & hand

δy = Standard deviation of standing height

δx = Standard deviation of combined length of forearm & hand. Efforts are also made to formulate multiplication factors for stature from forearm and hand in both the sexes and compare with the years known ratio 19/5.

Observation & Results:

Stature:

The standing height of males varied from 158.5 cm to 184 cm with mean value of 170.905 cm and standard deviation (S.D) 6.0204596. The stature of females varied from 147.5 cm to 167.5 cm with mean value of 156.495 cm and standard deviation 4.658811 (Table I).

Table I: Stature of the study group

	Total Males (100)	Total Females (100)
Minimum	158.5	147.5
Maximum	184.0	167.5
Mean	170.905	156.495
S D	6.0204596	4.658811

Length of Forearm & Hand:

(A) Males:

The length of right side forearm & hand varied from 41.5 cm to 52 cm in males with mean value of 46.8 cm, standard deviation 2.254 and co-relation coefficient with standing height 0.9055. The length of left side forearm and hand varied from 41.7 cm to 51.5 cm with mean value of 46.797 cm, standard deviation 2.2462 and co-relation coefficient with standing height 0.901227. The average of lengths of right and left sides of forearms and hands varied from 41.6 cm to 51.75 cm with mean value of 46.799 cm, standard deviation 2.246602 and co-relation coefficient with stature 0.904695 (Table II).

Table II: Combined length of forearm & hand in male

	Length of forearm & hand (in cm)		
Measurement	Right side	Left side	Average
Minimum	41.5	41.7	41.6
Maximum	52.0	51.5	51.75
Mean	46.8	46.797	46.799
Standard Deviation	2.254	2.2462	2.246602
Co-relation coefficient with stature	0.9055	0.901227	0.904695

(B) Females:

The length of right side forearm & hand varied from 38 cm to 45.1 cm in females with mean value of 42 cm, standard deviation 1.79 and co-relation coefficient with standing height 0.88. The length of left side forearm and hand varied from 38 cm to 45.3 cm with mean value of 42 cm, standard deviation 1.777 and co-relation coefficient with standing height 0.872. The average of lengths of forearms and hands of both the sides varied from 38 cm to 45.15 cm with mean value of 41.9825 cm, standard deviation 1.777218 and co-relation coefficient with stature 0.87992 (Table III).

Table III: Combined length of forearm & hand in female

	Length of forearm & hand (in cm)		
Measurement	Right side	Left side	Average
Minimum	38	38	38
Maximum	45.1	45.3	45.15
Mean	42	42	41.9825
Standard Deviation	1.79	1.777	1.777218
Co-relation coefficient with stature	0.88	0.872	0.87992

Regression equations for estimation of stature were derived from the combined lengths of forearm & hand of right, left and average of both sides separately in male and female with the formula $y = \pi \frac{\delta y}{\delta x} (x - \bar{x}) - \bar{y}$ as discussed above.

These were calculated as:

1. For male

$$\text{a. Distal half of right upper limb: } 0.9055 \times 6.0204596 / 2.254 (x - 46.8) - 170.905 = 2.42x + 56.64$$

- b. Distal half of left upper limb: $0.901227 \times 6.0204596 / 2.2464 (x - 46.797) - 170.905 = 2.42x + 56.64$
 - c. Distal half of average of right & left upper limbs: $0.904695 \times 6.0204596 / 2.246602 (x - 46.799) - 170.905 = 2.42x + 56.64$
 2. For female
 - a. Distal half of right upper limb: $0.88 \times 4.658811 / 1.79 (x - 42) - 156.5 = 2.29x + 60.3$
 - b. Distal half of left upper limb: $0.872 \times 4.658811 / 1.777 (x - 42) - 156.5 = 2.29x + 60.3$
 - c. Distal half of average of right & left upper limbs: $0.877992 \times 4.658811 / 1.777218 (x - 41.9825) - 156.5 = 2.31x + 59.$
 3. The regression equations for stature from right, left and average of both sides of forearm & hand in male are calculated as $2.42x + 56.64$ in all the three situations. Here x is the length between tips of olecranon to middle finger. By putting the value of x in different situations the statures are calculated and compared with the corresponding real standing height and these were close (± 3) in most of the cases. As in a male of 158.5 cm the length of right forearm & hand was 41.5 cm and the stature calculated by the regression equation $2.42x + 56.64$ was 157.1 cm which was 1.4 cm less than the real standing height.
 4. In females the regression equations for stature from right and left side of forearm & hand are calculated as $2.29x + 60.3$ and from average of both side of forearm & hand as $2.31x + 59.5$. By putting the value of x in different situations the statures are calculated and compared with the corresponding real standing heights and these were also close (± 4) in most of the cases. As in a female of 147.5 cm, the length of right forearm & hand was 38 cm and the stature calculated by the regression equation $2.29x + 60.3$ was 147.3 cm which was very close, only 0.2 cm, less than the real standing height. Such inferences were drawn in most of the cases of males and females

Multiplication Factor:

To establish multiplication factor, ratio of standing height and average of combined length of right and left forearm & hand are calculated separately in males and females which ranged from 3.51 to 3.83 with average of **3.67** in male and 3.54 to 3.92 with average of **3.73** in female (table V).

By these ratios errors in reconstruction of stature are more than ± 5 cm in 19% of males and

13% of females which ranges from -7.14 to +7.92 cm and -8.08 to +7.21 respectively.

Discussion:

Estimation of stature is a crucial requirement in post mortem examination of dead bodies especially when they are un-identified and badly decomposed, mutilated or skeletonised. In this study of reconstruction of stature by distal half of upper limb, a direct relationship was observed between combined length of forearm & hand and standing height and regression equations and multiplication factors are derived separately for males and females. The regression equations and multiplication factors for right and left arms were found same. So the role of right and left side measurements in determination of stature is statistically insignificant.

The regression equations for stature from forearm and hand are $2.42x + 56.64$ for male and $2.29x + 60.3$ for female and when we calculate statures by these formula the results are very close to actual height, less than ± 3 cm in most of the cases. A variation of more than ± 5 cm was observed only in 5% of males and 3% of females.

The multiplication factor between stature and forearm & hand is 3.67 in male and 3.73 in female. These are close to the observation of Vij (14). By these factors when statures are calculated the errors vary from -8.08 to +7.92, of which the difference of more than ± 5 cm in 19% of males and 13% of females table VI.

When statures are calculated from multiplication factor of 19/5 (3.8) there is a mark difference in actual and reconstructed statures. Here variation in calculated statures ranges from -14.71 to +4.51 and they are more than the real statures in 95% of males and 75% of females. So multiplication factors are statistically inferior and less reliable than regression equations.

Conclusion:

- Though standing height and combined length of forearm and hand were significantly higher in male, a direct relationship was observed between these parts in both the sexes.
- The difference in right and left side measurements are little and statistically insignificant in derivation of regression equation and multiplication factor.
- The regression equations for reconstruction of stature from distal half of upper limbs are $2.42X + 56.64$ for male and $2.29X + 60.3$ for female, where X is the length between tips of olecranon process to middle finger of the same side.
- Calculated statures from these equations are close to the actual height, only ± 3 cm in most of the cases.

- The multiplication factors between stature and forearm & hand are 3.67 in male and 3.73 in female which are much compatible than the ratio of 19/5.
- Regression equations are statistically superior and more reliable than multiplication factors.

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Table IV
Regression equations and variations in calculated stature

Subject	Side	Regression equation	Length of Forearm & hand	Standing height	Calculated stature	Variation in cm
Male	Right	2.42 X + 56.64	Min. 41.5 cm	158.5	157.1	-1.4
			Max. 52 cm	182	182.5	0.5
	Left	2.42 X + 56.64	Min. 41.7 cm	158.5	157.6	- 0.9
			Max. 51.5 cm	182	181.6	- 0.4
	Average of both	2.42 X + 56.64	Min. 41.6 cm	158.5	157.3	- 1.2
			Max. 51.75 cm	182	181.8	- 0.2
Female	Right	2.29 X + 60.3	Min. 38 cm	147.5	147.3	- 0.2
			Max. 45.1 cm	167.5	163.6	- 3.9
	Left	2.29 X + 60.3	Min. 38 cm	147.5	147.3	- 0.2
			Max. 45.3 cm	165	164	- 1
	Average of both	2.31 X + 59.5	Min. 38 cm	147.5	147.3	- 0.2
			Max. 45.15 cm	165	163.8	-1.2

Table V
Multiplication factor & variation in reconstructed stature

Ratio of standing height and average of distal half of right & left upper limbs	Male	Female
Minimum	3.51	3.54
Maximum	3.83	3.92
Average (Multiplication factor)	3.67	3.73
Variation in reconstructed stature with multiplication factor	-7.14 - +7.92 > +/- 5 in 19%	-8.08 - +7.21> +/- 5 in 13%

Table VI
Variation in reconstructed stature from Regression equation & Multiplication factors

Variation with regression equations	-6.08 - + 4.32> +/- 5 in 5 %	-6.14 - + 4.76> +/- 5 in 3 %
Variation with new Multiplication factor (3.67 / 3.73)	-7.14 - +7.92> +/- 5 in 19%	-8.08 - +7.21> +/- 5 in 13%
Variations with Multiplication factor 19/5 (3.8)	-14.71 - +1.48> +/- 5 in 69%	-11.09 - +4.51> +/- 5 in 30%

Original research paper

Estimation of Stature from Measurements of Long Bones, Hand and Foot Dimensions

*Chikhalkar B.G., **Mangaonkar A.A., ***Nanandkar S.D., ****Peddawad R.G.

Abstract

Estimation of stature holds a special place in the field of Forensic anthropometry. The present study is an attempt to evaluate a possible correlation between stature of an individual & six parameters; *hand-length, hand-width, foot-length, foot-width, forearm length & knee-to-ankle length* individually in a local population of Mumbai. A sample of 300 medical students; 147 male & 153 female studying in Grant Medical College & Sir JJ Group of Hospitals was considered & measurements were taken for each of the parameters. It was found that all the six parameters showed a correlation with stature but at different degrees (significance calculated through the paired t-test). *Forearm-length* showed the highest degree of correlation ($r = 0.6558$) followed by *foot-length* ($r = 0.6102$). *Knee-to-ankle length* showed the lowest degree of correlation ($r = 0.2086$). Mathematical formulae for estimating stature were developed for each of these parameters through basic linear regression. It can be concluded that the present study has provided regression equations for six different parameters that can be used for stature estimation in the population of Mumbai. These equations should not be used for other Indian population groups.

Key Words: Height, Stature, Hand-Length, Hand-Width, Foot-Length, Foot-Width, Forearm-Length, Knee-Ankle Length

Introduction:

Estimation of stature has a significant importance in the field of forensic anthropometry. Establishing the identity of an individual from mutilated, decomposed, & amputated body fragments has become an important necessity in recent times due to natural disasters like earthquakes, tsunamis, cyclones, floods and man-made disasters like terror attacks, bomb blasts, mass accidents, wars, plane crashes etc. It is important both for legal & humanitarian reasons. 'Stature' is one of the most important elements in the identification of an individual.

Many different body parts can be used in the estimation of stature. Certain long bones & appendages can be aptly used in the calculation of height of a person. Many studies have shown the correlation of stature with body appendages [1-9] & with long bones [10-19]. But there are inter-racial & inter-geographical differences in measurements & their correlation with stature. What may be true for one race or one region may not be true for the other.

Corresponding Author:

Assoc. Professor, Dept. of Forensic Medicine & Toxicology, Grant Medical College & Sir JJ Group of Hospitals, Byculla, Mumbai -400008.

E-mail: drbgchikhalkar@yahoo.com,

Ph No.: 09969037650

**Student, MBBS (III/II)

*** Professor & Head,

**** Resident Doctor,

Even within our vast homeland of India there are many different ethnic populations & they having their own variations. [1, 2, 6-13, 18, 19] The lack of anthropometric data concerning the local population of Mumbai was felt as the city is prone to disasters like the terror attacks on 26th November 2008. Hence the present study was aimed at & concentrated on the Indian population of Mumbai of known stature of which anthropometric measurements of upper limb & lower limb were calculated & correlated with stature to find multiplication factors & regression formulae. Study was carried out at Department of Forensic Medicine & Toxicology, Grant Medical College & Sir JJ Group of Hospitals, Mumbai.

Materials & Methods:

The study was a cross-sectional one with 300 subjects in the age group of 19 to 23 years, with 147 males & 153 females. The procedure, aims & objectives of the study were informed & explained in a group. A written valid informed consent was taken from each of the participants. A small group of ten students were taken for measurements each day at a fixed time to avoid diurnal variations. The students were measured for the following parameters:

- **Weight:** Using an electronic weighing machine.
- **Height:** Standard anthropometric measuring instruments.
- **Forearm Length:** From tip of olecranon process to mid-point joining radial & ulnar

tuberosity using a standard measuring tape (Position: Arm-Flexed).

- **Hand-Width:** From base of 5th to 2nd metacarpal using a standard vernier calliper (Position: Prone).
- **Hand-Length:** From mid-point below radial & ulnar tuberosity to tip of middle finger using a standard measuring tape (Position: Supine).
- **Foot Length:** From tip of toe to heel on the medial side using a standard measuring tape (Position: Standing).
- **Foot Width:** From base of 1st to 5th metatarsal using standard vernier calliper (Position: Standing)
- **Knee to Ankle:** From mid-point below radial & ulnar tuberosity to tip of middle finger using a standard measuring tape (Position: Sitting, knee flexed).

Statistical Analysis:

The primary outcome was the regression equation for each parameter. Correlation coefficient (-1 to +1) was calculated for each parameter as were range, mean and standard deviation. We analysed our data using SPSS (version 16.0.2) & calculated significance via the paired t-test.

Results:

The results are given below in the table after the statistical analysis. (Table-1)

Regression Equations:

The regression equations derived for each of the parameters are as follows:

Estimation of stature from hand-length:

- $Y = 116.892872 + 2.665389 * X$ (Y: Stature of individual, X: Hand-length)

Estimation of stature from hand-width:

- $Y = 113.561732 + 7.139216 * X$ (Y: Stature of individual, X: Hand-width)

Estimation of stature from Foot-length:

- $Y = 79.72379 + 3.650632 * X$ (Y: Stature of individual, X: Foot-length)

Estimation of stature from Foot-width:

- $Y = 114.828119 + 5.906901 * X$ (Y: Stature of individual, X: Foot-width)

Estimation of stature from Forearm- Length:

- $Y = 86.772654 + 2.997967 * X$ (Y: Stature of individual, X: Forearm Length)

Estimation of stature from Knee-to-ankle length:

- $Y = 156.543454 + 0.296018 * X$ (Y: Stature of individual, X: Knee-to-ankle length)

Discussion:

In a study done by Bhavna & Surinder Nath concerning estimation of stature based on lower limb measurements on 503 Shia Muslims in the age group of 20-40 years of New Delhi, the *Tibial Length* was found to be the best estimate of stature [13]. In the

present study, among the lower extremity measurements *foot-length* ($r=0.6102$) was found to be the best estimate of stature. Also, knee-to-ankle length correlated poorly with stature ($r=0.2086$) contrary to the findings in the above mentioned study.

A study based on the measurements of foot length and body height of total 502 students between 17 to 22 years of age was done by Patel Shah et al [2]. They had found that *foot-length* showed a high degree of correlation with height of the individual. The present study also highlights a strong correlation between height & foot-length ($r = 0.6102$).

A study was done to examine the relationship between stature and dimensions of hands and feet among Rajputs of Himachal Pradesh - a North Indian endogamous group done by Krishnan et al [6]. Hand length, hand breadth, foot length and foot breadth of 246 subjects were considered & it was found that *foot-length* was the best measure of estimating stature of an individual. In our study, among the hand & feet measurements, *hand-width* ($r = 0.6004$) was found to be the best estimate of stature. Studies by Agnihotri A, Purwar B [9] ; Sen J, Ghosh S [7] ; Kanchan T, Menezes RG [20] et al. had similar conclusions to the present study.

A study by Athawle et al. on one hundred Maharashtrian male adults of ages between 25 to 30 years, Showed that height could be reliably estimated from forearm length. The present study also showed similar results.

The present study highlights that hand-length, hand-width, forearm length foot-length & foot-width can be reliably used for estimation of stature in the region of Mumbai. Of all the parameters, forearm length showed the highest degree of correlation ($r = 0.6558$) followed by foot-length ($r = 0.6001$). Knee-to-ankle length showed the least correlation ($r = 0.2086$). It would not be wise to apply the same data on other Indian population groups.

Limitations:

1. In the present study, age range of only 19 to 23 years is considered.
2. Measurements of only healthy individuals are considered. Hence the data may not be applicable to individuals who are malnourished &/or suffering from congenital structural malformations.
3. Sex variation is not taken into consideration.
4. Applicability of anthropometric measurements in living & deceased individuals may practically differ.
5. The present study is a preliminary one & would be followed up by other studies to address the above limitations.

Table-1
Range, Standard Deviation (SD), Correlation Coefficient(r) & Regression coefficient(b) values of the Anthropometric Measurements

Parameters Assessed	Range (in cm)	Mean \pm SD	R	B
Height	138-186	167.265 \pm 8.494		
Hand-Length	11.50-27	18.938 \pm 1.88	0.5902	2.6654
Hand-Width	5.80-8.90	7.537 \pm 0.714	0.6004	7.1392
Foot-Length	20.85-28	24.008 \pm 1.420	0.6102	3.6506
Foot-Width	7.10-10.05	8.895 \pm 0.703	0.4886	5.9069
Forearm-length	23-31.20	26.884 \pm 1.866	0.6588	2.9980
Knee-to-ankle length	20.50-85.05	36.574 \pm 5.984	0.2086	0.2960

Conclusions:

The present study has established definite correlation between stature & six parameters individually, namely, hand-width, hand-length, foot-length, foot-width, knee-to ankle length & forearm length. Out of the six parameters studied, forearm length showed the highest degree of correlation($r = 0.6558$) and knee-to-ankle length showed lowest degree of correlation($r = 0.2086$); also regression equations have been established for each of them.

This is a study of the first kind in the Mumbai region. It will help in medico-legal cases in establishing identity of an individual when only some remains of the body are found as in mass disasters, bomb explosions, accidents etc. It will also help in establishing identity in certain civil cases.

There are lot of variations in estimating stature from limb measurements among people of different region & race. Hence there is a need to conduct more studies among people of different regions & ethnicity so that stature estimation becomes more reliable & identity of an individual is easily established.

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Original Research Paper

A Study of Serum Cholinesterase Levels in Organo phosphorous Poisoning Cases

*Dr. Bharath Kumar Guntheti, **Dr. Shaik Khaja, ***Dr. S.S. Panda

Abstract

The study period is 11 months that is from 01-01-2007 to 28-11-2007, 35 cases of organ phosphorus poisoning were admitted at Mamata General Hospital, khammam, Andhra Pradesh, India. The cases were studied on various epidemiological parameters and Proforma prepared for detailed data. In our study the majority of victims were males, married, Hindu, Literate, from rural area, medium socioeconomic group and common age of victims is 21 to 30 years. The common mode of poisoning is suicidal, one is accidental poison in child and one is occupational as contact poison while spraying. No homicidal poison was reported in our study. Majority victims have consumed poison in day time, commonly abused poison is monochrotophos, and approximate amount of poison consumed by majority of the victims is 250 ml to 500ml and majority were admitted within 3to6hours of consumption of poison. The common motive of poisoning was suicidal in both male [24cases] and female [10cases], especially young victims from rural domicile with agricultural occupation. The majority of victims consumed poison in summer followed by winter season. The probable reason is rain dependent agricultural occupation, unemployment, joint family and medium socioeconomic status of population of this area.

Key Words: Organo Phosphorus Compounds, Epidemiology, Serum Cholinesterase, Victim

Introduction:

Organo Phosphosphates are used extensively in horticulture and agriculture; hence they are occupying the top position among the poisoning cases worldwide including India. As reported by WHO 3 million people consume these compounds resulting in 40,000 deaths annually. An attempt has been made in the present study to find out epidemiology of poison and estimation of serum cholinesterase levels. Organo phosphorus compounds are powerful inhibitors of the enzyme acetylcholinesterases which are present in plasma on the membranes or cytoplasm of cells. These enzymes are two types, one is true cholinesterase found in red cells, nervous tissue and skeletal muscles and another one is pseudo cholinesterase found in plasma, liver, heart, pancreas and brain. These compounds inhibit the cholinesterase in all parts of body, due to which acetylcholine accumulates at the parasympathetic, sympathetic and somatic sites and preventing the nerve impulse at myoneural junction.

Corresponding Author:

*Assistant Professor

Dept of Forensic Medicine, Mamata Medical College, Rotary nagar, Door No.4-2-161

Khammam, Andhra Pradesh-Pin: 500702

Mobile No: 9908339507

Email.ID: bk62743@gmail.com

**Professor&HoD

***Associate professor

Phosphorylated acetyl cholinesterase loses an alkyl group, due to which the enzyme cannot spontaneously hydrolyze and become permanently inactivated and enzymes become irreversible. These compounds are usually consumed orally so the absorption and the onset of action is immediate. Because of the easy availability and rapid lethal action in smaller doses, they are chosen as suicidal poisons and these are leading to peaceful death.

Material and Methods:

During an 11 months period that is from 01-01-2007 to 28-11-2007, 35 cases of Organo Phosphorous poisoning were admitted at Mamata General Hospital, Khammam, and Andhra Pradesh, India. Study conducted includes Age, Sex, Religion, Marital status, Occupation, Diurnal, Seasonal variation, serum cholinesterase levels and associated diseases. Blood samples were collected on the day of admission for estimating serum cholinesterase levels by Kinetic calorimetric method at central laboratory of Mamata general hospital.

Observation:

In the present study, 51poisoning cases were admitted in the Mamata general hospital, out of which 35 cases were Organo phosphorus compounds poisoning. [Table No. 1]

Table No. 2 shows age wise distributions of Organo phosphorus poisoning out of 35 cases, majority victims 27 was in the age group of 15 -30 years, next in the age group of 31-60 years and least

one in the age group of 1-5 years. Table No. 3 shows sex wise distribution, in which 25 were male victims including male child and 10 were female victims. Table No. 4 shows marital status of victims, out of 35, 25 males were admitted, majority 25 males were married and 4 were unmarried. Out of 35, 10 females were admitted, 5 females were married 5 were unmarried. Table No. 5 shows area wise distribution, majority 28 victims belong to rural area and 7 victims belong to urban area.

Table No. 6 giving information regarding literacy status of victims, out of 35, 25 males were admitted, 22 males were literates and remaining are illiterates. 10 females were admitted, 8 were literates and remaining are illiterates. Table No. 7 shows the socioeconomic status of victims, out of 35, 27 victims belong to medium socioeconomic class, next is 6 victims were low socioeconomic class and 2 victims belong to high socioeconomic class.

Table No. 8 giving information about place of incidence, majority 27 consumed poison at home followed by 7 victims at work place and 01 victim at out side of home have consumed poison.

Table No. 9 showing occupation wise distribution of poisoning, majority 17 victims belong to farmers followed by 7 were unemployed, next 5 were house wife and last 2 were student victims

Table No. 10 showing the incidence of day and night time of poisoning, majority victims 32 were consumed poison during day [6am to 6pm] time and remaining were consumed poison during Nighttime [6pm to 6am]. Table No. 11 showing religion wise distribution of victims, majority 26 victims were Hindus next is 05 Muslims victims and 04 christian community. In India, majority population is Hindu community. Table No. 12 showing seasonal variation, majority victims 26 has consumed poison during summer followed by 8 during winter and one is in during monsoon season

Table No. 13 giving information about mode of poisoning, common mode is suicidal 33; followed by accidental 01 and 01 is in occupational in nature. No homicidal poisoning is not reported in our study. Table No. 14 showing the period of survival, majority 33 victims admitted in Mamata general hospital with in 3 to 6 hours, 01 victim after 8 hours and 01 victim admitted after 24 hours after consumed poison. Table No. 15 shows majority 33 victims have consumed approximate amount of poison is 250ml to 500ml followed by 10 ml by 01 victim and 01 victim become a contact poison during [occupational poisoning] spraying insecticide

Table No. 16 giving information about levels of serum cholinesterase in Organo phosphorus poisoning death cases, death with fatal doses eighty [8] out of thirty-five [35] are not compactable with life, show low levels of serum cholinesterase [70 to 878 u/L]. Serial no. 8 inspire of 878 u/L of serum

cholinesterase, victim already suffering with pulmonary tuberculosis. Table No. 17 giving information regarding survived male victims serum cholinesterase levels 814 u/L to 9056 u/L [17 cases] Table No. 18 giving information regarding survived female victims serum cholinesterase levels 1078 u/L to 9240 u/L [08 cases]. Table No. 19 showing the pattern of poisoning, commonest is organ phosphorus insecticide 35, followed by aluminum phosphid 11 and 5 were snake bite poisoning. Table No. 20 showing trade names of different Organo phosphorus compounds and no. of cases, commonly consumed insecticide is Monochrotophos [18], followed by Malathion [10] next Chlorpyrifos [4] and Quinalphos [2] least is Dimethoate. [1]

Discussion and Conclusion:

In the present study, total no of poisoning cases 51 admitted, out of 35 was organophosphorus poison cases were studied in detailed of epidemiology and serum cholinesterase levels. Males [71.57%] were more prone to suicide by poisoning compare to females [28.57%] and they were in age group of 15-30 years [77.14%] next age group is 31-60 years [20%] and 8 deaths was [22.85%] occur in age group of 21-40 year, similar results are reported by other studies. [1-3, 7] This age group is more active stage of life and more vulnerable for suicidal poisoning. This study reveals male preponderance [71.14%] compare to female [28.57%]. These are consistent with other studies. [1-3, 6, 8]

The majority of victims are married [74.28%] and remaining were unmarried [25.71%], this report suggest that, more victims among married compared to the unmarried population, because married population exposure to more problems of social, financial, occupational and as well as domestic worries. Similar results are observed by other studies. [1-6] The majority of victims were from rural [80%] and urban [20%] domicile variation is reported. These are consistent with other studies. [8, 4] The higher incidence was observed in literate [85.71%] compared to illiterate [14.28%]. These are consistent with other studies [4, 8] because they can easily get poison by trade name.

Most of victims were belong to [77.14%] medium socioeconomic class. This might be due to modern life style, stress, tension, family and social problems more common in this class. These similar finding is made by other studies. [2, 8, 14] The majority of victims are consumed poison at home [77.14%], [14] this might be due to a firm decision was taken in the mind of victims to die that is why there are only stay at home.

The high incidence was observed in farmers [48.57%] compare to that in people of other occupation. [2, 8] More victims are committed suicide during day time [91.42%] [14] compare to

night time [8.57%]. These results are reported by Indian authors. Most of the victims were Hindu, because the major population of India is Hindu. [3, 8]

The most of victims committed suicide in summer season [8, 14] [74.28%] compare to other seasons. The commonest mode of poisoning is suicidal [1, 2, 3, 4, 5, 6, 7, 8] [94.28%] followed by accidental [5.71%] [3] and homicidal poisoning was not reported in present study. It is observed that 33 cases were admitted in hospital with in 3 to 6 hours [94.28%] after consumption of poison. [8, 11]

Most of victims [98.28%] consumed the approximate amount of poison is 250ml to 500ml is based on history given either by victims or and relatives. Incidence of deaths was found in 22.85% [8cases] followed by 3-6hours of period of survival, and serum cholinesterase levels found 70 u/l to 878u/l. Present study shows that serum cholinesterase levels 814u/l to 9056u/l in survived male victims [17] and in survived female [10] victims 1078u/l to 9240u/l. From the study it was observed that, organophosphorus insecticide was the commonest poison [68.62%] followed by aluminum phosphide [19.60%] and snake bite [9.80%]. Similar observations made by other studies. [1-15] Majority of victims [51.42%] were consumed monochrotophos [4] followed by Malathion [28.57%] and Quinalphos [5.71%] among the different trade names of organophosphorus compounds. Serum cholinesterase levels between 70 U/L to 130 U/L appears to be incompatible with life except in 1 case where death occurred with 878 U/L levels. But he was found suffering from pulmonary tuberculosis.

Table No. 1 Organo phosphorus poisoning cases

No. of poisoning cases	No. of organophosphorus cases (%)
51	35(68.62)

Table No. 2 Age wise distributions

Age in yrs	Common [m/f]	%	Female	Male
1 to 5	1	0.28	0	1
15 to 30	27	77.14	10	17
31 to 60	7	20	0	7
Total	35		10	25

Table No. 3 Sex wise distributions

Sex	No. of victims (%)
Male	24 (68.57)
Female	10(28.57)
Male child	1(2.85)
Total	35

Table No. 4 Marital status of victims

Marital status	No. of victims	percentage
Married	26	74.28%
Un married	9	25.71%
Total	35	

Table No. 5 Area wise distribution

Domicile	No. of victims	Percentage
Rural	28	80.00%
Urban	7	20.00%
Total	35	

Table No. 6 Literacy status of victims

Sex	No. of literate victims (%)	No. of illiterate victims (%)
Male	22(62.85)	2(5.71)
Female	8(22.85)	3(8.57)
Total	30(87.71)	5(14.28)

Table No. 7 Socioeconomic status of victims

Socioeconomic status	No. of victims (%)
Low	6(17.14)
Medium	27(77.14)
High	2(5.71)
Total	35

Table No. 8 Place of incidence

Place of incidence	No. of victims (%)
Home	27(77.14)
Workplace	7(20.00)
Outside home	1(2.85)
Total	35

Table No. 9 Occupation wise distributions

Occupation of victim	No. of victims (%)
Farmers	17(48.57)
unemployment	7(20.11)
House wife	5(14.28)
Daily labor	4(11.42)
student	2(5.71)
Total	35

Table No. 10 Diurnal variation

Time	No. of victims (%)
6 am to 6pm	32(91.42)
6pm to 6am	3(8.54)
Total	35

Table No. 11 Religion wise distribution

Religion	No. of victims (%)
Hindu	26(74.28)
Muslim	5(14.28)
Christian	4(11.42)
Total	35

Table No. 12 Seasonal variation

Season	No. of victims (%)
Summer	26(74.28)
monsoon	8(22.85)
winter	1(2.85)
Total	35

Table No. 13 Mode of poisoning

Mode of poisoning	No. of cases (%)
Suicidal	33(94.28)
Accidental	2(5.71)
homicidal	Nil
Total	35

Table No. 14 Period of survived

Period of survival	No. of victims (%)
Within 3to6 hrs	33(94.28)
More than 8hrs	1(2.85)
Less than 24hrs	1(2.85)
Total	35

Table No. 15 Amount of poison consumed

Mode of poison	Approximate amount of poison consumed	No. of victims (%)
suicidal	250ml to 500ml	33(94.28)
Accidental	10ml	1(2.85)
occupational	Contact poison	1(2.85)
homicidal	Nil	Nil
Total		35

Table No. 16 Serum cholinesterase levels in death 8 cases

Sl. No	Age/sex	Approximate amount of poison consumed	Serum cholinesterase levels
1	60/M	500ml	70u/l
2	15 / M	450ml	110 u/l
3	22/M	500ml	80u/l
4	43 /M	500ml	70u/l
5	23/M	500ml	130u/l
6	22/M	500ml	134u/l
7	25/M	500ml	70u/l
8	50/M	500ml	878u/l

Table No. 17 Serum cholinesterase levels in survived male

Sl. No	Serum cholinesterase levels	Mode of poisoning	prognosis
1	4850u/l	suicidal	Recovered
2	5400u/l	Suicidal	Recovered
3	1981u/l	Suicidal	Recovered
4	814u/l	Suicidal	Recovered
5	1434u/l	Suicidal	Recovered
6	3501u/l	Suicidal	Recovered
7	4014u/l	Suicidal	Recovered
8	1356u/l	Suicidal	Recovered
9	990u/l	Suicidal	Recovered
10	2616u/l	Accidental	Recovered
11	1155u/l	Contact poison	Recovered
12	2976u/l	Suicidal	Recovered
13	1050u/l	Suicidal	Recovered
14	9056u/l	Suicidal	Recovered
15	1030u/l	Suicidal	Recovered
16	5600u/l	Suicidal	Recovered
17	2010u/l	Suicidal	Recovered

Table No. 19 Pattern of poisoning

Sl. No.	Poison	Male victims	Female victims	Total (%)
1	Insecticide organophosphus	25	10	35(68.62)
2	Aluminum phosphide	2	8	10(19.60)
3	Snake bite	4	1	5(9.80)
4	Uknown poison	1	Nil	1(1.96)

Table No. 20 Trade names of O. P. Compounds

Sl. No.	Trade name of different organophosphorus compounds	No of victims consumed poison (%)
1	monochrotophos	18(51.42)
2	malathion	10(28.57)
3	Chlorpyrifos	4(11.42)
4	Quinalphos	2(5.71)
5	Dimethoate	1(2.85)
	Total	35

Table No. 18 Serum cholinesterase levels in survived female

Sl. No.	Serum cholinesterase levels	Mode of poisoning	Prognosis
1	1166u/l	Suicidal	Recovered
2	1113u/l	Suicidal	Recovered
3	6136u/l	Suicidal	Recovered
4	3486u/l	Suicidal	Recovered
5	2180u/l	Suicidal	Recovered
6	9240u/l	Suicidal	Recovered
7	1156u/l	Suicidal	Recovered
8	5833u/l	Suicidal	Recovered
9	7210u/l	Suicidal	Recovered
10	1078u/l	Suicidal	Recovered

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Original research paper

ABO Blood Grouping from Tooth Material

*Dr. Mahabalesh Shetty, **Dr. Premalatha K

Abstract

Human identification is a mainstay of civilization and identification of unknown individuals has always been of paramount importance to society. Establishing individuality is an imperative aspect in any investigating procedure. The use of biological evidence for identification of an individual is a relatively recent development, but it is expensive and time consuming.

The Forensic importance of dental tissue has been well recognized because of the fact that tooth is hardest of all human tissues and they can be preserved intact for a long period of time after death. Blood group has been one of the corner stones for identification of biological materials in Forensic investigations, and ABO blood grouping is widely used in Forensic laboratories. In this study an attempt is made to determine ABO blood group from the dental pulp and the dentin extracted from dead body by absorption –elution method.

Key Words: Human identification, ABO blood grouping, Pulp, Dentin

Introduction:

Forensic identification over a period of time has evolved into an art of science and involves various specialties. A doctor's role as forensic pathologist, a Forensic Odontologist goes hand in hand with the police officer in establishing the 'IDENTITY' of individual in mass disasters. Teeth are the most durable organs in the body and can be heated to temperatures of 1,600 C without appreciable loss of microstructure. [1] Teeth can survive long after soft and skeletal tissues have been destroyed [1]. Biological evidence generally means the comparison of genetic material like DNA. But DNA analysis can be expensive and time consuming. [2] The use of blood group substance in medico legal examination is based on the fact that once a group is established in an individual it remains unchanged throughout his life.[3] Blood group substances in the hard dental tissues thus remain unaffected even in adverse environmental conditions.

Pulp tissue is one of the most protected of the oral tissues being surrounded from all sides by dental hard tissues; and also tooth pulp contains lot of blood vessels, blood group antigens are most certainly bound to be present in tooth pulp. [4] It is presumed that blood group substances in dentine were located in dentin tubules. [4]

Corresponding Author:

*Associate Prof. & HOD

Forensic Medicine & Toxicology

K.S. Hegde Medical Academy, Mangalore, Karnataka

E-mail: drmabs@yahoo.co.in

**Prof. & HOD, Deptt. of Maxillo- Facial Surgery

Manipal college of Dental Sciences,

Manipal University, Mangalore

Thus it was decided to use dental pulp and dentine for detection of ABO group substances. In this study an attempt is made to determine ABO blood group from the dental pulp and the dentin by absorption –elution method. [5]

Material & Methods:

The present study was conducted in K S Hegde Medical Academy, Mangalore. 60 extracted teeth were collected, and these teeth were extracted from dead bodies brought to our Mortuary for medico legal autopsies. The age ranging from 14-60yrs. 31 males and 29 females were selected for the study.

Exclusion Criteria:

Putrefied bodies, Deciduous tooth, Injured tooth, Root canal treated and Carious tooth because of the possibility of showing false positive or false negative results, were excluded. After routine extraction procedure, blood was taken from the freshly extracted socket for blood group determination by agglutination method and acted as control group.

The extracted teeth were washed under running water and debris were removed with the probe, and wiped with gauze and kept in numbered bottles: the teeth were dried and stored for a span of 6months at the room temperature without any preservative. The blood grouping was performed by absorption elution test using dentin and dental pulp, which was later, compared with the recorded blood group from the extracted socket.

Laboratory Procedure:

Modelling wax was folded and made into block. The tooth was then embedded on the modelling wax block. The tooth was split vertically with carborundum disc and then the dental pulp was scooped with sterile spoon excavator which was

placed in a test tube containing sterile thread and a drop of saline.

The test tubes were placed in the incubator at 56°C for 30 minutes for drying where the blood group antigens of dental pulp were absorbed on sterile cotton thread.

Only anti -A & anti -B antisera were used, assuming blood group O when no agglutination occurred.

Blood stained threads of 2 mm length were cut and placed in a drop of anti-A serum in a slide cavity. Similar pieces were placed in anti-B serum. The slides were then kept in moist chamber at 4°C for 2 hours for complete absorption. After absorption, the antiserum was pipetted off from the thread by capillary pipettes and then the thread was thoroughly washed 3 to 4 times in ice cold saline, for the complete removal of unreacted antibodies from it.

Slides were again placed in moist chamber and kept in an incubator at 56°C for 30 minutes to break the antibody- antigen bond (Elution). One drop of a 0.5% suspension of known RBC blood group was added and the samples were again placed in the humidified recipient and were incubated at 56° C for 15 minutes to enhance agglutination.

The slides were then removed from the incubator to be kept at room temperature for 45 minutes to 1 hour and were observed under microscope at magnification of 100x for agglutination i.e. ABO blood groups.

The remaining tooth consisted of dentin, which was pulverized, with straight fissure bur. The pulverized tooth powder was put in two test tubes, to each of this test tubes 3 drops of antiserum A, B was added and confirming the test samples being sufficiently soaked with antiserum for two and half hours and left standing at room temperature.

After removing antiserum, each sample was washed three times with cold saline solution (it was centrifuged and the supernatant was sucked with pipette).

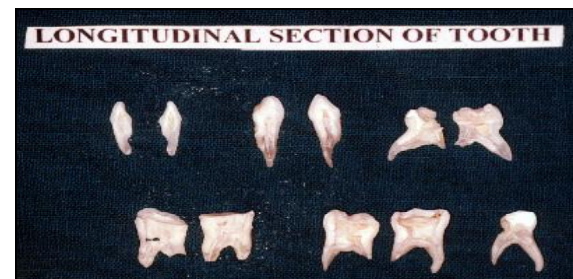
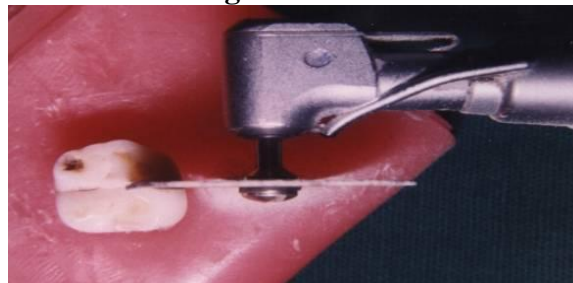
Then two drops fresh saline was added to the sample and the test tube were heated in a water bath (50-55oc) for 10 minutes to elude the antibodies.

A drop of 0.5% A or B group red cell suspension was immediately put into each respective test tube of known blood and the samples were again put in humidified recipient.

They were incubated for 37°C for 30min to enhance agglutination, and after this procedure it was centrifuged at 1,500-2000rpm for min. By gentle shaking of the test tube the presence or absence of red cell agglutination was ascertained with microscope at magnification of 100X.

It was further cross-confirmed with control group.

Tooth Sectioning:



Results:

The blood grouping was attempted to establish from dentin and pulp and it was further confirmed with the control. 60 permanent teeth were collected from 60 subjects, 29 were females, age ranging from 15 yrs to 56 yrs. There were 31 males, age ranging from 16 yrs to 55 yrs. (shown in table 1).

Table - 1: Age Distribution with Sex

Age(yrs)	Male	Female	Combined
	No. (%)	No. (%)	No. (%)
< 20	11 (18.33)	12 (20)	23 (38.3)
21-40	12 (20)	11 (18.33)	23 (38.3)
41-60	8 (13.33)	6 (10.0)	14 (23.4)
Total	31 (51.67)	29 (48.33)	60 (100.0)
Mean \pm SD	27.74 \pm 11.35	25.86 \pm 12.35	26.92 \pm 12.74

Blood group belonging to 'O' were 26 in numbers (43.4%). Blood group A were 20 (33.3%), Blood group B were 11 (18.3%), Blood group AB were 3 (5%) of the control as shown in table 2. Blood grouping on Dentin was done after 180 days of extraction. None of the teeth showed ABO antigen in Dentin after 180 days of extraction (table 2).

Table- 2: Blood Grouping on Dentin after 180 Days of Extraction

Blood groups	Control group	Dentin	
		Study group	
		Positive	Negative
A	20 (33.3%)	0(0%)	20(33.3%)
B	11(18.3%)	0(0%)	11(18.3%)
AB	3(5%)	0(0%)	3(5%)
O	26(43.4%)	0(0%)	26(43.4%)
Total	60(100%)	0(0%)	60(100%)
Inference	ABO antigens were not found in Dentin		

Blood grouping on pulp was done after 180 days of extraction. 58 teeth showed positive results for ABO Blood group in pulp. One tooth showed negative results for ABO blood group and mistyping in another tooth. Sensitivity of pulp in relation to control is 96.7% as shown (table- 3).

Table -3: Blood Grouping on Pulp after 180th Day of Extraction

Blood groups	Pulp		
	Control	Positive	Negative
A	20 (33.3%)	19(95%)	1(5%)
B	11(18.3%)	11(100%)	0
AB	3(5%)	3(100%)	0
O	26(43.4%)	25(96.15%)	1(3.84%)
Total	60(100%)	58(96.70%)	2(3.3%)
Inference	Sensitivity of Pulp in relation to Control is 96.7%		

Discussion:

Identification connotes “determination or establishment of individuality of person – living or dead” [6, 7] the identification of unknown individual has always has been of paramount importance to society. Teeth are the most stable biological clue material which could be used for identification even in most adverse environmental condition. [8]

The use of blood group substances in medico legal examinations is based on the fact that once a blood group is established in an individual it remains unchanged throughout his life. [3] In this study an attempt was made to determine blood group from teeth. This study consisted of 60 teeth, which were extracted from dead bodies brought to our Mortuary. Putrefied bodies, Injured tooth, Root canal Treated and Carious tooth were excluded because of the possibility of showing false positive or false negative results. The blood group determination was done six months after extraction, to examine if blood grouping on teeth remains possible after relatively long storing periods.

Determination of blood group was done in dentine and pulp and was correlated with blood grouping of blood from extraction socket of the same subject. In our study 58 teeth out of 60 showed positive results in pulp. This showed 96% sensitivity.

This finding is consistent with the studies done by Smeets et al [4], Xingzhu X et al [9] The negative results in one sample and mistyping in another sample could be attributed to insufficient quantity of pulp, due to calcification of the canal.

Similar finding was also noted by Parekh et al [10]. Recent tooth specimen could be expected to provide good sources for determination of blood groups. However the effect of autolysis, dehydration, loss of pulp antigens or high number of errors due to foreign antigen borne by bacteria in carious teeth may lead to variation in the study. [8]

Dental tissues from pathologically affected or damaged teeth are often invaded by certain bacteria which impart their adventitious antigenic activities to them and cause false positive reactions. [11, 12] It is therefore possible that the occasional mistyping of blood groups from oral material (e.g. teeth and alveolar bone) may be caused by the

aerobic gram-negative oral flora, especially in heavily contaminated or putrefying material. [13]

In the present study blood grouping from dentin was not possible in any of the samples. This is consistent with study done by Kramer et al [14] in which it was thought that negative finding might be a result of inaccessibility of blood group substances in the dentin because of high degree of calcification. Korszun A.K. et al [12] also accepted the fact that detection of ABO blood grouping activity in hard dental tissue is unreliable. The distribution of ABO substances from the pulp cavity wall to the dentine edge and to the enamel decreases gradually because of fewer possibilities for diffusion of antigen from both blood and saliva. [5]

Conclusion:

It can therefore be concluded that blood grouping on tooth pulp might be of great help in identification even after a span of six months of death but the results of blood grouping on dentin would seem to be of limited value.

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Case report

Fatal Traumatic Rupture of Ascending Aortic Aneurysm Having Idiopathic Cystic Medial Necrosis: An Autopsy Case

*Pannag S. Kumar, **Silvano Dias Sapeco, ***R.G. Wiseman Pinto, ****Francisco Couto

Abstract

This report describes an autopsy case pertaining to death due to traumatic rupture of aortic aneurysm. A 21 year old deaf and dumb male was assaulted with kicks over the chest. Autopsy revealed external injuries over the body. Internally, a fusiform aneurysmal dilatation of the lumen of the aortic root and tubular segment of the ascending aorta were observed, with tear of the anterior wall of the ascending aorta and resultant haemopericardium.

Histologically, the wall of the aneurysm revealed cystic medial necrosis, which appears to idiopathic in nature. A Common complication of aortic aneurysms is dissection, with subsequent spontaneous rupture. In this case, there was no evidence of dissection and the rupture was traumatic in nature. Death was certified as due to cardiac tamponade.

The extent of trauma to which the victim was subjected to, appears to be such as would have been insufficient to cause death in an otherwise normal individual. An account of the findings, along with a discussion of the pathology of aneurysms and cystic medial necrosis as also of the mechanism of rupture of aneurysms is provided.

Key Words: Cystic Medial Necrosis, aortic aneurysm

Introduction:

An aneurysm is a pathological dilatation of the lumen of a vessel. Degeneration of the medial layer of the aortic wall leads to weakening of the wall, resulting in progressive dilatation of the wall, leading to the formation of an aneurysm. Cystic medial degeneration of the aorta can occur due to connective tissue disorders like Marfan's syndrome or simply as an idiopathic condition due to various risk factors. An Aneurysm is at constant risk of rupture which may happen either spontaneously, or following trauma, leading to development of haemopericardium and resultant cardiac tamponade and death.

Case History:

The victim was a 21 year old mentally subnormal deaf and dumb male person. During a quarrel with his brother (who was also mentally – subnormal and congenitally deaf – mute), he was pushed from the staircase at his residence by his brother following a petty quarrel.

Corresponding Author:

*Assistant Lecturer,

Forensic Medicine,

Goa Medical College, Bambolim – Goa

**Professor & Head

***Professor & Head,

Department of Pathology, Goa Medical College

****Associate Professor,

Department of Pathology, Goa Medical College

When the victim landed over the cemented surface at the bottom of the flight of stairs, the accused person assaulted the victim with kicks over his chest and abdomen, following which the victim became unconscious. He was moved to the Community Health Centre of the area, where he was declared “brought dead”.

Autopsy Findings:

External Injuries:

The following external injuries were observed over the body:

1. Reddish contusion, roughly circular, of 2 cms diameter and 1/4th cm deep (on cut section) over lower part of front aspect of left side of the chest.
2. Vertical grazed abrasion, measuring 13 cms x 9 cms over the back of left shoulder.
3. Reddish abrasion measuring 3 cms x 1 cms over lower part of left side of back of chest, below the angle of the scapula.
4. Reddish abrasion, measuring 4 cms x 3 cms, over the left side of lower trunk.

Internal findings:

The aortic root and tubular segment of the ascending aorta showed a fusiform aneurysmal dilatation of the lumen, with a diameter of 7 cms. There was a 9 cms tear of the entire thickness of the anterior wall of the ascending aorta. The pericardial sac contained 613 gms of clotted blood and 337 ml of fluid blood. No evidence of aortic dissection was noted in the wall. The other organs did not show any significant pathological changes. No alcohol or any

other substance was detected at chemical analysis of viscera. No fractures of the ribs or the sternum were found.

Histopathological Examination Findings:

Sections from the wall of the ascending aorta showed myxoid degeneration in the media. There was elastic tissue fragmentation and separation of the fibromuscular and elastic elements of the media by numerous cystic cleft – like spaces in the media containing basophilic amorphous extracellular matrix / ground substance. There was increased fibrosis of the media. These findings are consistent with Cystic Medial Necrosis.

Cause of Death:

Death was certified as “due to cardiac tamponade consequent to rupture of the dilated ascending aorta having cystic medial necrosis as a result of cumulative effect of the external injuries on the body, which was likely to cause death”.

Discussion:

The aorta is composed of three layers: the thin inner layer or intima, a thick middle layer or media and a rather thin outer layer called the adventitia. The strength of the aorta lies in its media, which is composed of laminated but intertwining sheets of elastic tissue arranged in a spiral manner that affords maximum tensile strength. This tremendous accretion of elastic tissue gives the aorta not only tensile strength but also distensibility and elasticity.

The term aortic aneurysm refers to a pathological dilatation of the normal lumen, being defined as a permanent localised dilatation of the aorta having a diameter at least 1.5 times of the expected normal diameter of that given aortic segment. [1] The normal diameter of the ascending aorta is about 3 cms and length is about 5 cms. [2] In the instant case, the ascending aorta was dilated to a clearly aneurysmal width of 7 cms. An area of expanding investigation is the role of cellular mechanisms in the pathogenesis of aortic aneurysms. Destruction of the media and its elastic tissue is the striking histological feature of aortic aneurysms.

Experimental evidence indicates excessive activity of proteolytic enzymes in the aortas of affected patients, which may lead to deterioration of structural matrix proteins such as elastin and collagen in the aortic media and thereby promote or perpetuate the formation of aneurysms. Aneurysmal aortas contain elastolytic activity with an active elastase not present in the normal aorta, and other active proteolytic enzymes as well. The risk of rupture increases with aneurysm size. Smaller than 4 cms Aneurysm have 0-2 % risk of rupture, whereas those larger than 5 cms have 22% risk. [1]

Aneurysms of the ascending aorta most often result from the process of cystic medial

degeneration/ necrosis. [1] Histologically, as in the instant case, cystic medial necrosis is characterised by elastic tissue fragmentation and separation of the fibromuscular and elastic elements of the tunica media by small left – like spaces where the normal elastic tissue is lost, and these areas are filled with the amorphous extracellular matrix of connective tissue and resemble, but are not true “cysts”. Ultimately, there may be large scale loss of elastic laminae. Thus, the terminology “cystic medial necrosis”, as medial degeneration is often called, is inaccurate, because neither true necrosis nor true cysts are present. Inflammation is absent. [1]

Although these changes occur most commonly in the ascending aorta, in some cases, the entire aorta may be involved. The histological changes lead to weakening of the aortic wall, which in turn results in the formation of a fusiform aneurysm. Cystic medial necrosis is found in connective tissue disorders like Marfan's Syndrome and Ehler Danlos Syndrome. However, in patients without Marfan's syndrome, it is not possible to recognise the histological diagnosis of cystic medial necrosis prospectively, i.e. without surgery or autopsy.

This fact has significantly limited understanding of cystic medial degeneration and its natural history by the scientific community, and it remains unclear as to what extent cystic medial degeneration may represent an independent disease process versus a manifestation of another disease state. It has long been suspected that patients who have proven cystic medial degeneration without the classic phenotypic manifestations of Marfan's syndrome may in fact have a variation or '*forme fruste*' of Marfan's syndrome; though this theory remains unproven. [1] In fact, Kubota J et al have reported a case of two brothers who presented with multiple visceral artery aneurysms and diffuse connective tissue fragility, but did not have any features of Marfan's syndrome. According to them, these cases belong to the heterogenous group of Marfan's syndrome in accordance to the above mentioned theory. [4]

However, on the contrary, many patients with ascending thoracic aortic aneurysms appear to have nothing more than idiopathic cystic medial degeneration, where it is unclear as to what specifically predisposes to the development of medial degeneration. It was first thought to be a degenerative process associated with old age, but subsequent reports have shown that it occurs not infrequently in young people. Hypertension is a common risk factor. Another risk factor is syphilis, though now a rare cause, in which degeneration of the aortic media occurs during the secondary phase of the disease producing a weakening of the aortic wall. Other risk

actors are Toxemia, nicotine, hyperadrenalism, infectious aortitis, great vessel arteritis. [1, 2, 5]

In the instant case, the since deceased was mentally subnormal and congenitally deaf – mute. His brother, the assailant, was also known to be mentally subnormal and congenitally deaf – mute. Otherwise, there were no definitive physical characteristics to suggest that the victim was suffering from either Ehler Danlos Syndrome or Marfan's syndrome. Hence, it appears most likely that the case is one of idiopathic cystic medial necrosis, rather than one due to Marfan's or Ehler Danlos syndrome. A genetic study in the instant case would have been helpful in arriving at a diagnosis, to prove or disprove the above mentioned theory that the victim may have been suffering from a variant of Marfan's syndrome.

A common complication of aortic aneurysms is "dissection", which begins with a tear in the intima that exposes a diseased medial layer to the systemic pressure of intraluminal blood. The blood penetrates into the media, cleaving it into two layers longitudinally and producing a blood filled false lumen within the aortic wall. This false lumen propagates distally progressively for a variable distance. Dissection is common in connective tissue disorders like Marfan's and Ehler Danlos syndrome. [2] Such a dissecting aneurysm frequently ruptures spontaneously or following trivial trauma or following a bout of hypertension, resulting in haemopericardium. In the instant case, there was no evidence of dissection. The rupture of the aneurysm was rather, secondary to trauma to which the since deceased was subjected to by the assailant.

Cardiac tamponade is a clinical syndrome caused by the accumulation of fluid in the pericardial space, resulting in reduced ventricular filling and subsequent hemodynamic compromise. In cardiac tamponade, blood accumulates in the pericardial sac faster than it can escape, either because the bleeding rate exceeds the drainage. When there is no laceration of the pericardium, there is no escape route for the blood from the pericardial sac. When sufficient blood accumulates, the pressure in the pericardial sac increases and begins to prevent the passive filling of the atria during diastole. The cardiac output falls, as does the systemic blood pressure and the venous pressure rises. If unrelieved, death follows, though the time that this takes is variable and difficult to calculate retrospectively on pathological findings. About 400-500 ml of blood is sufficient to cause death, though this seems to be a greater volume than is seen in tamponades. [6] In the instant case, the pericardial sac contained 613 gms of clotted blood and 337 ml of fluid blood.

Medico legally, culpability of the accused person would be determined by the interaction of trauma and disease. The injury sustained by the since

deceased would be categorized as one that is "likely to cause death", because although it was an injury that posed a threat to the life of the victim and death as a consequence was not surprising owing to the structures involved, yet it was one where the death was caused due to superimposed trauma in an already diseased person. The same degree of external trauma to which the since deceased was subjected would not have resulted in death in a normal and healthy individual. Hence, the accused would be held guilty vide S. 299 IPC and punishable vide S. 304 PC for culpable homicide not amounting to murder. [9]

The ascending aorta is one of the four common sites where the aorta may rupture following trauma, the others being the aortic isthmus distal to the ligamentum arteriosum, the lower part of the aorta above the diaphragm, and at the junction of the innominate artery with the aortic arch. [8]

Rupture is more likely at sites of aneurysms, because of the reduced thickness and hence greater weakness of the wall, and because of the "La Place's law", according to which tension acting on the wall of a vessel is greater where the luminal diameter is greater. Hence, a much lesser degree of trauma would be required to rupture an aneurysmal aorta as compared to a normal one, as in the instant case.

According to the osseous pinch mechanism / the aorta is crushed or pinched between the vertebral column and the inner surface of the manubrium, first rib and the clavicles during antero-posterior thoracic compressive deformation. [9]

Sudden deceleration also contributes to trauma to the aorta. During sudden deceleration, traction and torsion forces are placed on the aorta at points of anatomic fixation, i.e. isthmus and supra-avalvular ascending aorta. This is called the mechanism of "differential deceleration". During falls, the primary stress is longitudinal traction, with the weight of the heart producing greatest traction on the aortic root. Also, a sudden increase in intraluminal aortic pressure occurs with the force of impact, which is called the "water hammer effect." [10]

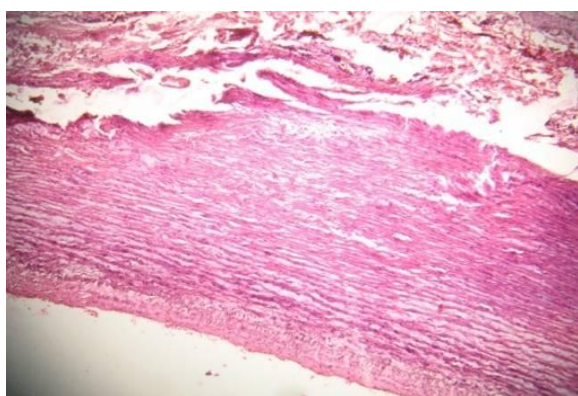
In the instant case, all of the above mechanisms may have acted together to produce laceration of the wall of the aorta. There was history of direct trauma to the chest by kicks from the assailant. The victim was seen to have been lying on the floor at the time he was being kicked, indicating that the chest would have been fixed, the back being supported by the floor. Presence of a bruise over the precordium as mentioned above makes it highly likely that kicks may have been perpendicularly directed with respect to the chest wall in a stamping – like action. This would cause antero posterior compression of the chest, traumatizing the ascending aortic aneurysm in accordance with the osseous pinch

mechanism, acting along with the “water hammer effect” mentioned above.

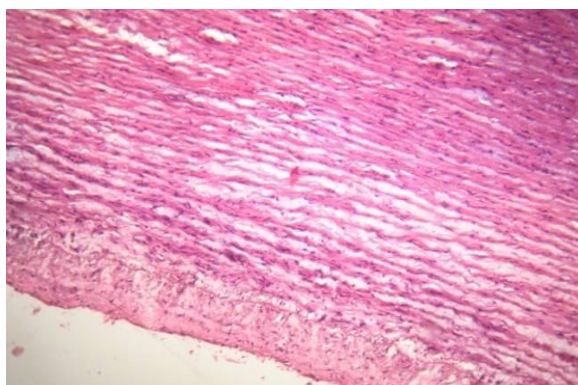
As the victim was pushed down a flight of stairs, sudden deceleration of the heart would have occurred, which would give rise to traction forces acting on the aorta, resulting in its rupture in accordance with the mechanism of differential deceleration.



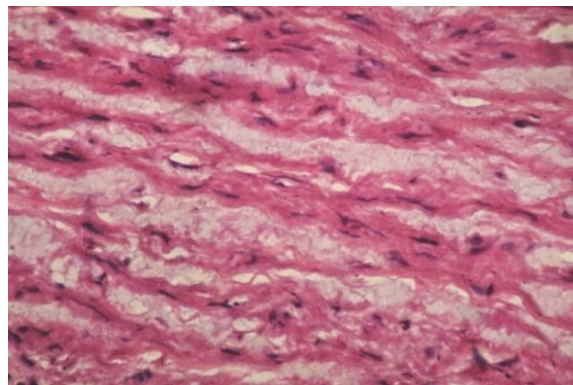
Photograph of the thorax showing Haemopericardium consequent to rupture of aortic aneurysm



Photomicrograph of the wall of aortic aneurysm showing cystic medial necrosis (Stained with H & E, x 5 magnification)



Photomicrograph of the wall of aortic aneurysm showing cystic medial necrosis (Stained with H & E, x 10 magnification)



Photomicrograph of the wall of aortic aneurysm showing cystic medial necrosis (Stained with H & E, x 40 magnification)

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Case report

Death Due to Swine Influenza -A Forensic Autopsy Report

*Dr. Manpreet Kaul, **Dr. Jagdish Gargi, ***Dr. Ashok Chanana, ****Dr. Rajeev Kumar Chaudhary

Abstract

A 29 year male who was working in army (soldier) at Pune, came to his house at Tarntaran (Punjab) on vacations to meet his family where he developed high grade fever, cough, dyspnoea, and was admitted in a private hospital. He was clinically suspected to be suffering from bilateral viral pneumonitis but the diagnosis of viral pneumonitis was never confirmed by laboratory tests in spite of admission in a hospital. Later on he died & the police was informed about his death. The police completed the inquest U/S 174CrPC & the dead body was shifted to the mortuary of Govt. Medical College, Amritsar for post mortem examination. A team of autopsy surgeons conducted the post mortem examination. The dead body was examined; nasal & pharyngeal swabs along with blood sample were taken from deceased and were sent to virology Deptt. , Post Graduate Institute, Chandigarh. The laboratory report mentioned the findings in favor of H₁N₁ virus & cause of death was declared as asphyxia as a result of viral Pneumonia (Species Swine Flu).

Key Words:-Soldier, Migration, Viral Pneumonia, Autopsy, H₁N₁

Introduction:

Swine influenza is also called Pig influenza, swine flu, hog flu and pig flu. Swine Influenza (swine flu) is a respiratory disease of pigs caused by type -A influenza viruses that causes regular outbreaks in pigs. Basically this is a disease of pigs, but human infections can and do happen. Swine flu viruses have been reported to spread from person-to-person. This transmission is limited in late March and early April 2009. Cases of human infection with swine influenza A (H1N1) viruses were first reported in Southern California and near San Antonio, Texas. [1] Perhaps to the best of our knowledge this is the first & only reported case till date from India in which in-spite of suffering from viral pneumonitis no attempt was made to confirm the diagnosis of H₁N₁ in the patient even if it was well known fact that Pune was a pandemic diseased area at that time & this was confirmed only after his death at autopsy examination by Forensic experts.

The disease is due to viruses from the type A of the Orthomyxoviridae family, (there are three types of Orthomyxoviridae, A, B and C). [1]

Corresponding Author:

*Deptt. of Forensic Medicine & Toxicology
Govt. Medical College, Amritsar
Email- kaulmanpreet@gmail.com
Ph. No.:- 9878014129
** Prof & Head
***Associate Professor
****Junior Resident
Deptt. of Forensic Medicine & Toxicology,
Govt. Medical College, Amritsar

Etiology of Swine Influenza is complex according to the high genetic variation of the causative viruses, mainly on two glycoprotein: haemagglutinin (H) and neuramidase (N). The known Swine Influenza virus strains include influenza C and the subtypes of influenza A known as H1N1, H1N2, H3N1, H3N2, and H2N3. [2]

Swine influenza virus is common throughout pig populations worldwide. Transmission of the virus from pigs to humans is not common. People with regular exposure to infected pigs are at increased risk of swine flu infection. The meat of an infected animal poses no risk of infection when properly cooked. Pigs are the main host. However, strains of swine influenza virus can also be directly transmissible to humans, and reciprocally. Swine influenza was responsible for the human outbreak in 1918-20 that killed more than 20 million people over the world (Spanish flu). [3]

Swine influenza was first proposed to be a disease related to human influenza during the 1918 flu pandemic, when pigs became sick at the same time as humans(4). The first identification of an influenza virus as a disease of pigs was established about ten years later, in 1930. [5] For the following 60 years, swine influenza strains were almost exclusively considered H1N1. Then, between 1997 and 2002, new strains of three different subtypes and five different genotypes emerged as causes of influenza among pigs in North America.

People who work with poultry and swine, especially people with intense exposures, are at increased risk of zoonotic infection with influenza virus endemic in these animals, and constitute a population of human hosts in which zoonosis and reassortment can co-occur. [6] Vaccination of these

workers against influenza and surveillance for new influenza strains among this population may therefore be an important public health measure. [7] Transmission of influenza from swine to humans who work with swine was documented in a small surveillance study performed in 2004 at the University of Iowa. [8] The transmission from swine to human is believed to occur mainly in swine farms where farmers are in close contact with live pigs. Although strains of swine influenza are usually not able to infect humans this may occasionally happen, so farmers and veterinarians are encouraged to use a face mask when dealing with infected animals.

The use of vaccines on swine to prevent their infection is a major method of limiting swine to human transmission. Influenza spreads between humans through coughing or sneezing and people touching something with the virus on it and then touching their own nose or mouth. Swine flu cannot be spread by pork products, since the virus is not transmitted through food.

The swine flu in humans is most contagious during the first five days of the illness although some people, most commonly children, can remain contagious for up to ten days. Diagnosis can be made by laboratory examination of the virus infected specimen or mucus or blood, collected from the patient during the first five days. [9]

When in such infected cases death is reported and inquest is held then autopsy surgeon should conduct postmortem examination as per universal work precaution for minimizing risk of exposure to blood & body fluids as mentioned below

Autopsy Procedures

In general, Standard Precautions should be used and safety procedures for human remains infected with novel influenza virus should be consistent with those used for any autopsy procedure. However, additional respiratory protection is needed during an autopsy procedure that generates aerosols (e.g., use of oscillating saws). It is prudent to minimize the number of personnel participating in post mortem examinations. [10]



Figure 1- Showing the Personal Protection Equipment Kit Supplied by Government



Figure 2- Showing Contents of Personal Protection Equipment Kit [Plastic Cover (1) containing Gown & Hood (2), one pair of Shoe Covers (3), One Face Mask (4), One Pair of Gloves (5), One Protective eye wear (6)]



Figure 3- N-95 Face Mask (Not Supplied with the PPE Kit)



Figure 4- Autopsy Surgeon wearing Personal Protective Suit



Figure 5- Vial containing Nasopharyngeal swabs

Personal protective equipment (PPE):

- Wear standard autopsy PPE, including a scrub suit worn under an impervious gown or apron, eye protection (e.g. goggles, face shield), double surgical gloves with an interposed layer of cut-proof synthetic mesh gloves, surgical mask or respirator, and shoe covers.
- Add respiratory protection if aerosols might be generated. This includes N-95 (Figure 3) disposable particulate respirators or powered air purifying respirator (PAPR). Autopsy personnel who cannot wear a disposable particulate respirator because of facial hair or other fit limitations should wear a loose-fitting (e.g. helmeted or hooded) PAPR.
- Remove PPE before leaving the autopsy suite and dispose in accordance with facility policies and procedures.

Engineering Controls:

- Whenever possible, perform autopsies on human remains infected with novel influenza A (H1N1) in autopsy settings that have adequate air-handling system. This includes a minimum of six (old construction) to twelve (new construction) air changes per hour (ACH), negative pressure relative to adjacent areas as per recommendations for airborne infection isolation rooms (AIIRs) and direct exhaust of air to the outside or passed through a HEPA filter if air is re-circulated. Exhaust systems around the autopsy table should direct air (and aerosols) away from health care workers performing the procedure (e.g., exhaust downward). For autopsies, local airflow control (e.g., laminar flow systems) can be used to direct aerosols away from personnel; however, this safety feature does not eliminate the need for appropriate PPE.
- Use containment devices whenever possible. Use bio-safety cabinets for the handling and examination of smaller specimens. When available, use vacuum shrouds for oscillating saws to contain aerosols and reduce the volume released into the ambient air environment.
- Protective outer garments should be removed when leaving the immediate autopsy area and discarded in appropriate laundry or waste receptacles, either in an antechamber to the autopsy suite or immediately inside the entrance if an antechamber is unavailable. Hand hygiene is recommended immediately after PPE removal.

Prevention of Percutaneous Injuries:

- Follow standard safety procedures for preventing percutaneous injuries during autopsy.

Case History:

The present case report relates to a 29 years old male military employ posted at Pune who came to his home at Tarntaran, Punjab on vacations to meet his family members. He suffered from high grade fever, cough, dyspnoea for 4-5 days & was admitted to private hospital where he was clinically diagnosed as case of viral pneumonitis, in spite of prevalence of Swine flu in his area & symptoms indicating toward viral disease, he was never tested for swine flu the reason best known to treating physician & after 5 day of treatment patient died.

The dead body was brought for postmortem examination, U/S 174 CrPC to the mortuary of Forensic Medicine & Toxicology department, Govt. Medical College, Amritsar, in December 2009. After going through the history of case and hospital record Postmortem examination was conducted after adhering to the universal precaution (fig.1-5).

Post mortem Examination:

External Finding: It was a dead body of a male 5'8" in length moderately built & nourished wearing apparels. Rigor Mortis was present throughout body. Post mortem staining was present on the back sparing areas of contact pressure, fixed & purplish in colour. Eyes and mouth were closed. No injury was found.

Internal Examination: Bilaterally pleurae were congested & adherent at places. On gross examination of both lungs patchy areas of reddish grey consolidation affecting lobes bilaterally were found (more involvement seen in lower lobes). On cut section patchy lesion of granules, firm, red grey raised above surface were present, on squeezing yellowish pink fluid exuding out. Generalize visceral congestion was present.

After completion of examination a sealed jar containing Heart, piece of each lung, liver, kidney (half each) in 10% formalin-saline solution were preserve for histopathological examination. Nasopharyngeal swab were taken in a vial containing viral transport media & blood samples were placed in a triple polythene cover & were covered in a plastic jar bearing a seal. This was kept in a vaccine carrier containing ice packs for maintaining cold chain. It was sent to department of virology Postgraduate institutes Chandigarh.

Histopathological Examination: showed following findings in lungs-Dilated alveoli filled with proteinaceous material and lined by thick hyaline membrane. In the interstitium, mononuclear infiltrate is seen.

Impression:- features are those of viral pneumonia.

Virology PGI Report: Nasopharyngeal swab was positive for H1N1 test.

Opinion:

After going through post mortem finding, virology report from Postgraduate institutes Chandigarh & pathology report cause of death declared in this case was asphyxia as a result of viral pneumonia (species swine flu) which was sufficient in ordinary course of nature to cause death.

Discussion:

Patient who had migrated from Pune to Punjab & experienced features of viral pneumonia remained under treatment in private hospital for 4-5 days but the clinical diagnosis was never confirmed by laboratory method and in spite of free laboratory testing facilities provided by state Govt. for detection of suspected swine influenza case.

In this case treating physician never suspected swine influenza infection in the said patient who was having undoubted history of migration from swine pandemic area & symptom pointing towards swine influenza infection, like high grade fever, cough & respiratory distress. Treating physician never bothered to collect & get blood & nasopharyngeal swabs examined for detection of swine influenza infection. The job of attending physician was ultimately accomplished by Forensic experts at the time of autopsy examination which lead to confirmation of swine flu (H1N1) viral infection which was too late.

If diagnosis of H1N1 viral infection had been confirmed by treating physician the patient would have been saved by giving specific treatment & there would have been no need of Medico-legal Autopsy. To the best of our knowledge this is first Autopsy report case of confirmation of death by swine flu (H1N1) viral infection in spite of the patient being admitted in the hospital where clinical diagnosis was never confirmed. So the author feel it need publication giving the guidelines to autopsy surgeon's of the due precautions to be taken at the time of post mortem examination & other related issues

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Case report

Suicidal Acid Injury: A Case Report

*Vijayanath.V, ** Raju.G.M, *** K.Nagaraj Rao, **** Anitha. M. R.

Abstract

Deaths from exposure to caustic substances are infrequently reported in the Forensic Medicine literature. A case of death due to Sulphuric acid ingestion in a patient of Major Depressive Disorder is being reported. This patient was planned for Electro-convulsive therapy, prior to the procedure he had been to bathroom. And when planned to prepare for the procedure on the ECT table, his mouth has smell of pungent odour. This made the psychiatrist to withhold the procedure and subjected him for observation. Later he complained of severe chest pain and restlessness, for which he has been shifted to emergency ward with possible precautions taken before shifting.

He was provisionally diagnosed of acid ingestion but there was no history either from patient or from his relatives, as patient has consumed in the bathroom just before the Electro convulsive therapy. Diagnosis was confirmed only after autopsy report. The legal issues concerning suicide in mentally ill patient, autopsy findings, forensic issues and Patho-physiology concerning death by acid ingestion have been discussed.

Key Words: Suicidal Acid injury; Major Depressive Disorder

Case Report:

An 18 year old, unmarried male youth gold smith by occupation reported to psychiatry OPD of a general hospital with complaints of severe suicidal ideas and suicidal gestures through hanging, sadness, loss of interest in work and daily activities, easy fatigability, lack of concentration, sleeplessness and lack of appetite of three weeks duration. He had approached a private psychiatric nursing home a day to prior to it. He was referred to the hospital due to his strong suicidal ideas. He was diagnosed to have severe Major depressive Disorder.

Physical examination revealed no abnormality. Patient was on empty stomach. Considering his strong suicidal ideas, ECT was planned. While making arrangements for administration of ECT patient was made to wait in the reception along with attendants. After a lapse of about half an hour he was taken on to ECT table. There the doctor smelt pungent odour, when the observation was "- continued patient became restless and was clutching his upper abdomen.

On enquiry he complained of burning in chest and severe pain abdomen in gastric region. His blood pressure was 130/ 70 mm of Hg, Pulse was 120 beats per minute, pupils were of midsize were non reactive. A tentative diagnosis of Acid Poisoning was done. He was given 2 egg albumin and 3 bananas. Patient was shifted to emergency ward. As the patient developed difficulty in breathing and became semiconscious he was put on assisted breathing through ventilator. The patient's condition gradually deteriorated and he died after 2 hours. An autopsy was performed 6 hours after the death.

Autopsy revealed extensive demarcated cutaneous burns on the inner aspect of the lips. The stomach was perforated, discolored and was disfigured. The liver and spleen were fixed to thoracic cage, hardened on their outer surface and were covered with approximately 2 cms of the firm gray tissue on the surface. Bilaterally, the hemi diaphragm, intercostals and psoas- muscles showed marked liquefaction. The pleural cavities were filled with a tar-like fluid along with black particles. Attempt of eviscerate the hollow organs resulted in their immediate dissolution. The kidney, pancreas and portion of the bowel had no features of the post mortem autolysis and their morphology was well retained. The gall bladder filled with bile, testes, prostate large arteries, brain, and spinal cord were not grossly affected. The blood in the heart and vessels was not clotted and still was in liquid state. Black liquid material in the stomach, blood, pleural fluid and viscera's were collected, sealed and sent to FSL. Report from Forensic laboratory: This mixture resulted from dissolution of the muscles lining the

Corresponding Author:

*Assistant Professor

Department of Forensic Medicine & Toxicology
S.S.Institute of Medical Sciences & Research Centre
Davangere- 577005, Karnataka (India)

E mail: drvijayanath@gmail.com

Contact No.; 91-99866-16961

**Department of Forensic Medicine & Toxicology
J.J.M. Medical College, Davangere-577004

***Prof. & HOD, Department of Psychiatry

****Assist. Prof. Department of Anatomy

inner aspect of the body cavities and presence of Sulphuric acid and pH of 2.5 in the plural fluid.

The majority of these gross changes were the result of post-mortem contact with the acid. The interval between the times of discovery of the victim and time of death was approximately about 5 hours. An additional 9 hours lapsed before the autopsy done. This allowed for continuous contact with the tissues for more than 14 hours. The formation of 3500 ml of highly acidic pleural fluid was most likely because of leaching of the acid from the digestive tract into the thoracic cavity where it dissolved muscular and connective support structures. Rapid cellular death, destruction of stomach and esophagus prevent histological examination to confirm the damage. The most noteworthy findings were a chemical test result which indicated the presence of Sulphuric acid and pH of 2.5 in the plural fluid.

Discussion:

Gimmon et al [1] recognize children, psychotics, and persons attempting suicide as being individuals most commonly involved in acid ingestion. Within the adult population, suicidal intentions are recognized as the commonest cause of sulfuric acid ingestion [2] as was in this case. The noteworthy point in this case was that the individual was suffering from severe major depressive disorder with strong suicidal ideas and despite constant attendance of attendants with the patient the patient managed to consume the acid. The ease of availability of acid with the goldsmiths contributed to selection of this mode of attempting suicide. The interval of time before death, known as lethal time, after acute ingestion of sulphuric acid is a LT min (minimum time after ingestion of fatal dose of poison that will cause death) of 30 Minutes and an LT50 (time in which 50% of persons will die after ingesting a fatal dose of a Poison) of 5 hours. [3]

The time before death in the present case was about 5 hours. When perforation does occur in those rare and severe cases, it may occur in a fasting state, and in those cases, is usually seen within 24 hours of ingestion. At autopsy, tissues may be gray-black in colour, hard and dry, and well demarcated. If enough heat had been generated, there may be subsequent charring. [4] When a strong acid ($\text{pH} < 2$) comes into contact with internal tissue, it causes coagulation necrosis, tissue disintegration and or ulceration of tissue. Coagulation necrosis produces rapid tissue changes which include consolidation of normally loose connective tissue, thrombosis of intramural vessels, ulceration, fibrosis, and haemolysis of erythrocytes. Sulphuric acid ingestion will lead to death by rapid cardiovascular collapse or shock Secondary to gastrointestinal tract rupture related chemical peritonitis. [5]

Acids can be highly irritative & unpleasant taste, which can lead to choking and gagging after ingestion. Choking and gagging leads to the acid coming into contact with glottic structures and chemical epiglottitic with airway compromise can result.[6] Individuals who attempt suicides by ingesting acid are typically conscious and lucid during the process, and as a result, concomitant aspiration pneumonia rarely occurs. When it occurs, it greatly increases the likelihood of death. [7]Unlike alkalis which cause severe injuries to esophagus without significant trauma to the stomach, acids conversely leave the esophagus relatively spared, but cause significant trauma to the stomach. [8] The findings of a tar-like fluid along with black particles in the pleural and peritoneal cavities call for explanation. One useful classification scheme groups chemicals according to how they damage protein; corrosives (sulfuric acid, hydrochloric acid etc.), reducing agents (ferrousion, sulfite compounds, etc.) desiccants (calcium sulfate, silica gel etc.), vesicants (sulfur mustard, etc) and protoplasmic (hydrazoic acid, etc) poisons. [9]

Conclusion:

Suicidal ingestion of sulfuric acid and other corrosive agents is uncommon but not rare. Exposure to human being produces characteristic set of injuries in those who survive long enough to develop a significant systemic response. Investigating officers & Physicians must keep these points in their mind regarding acid ingestion.

1. Acid ingestion kills a person very rapidly.
2. Those that die late, subsequent to acid exposure, a spectrum of predictable injuries are seen.
3. In those who died rapidly after ingestion of an acid, many of the autopsy findings may represent post-mortem artifact

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Review paper

Taser Technology: Medical, Legal, Ethical & Social Implications of Introduction of Taser Gun in India

*Richa Choudhary, **Imran Sabri

Abstract

A person struck by a taser gun experiences stimulation of his sensory and motor nerves, resulting in strong involuntary muscle contractions. This may lead to physiological changes similar to a moderate intensity exercise. The mechanism of action of Taser gun is Electro-Muscular Disruption (EMD) technology. Though Tasers are considerably safe, some incidents of injury and deaths have been reported. The primary cause of such deaths is found to be influenced by some underlying pathology or some external factor, rather than Taser itself. Recent introduction Taser gun as weapon in Indian police has raised various medico legal, social and ethical issues regarding the safety of using taser guns. In this article we have reviewed all the medical, Legal, Ethical and Social aspects of introduction of taser gun in India as weapon. It has been concluded that Taser is a proportionate, low risk weapon can be used to resolving incidents where the public or officers face severe violence or the threat of such violence which cannot safely be dealt with by other means.

Key Words: Taser, Electroshock Weapon, EMD (Electro Muscular Disruption), Neuromuscular Incapacitation, Sensory and Motor Nerves, Police, Weapon

Introduction:

A Taser is an electroshock weapon which uses electrical current to disrupt voluntary control of muscles. The base of activity of Taser is neuromuscular incapacitation of the person against which the gun is used. Amongst the various "less lethal" weapons like impact devices like baton, bean bags, rubber bullets; water cannons; tear gas or mace; electroshock devices like stun guns, stun grenades, and Taser guns (the latest variant of LLW), the Indian government has decided to introduce Taser in Indian Police as a substitute for the lethal firearms for controlling potentially dangerous and violent suspects and for controlling mob violence.

Taser was developed by Jack Cover a NASA scientist & is an acronym for a fictional weapon: Rifle. A Taser is an electroshock weapon which uses electrical current to disrupt voluntary control of muscles. The effect is "neuromuscular incapacitation" and the devices' mechanism "Electro-Muscular Disruption (EMD) technology". A person struck by a Taser experiences stimulation of his sensory nerves and motor nerves, resulting in strong involuntary muscle contractions.

Corresponding Author:

*Assistant Professor

Rural Institute of Medical Sciences and Research
Saifai, Etawah, U.P.

Email: drricha_c@hotmail.com

**Assistant Professor, S.N. M.C. Agra

At the present time, there are two main police models, the M26 and X26. Recently X3 model was introduced which can subdue three suspects without reload. The civilian model is called C2 which is used for self defense.



The Taser M26 and Taser X26

A single 5 s taser shot releases two probes, which carry muscle-locking electric pulses into the target, creating neuromuscular incapacitation. The incapacitation is immediate and unavoidable. Once the electricity flow stops, the subject immediately regains control of his body. The maximum range is about 35 feet.

Medical Aspects of Taser Use:

Generalized effects- Usually a five second exposure is given with one shot. There is no loss of consciousness during or after shock. But secondary injuries may occur due to fall after the use of weapon. The sharp metal probes may cause puncture wounds in the skin. However, they may cause severe injury on striking the eyes, genitals, superficial blood vessels etc. [1, 2, 3]

Cardiac Effects:

The Taser produces a current of 0.36 - 1.76 joules per pulse. This is generally not expected to affect cardiac conduction. No dysrhythmias have been reported in small studies of healthy volunteers, though cardiac dysfunction could occur in cases of people on pacemakers, mentally ill, drug abusers, epilepsy patients etc. [4, 5, 6]

Physiological Effects:

The Systolic blood pressure decreased while Diastolic blood pressures, heart rate, calcium, sodium, potassium, bicarbonate and lactate levels and blood pH changed slightly after a 5 second Taser exposure.[6]

The VE, RR, and TV were mildly elevated for a brief period; there was no metabolic acidosis induced hyperventilation.[7] The heart rhythm before, during & after taser exposure showed no adverse cardiac effects or rhythm changes.[8, 9]

Legal Issues:

Tasers are illegal or subject to legal restrictions on their availability and use in many jurisdictions. In India only licensed police officials, CRPF men and National Security Guards can use the Taser guns.

It is legal to use Taser or any force by the police if it is found reasonable as measured from the perspective of a reasonable officer at the scene.

The government has approved their use against individuals fighting against the police rather than on those who merely fail to comply with police commands. The proposed TASER use policy for the Indian Police Department would allow for the use of the TASER against an individual only if that person is actively resisting arrest or in circumstances where deadly force is authorized. [10]

Though use of tasers for personal security or self defense is legal in many countries, in India it is illegal to carry a taser for personal use.

Indian Scenario:

Indian Police and Central Reserve Police Force personnel in occupied Kashmir have been regularly using bullets and tear-gas shells to kill or injure peaceful pro-freedom protesters. The firearms have also killed a number of civilians during the anti-India demonstrations.

Indian state police forces and central security forces, which are conducting joint anti-Maoist operations, have signed contracts for Taser weapons with the Taser International. The Jammu and Kashmir is the first state in India to order and use Taser guns. Punjab has issued its police 80 of the weapons. Madhya Pradesh and the anti-hijack teams of National Security Guards are also likely to order the weapon.

Ethical Aspects:

The police officers or NSGs should focus on the use of negotiation techniques and should not over rely on Taser guns. They should use the Taser in those situations where use of lethal force is also permitted.

Taser should never be used on children, pregnant females, elderly, and heart patients having pacemaker, drug abusers, and mentally ill people. This is to avoid likelihood of injury and death. [11]

The officer using a taser gun should be properly trained in ethical use of force based on the scenario.

The purpose of Taser is to subdue violent and dangerous individuals. It should never be used solely for the purpose of inflicting punishment or pain.

Taser should only be used on dangerous individuals and never on those who are passively resisting arrest.[12] Various philanthropic societies like Amnesty International consider Taser as a form of torture, causing extreme pain and sometimes severe injury or even death of the person struck by Taser. [13]

Social Aspects:

Taser are guns are being used or overused in various developed nations throughout the world. Its recent introduction in Indian Law enforcement system may have a dual impact on the society. From the perspective of the police, Taser is a welcome thing, providing them extra security while dealing with hard core criminals or to disperse or sub due a violent mob. As far as Indian society is concerned, they may not like the idea of being tasered while doing protests against the government. If some incident of injury or death occurs due to Taser use, this may lead to further protests by the Human Rights Activists, against the use of taser. Besides, the law authorities should also be prepared for dealing with the compensation claims resulting from any accidental injury by the use this controversial gun.

Discussion:

Introduction of newer weapons in India is a matter of discussion. Taser gun is just an example of that. Many questions arise while using newer techniques in India. Acceptability of newer weapons depends on its outcome as well as social acceptance. The main aim of the police is to control the miscreants without or with minimum loss of life and injuries. Use of taser can be a better alternative to achieve this goal. A new weapon to be effective is to be well accepted socially also. The political intervention in use of newer techniques is also to be seen. An ideal weapon for the police is that achieves the target with minimum loss of life. Taser gun is medically good technique as it causes temporary incapacitation of the culprits with minimum effects on the body. Legally the Taser gun cannot be given in

public hands as they can misuse it. However police can be authorized to use it. Ethically taser can be used with some exceptions. Socially it may be not acceptable by the general public as is the case with other weapons also. Keeping all this in view the Taser gun is very close to an ideal weapon for the police is day to day mob control exercises.

Conclusion:

Thus we can say that introduction of Taser gun has got minimum medical dangers, least legal problems, ethically acceptable and socially sound. By using a Taser a dangerous assailant or violent mob could be controlled, thus preventing any injury or harm to law enforcement officers, innocent citizens, or themselves. This reinforces the value of Taser as a useful tool to make the public and officers safer and to resolve potentially violent situations effectively and rapidly. To conclude we'll say Taser is a proportionate, low risk means of resolving incidents where the public or officers face severe violence or the threat of such violence which cannot safely be dealt with by other means.

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Review paper

Aluminium Phosphide Poisoning: Management and Prevention

*Dr.S.Ranjan Bajpai

Abstract

Death by Aluminium phosphide (AIP) and organo-phosphide poisoning are the commonest forms of poisoning in India. Aluminium phosphide is used as rodenticide and pesticide in grain storage facilities. It produces phosphine gas, which results in mitochondrial poisoning. There is no known antidote for AIP poisoning. The effects of AIP poisoning, mediated by phosphine and mechanism of action have not been established. The information related to this poisoning is available in the literature and substantiated by practical experience. Liberated phosphine cannot be detoxified but Magnesium sulphate has been reported to be effective. Another remedy can be rapid absorption by coconut oil which might be helpful.

Treatment consists of gastric lavage with potassium permanganate solution, oral administration of charcoal and sorbitol suspension, intravenous administration of sodium bicarbonate, magnesium sulphate and calcium gluconate, and oral administration of sodium bicarbonate and coconut oil. Use of coconut oil for treatment in this poisoning is suggested, although clinical trials and scientific approval is still awaited. Every suggestion, news regarding new modality of treatment for this poisoning needs to be shared in the interest of saving precious human lives. It is with this aim the present paper is written.

Key Words: Aluminium Phosphide, Phosphine, Rodenticide, Pesticide

Introduction:

Agrochemical poisoning is a major public health problem in developing countries particularly in setting of low education and poor regulatory frameworks. Aluminium phosphide is a solid fumigant pesticide. It is marketed in India as tablets of celphos and quickphos. Aluminium phosphide has currently aroused interest with increasing number of cases in the past three decades due to increased use in agricultural and non-agricultural purpose; hence easy availability has increased its misuse to commit suicide.

Management:

Patients with Aluminium phosphide poisoning are managed conservatively as no specific antidote to the poison is known. The objective of the treatment is to provide symptomatic and supportive aid to the patients till phosphine is excreted through the lungs and kidneys.

A. Reducing absorption of phosphine:

- i. Gastric lavage with KMnO_4 (1:10000) or with magnesium sulphate (MgSO_4) to oxidise the unabsorbed poison.

- ii. Slurry of activated charcoal orally or through nasogastric tube to adsorb phosphine from the gastro intestinal tract.
- iii. Antacids, to reduce symptoms pertaining to the stomach and to reduce the absorption of phosphine through the stomach, H_2 antagonists can also be used.
- iv. Medicated liquid paraffin or MgSO_4 to accelerate the excretion of Aluminium phosphide and phosphine from the gastro intestinal tract.

B. Reducing Cellular Toxicity of phosphine:

Phosphine produces atmosphere of hypoxia and free radical stress by binding with cytochrome oxidase and by inhibiting catalase. Magnesium ions help in scavenging free radicals through GSH recovery hence is effective as parenteral antioxidant in this poisoning. Magnesium is anti-hypoxic and anti-arrhythmic agent, hence due to all its beneficial effects; it is effective in reducing the mortality in this poisoning. The dose schedule observed to be effective was 1 gm of MgSO_4 i. v. stat followed by 1 gm after every 4 – 6 hours, with magnesium levels remaining within safe limits (3 – 3.6 mEq.). Lower or higher dosages have not been observed to be much effective.

Liberated phosphine cannot be detoxified as there is no specific antidote available. Magnesium sulphate has been reported to be effective in reducing mortality but some workers had found no significant difference in dose related mortality rates in patients treated with and without MgSO_4 . In a study

Corresponding Author:

*Assistant Professor
Department of Forensic Medicine
A. J. Institute of Medical Sciences
Mangalore (Karnataka)
Email: sr.bajpai@rediffmail.com
Mobile No.: +91 - 9425301920

conducted by U.K.Singh et al. (1997), survival was better in patients who presented within 4 hours and i.v. MgSO_4 was started and the authors believe that MgSO_4 therapy should be instituted early in all patient(s) with Aluminium phosphide poisoning, based on serum magnesium levels, considering the high mortality of Aluminium phosphide and lack of specific antidote.

Magnesium sulphate has been tried with limited success for its general membrane stabilising effect in cardiac cells.

Sushil Kumar et al. (1990) report that shock and ECG changes in Aluminium phosphide poisoning cases could be reverted in large percentage of cases with larger doses of i.v. MgSO_4 , which raised the serum Mg levels to about 5.2 mEq/Lt.

Chugh et al. (1994) in a study on 155 patients of Aluminium phosphide poisoning studied the efficacy of magnesium sulphate in relation to dose of Aluminium phosphide ingested and concluded that the effect on is mortality related to the dose of pesticide consumed. They also observed that MgSO_4 reduced the mortality more or less equally, irrespective of the dose of pesticide consumed.

Siwach et al. (1994) have also observed that dose related mortality rates in patients treated with and without MgSO_4 are not significantly different. They estimated serum Magnesium at six points within first 24 hours and found no evidence of hypomagnesemia at any stage, they also observed that the chemical method of Mg^{++} estimation (especially titral yellow) may give low values in patients receiving calcium gluconate simultaneously and tissue Mg^{++} reflects more accurately total Mg^{++} status of the body in comparison to serum level alone. Magnesium estimation was done by them using atomic absorption spectrophotometer which is the more reliable method for Mg^{++} estimation. Magnesium content of various organs in non survivors and RBC Mg^{++} content along with serum level were estimated. Hypomagnesemia was not observed in any case. Magnesium content in the organs was observed to be significantly higher than control.

The authors also state that magnesium is weak antiarrhythmic agent and may be useful in controlling few supra ventricular arrhythmia and recommend use of more potent antiarrhythmic agent like Amiodarone and continued cardiac monitoring for timely control ventricular arrhythmias observed in Aluminium phosphide poisoning.

Siwach also report (1997) that correction of acidosis by slow infusion of sodium bicarbonate is very helpful. If blood gas analysis is possible, total base deficit may be calculated using the following formula.

Base deficit = $0.4 \times \text{body wt.} \times \text{desired } \text{HCO}_3^- - \text{measured } \text{HCO}_3^-$ (mEq).

(Desired $\text{HCO}_3^- = 25$ mEq/L) half of the calculated dose should be infused immediately and repeated doses calculated in every 3 hours. If blood pH improves with use sodium bicarbonate, it is associated with good prognosis.

C. Steps to increase phosphine excretion:

Phosphine is stable and is excreted through breath and urine. Adequate hydration, renal perfusion with IV fluid and low dose dopamine (4 to 6 micro gm/kg/min) enhances the excretion through urine. Diuretic in presence of BP 70 – 80 mm Hg may be useful.

Dialysis is indicated in cases with acute renal failure if the patient is haemodynamically stable. Supported measures in the treatment of Aluminium phosphide poisoning include treatment of hypoxia by oxygen inhalation or endotracheal intubation or assisted ventilation along with monitoring of blood gases. Treatment of shock with 3 to 4 liters of 0.9 % saline in first 8 to 12 hours, low dose dopamine with dobutamine, hydrocortisone 200 to 400 mg I/V after 4 to 6 hours to reduce dose of dopamine to check the capillary leakage in lung and to potentiate the responsiveness of shock to endogenous catecholamines. Hydrocortisone also compensated for low levels of cortisone found in this poisoning.

Prevention:

Since death is rapid and survival after significant poisoning is rare, prevention is the logical option. The most effective way for prevention is to either ban or impose strict regulation on the sale of aluminium phosphide tablets.

Cageing of tablets in smaller plastic with holes and spikes so that they can't be swallowed as such, is likely to reduce the incidence of Aluminium phosphide poisoning.

Preventive measures have been classified by Chug et al. under following headings:

I. Prophylaxis during and after fumigation at home and outside:

- Protect the copper containing parts before fumigation.
- Do not fumigate the grains when temperature is below 5°C .
- Adequate washing facility should be available at times during handling.
- Eating, drinking, smoking should be prohibited during and before washing after handling.
- During fumigation, operator must be given efficient respiratory protection.
- Complete the distribution of tablets within limited time.
- In warehouses, person should not sleep in the room fumigated.

- h. Wear synthetic rubber gloves, boots, light weight impervious clothes, apron, and suitable eye protectives during fumigation and at the time of opening the container.
- i. Always open the container in air.
- j. Do not inhale dust or fumes of fumigated grains.
- k. Use of phosphine detectors strips before entering a fumigated area.

The optimum temperature for fumigation is 15°C to 20°C and humidity 63.7 %. When fumigated grains is exposed to air for half an hour, the whole phosphine gets dissipated rapidly and the cereals become fit for consumption. Phosphine in humid air is oxidised and becomes non-toxic.

II. Education:

Farmers handling the fumigant must be made aware of its lethal aspects. They should demand the required amount of tablets. They should be advised to bury the tablets in open fields after use. They should keep their tablets away from the reach of children and other family members.

III. Advice to Government Agencies:

State agencies should restrict the open sales of this pesticide. The tablets should not be given to young persons and children without proper verification and confirmation. Dealers not following the Government instructions should be punished. The manufacturers should be advised to make small packs of 2 – 3 tablets with suitable container. If possible the pesticide should be banned.

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Review Paper

Serum Enzymes Changes after Death & Its Correlation with Time since Death

*Dr. S. P. Garg, **Dr. Vidya Garg

Abstract

Estimation of time since death is one of the primary objectives of an autopsy. Forensic Scientists and researchers have been persevering hard to find out methods of accurate determination of postmortem interval since long. However, the concept of “Postmortem Clocking” so far seems to be a distant dream only. The favorite biological fluids, to study postmortem biochemical changes, have been those which withstand putrefactive changes for longer duration, like vitreous humor, cerebrospinal fluid, pericardial fluid etc. In blood, markers like electrolytes, urea, creatinine, glucose etc have been more commonly studied. Enthusiastic studies have been undertaken by various researchers to find out reasonably reliable methods of estimating postmortem interval by studying serial quantitative changes in serum levels of various enzymes and to extrapolate the data obtained therefore in terms of duration of death. However, the accuracy of such an opinion remains big area of concern even today, as the range of duration is mostly too wide to be practically useful.

Key Words: Time since death, Serum enzymes, Amino Transferases, Acid Phosphatase

Introduction:

The estimation of time since death is most important yet most inaccurate & controversial topics in Forensic Medicine.[12]When calculated accurately, it has the potential to unravel many unfolded medico-legal mysteries. The estimation of time since death by whatsoever means or methods relies on changes that occur in the body after death [10]. Autopsy surgeons continue to rely on age old subjective methods of observing the degree and chronological staging of external as well as visceral postmortem somatic changes like cooling of the body, rigor mortis, changes in the eyes, hypostasis, signs of decomposition, mummification, adipocere formation, maggot infestation etc corroborated with circumstantial evidences for the same.

Review of Literature:

Little has changed from the ancient days, except that the data acquisition equipment then was merely the back of the hand to test the coolness of the corpse's skin and their eyes & nose to evaluate decomposition, we now have multichannel thermometry with thermocouples sensitive to a fractions of a degree, enzyme methods, vitreous chemistry, muscular reactivity and several other avenues for collecting data.

Corresponding Author:

* Associate Professor,

Department of Forensic Medicine

E-14, Doctor's Colony, Rewa (MP) 486001

E-mail:shashidhar_garg@yahoo.com

Mobile: 094254-70383

**Assistant Professor, Department of Physiology
Bundelkhand Medical College

Regrettably, the accuracy of estimating the postmortem interval has by no means kept pace with the enormous strides made in technological sophistication [13]. Hence the estimation of time since death continues to be a difficult task for the Forensic Pathologist [19] and there is a continuous need for the development of an accurate method by which the time of death can be determined to within a few minutes.

The first thing to recognize is that an estimate based merely on the changes in the body after death is liable to serious error [9], highly inaccurate [4] and only an approximation can be achieved if proper observations are made from the beginning [19], [16]. K S N Reddy [22] goes to the extent of saying that that exact time of death cannot be fixed by any method. However Jung wrote of Columbus that “using subjective assumptions, a false hypothesis and a route abandoned by modern navigation nevertheless (he) discovered America [9].

Several studies have been undertaken to find out objective methods such as biochemical, histological, serological assays etc involving variety of biological fluids & tissues. In the past enthusiastic studies have been undertaken by various researchers to find out some such methods by studying serial quantitative changes in serum levels of various enzymes and to extrapolate the data obtained therefore in terms of duration of death. However, the accuracy of such an opinion is a big area of concern, as the range of duration is mostly too wide to be practically useful.

The favorite biological fluids, to study postmortem biochemical changes, have been those which withstand putrefactive changes for longer

duration, like vitreous humor, cerebrospinal fluid, pericardial fluid etc than blood. The available literature on biochemical (enzymal) changes in postmortem blood (serum) and its relation with time since death is largely contributed by forensic scientists from the temperate countries. Nandy [17] cautions that the values of such studies may not be usefully applicable in our country over a vast area as the decomposition is much advanced by 3rd/4th day after death. Pillay[21] is of opinion that though a lot of research work has been undertaken to estimate the time since death based on biochemical changes in various body fluids after death, they are mostly only of academic interest. They are of limited practical value.

Transaminases/ Aminotransferases:

Several authors and scientists have reported a definite & progressive rise in the levels of transaminases in serum of the dead body as the time since death increases but the most elaborate study has been done by Hall [11], Enticknap [6] and Coe [3]. Parikh C. K. [19], Modi JP, Subramaniam B. V. [16], K S N Reddy [22], Simpson [23] and Biswas[2] have reported definite rise in these enzymal levels after death but do not offer any details regarding estimation of time since death from such results. However, Mukherjee [15] & Nandy [17] report the rising trend of serum aminotransferase levels up to second to third day of death and opine that such calculations are too erratic and asymmetrical to be of any help in anything like "Postmortem Clocking".

Evans [7] establishes the initial rise of transaminase activity of three to four hours after death and there was a fairly steady climb to high levels until about sixty hours postmortem (also reported by B Knight [13]), when diminution activity commenced.

Hall [11] reported a large, rapid postmortem increase in SGOT in intracardiac blood but found little elevation of the level in femoral blood from clinically well patients who died abruptly.

Enticknap [6] showed a striking progressive increase in SGOT levels in blood from arm vessels. The level rose from nearly nil to about 10 µm per ml per hour after 4 hours and then the curve became less steep so that a about 18 hours after death the level was about 15 µm per ml per hour. The graph then became nearly horizontal up to 30 hours after death when again the graph line rose steeply to register the peak at about 55 hours after death at the level of about 28 10 µm per ml per hour. From this point the level kept on falling till about 66 hours. He observed that such a trend of change can be used to estimate time since death.

Acid Phosphatase:

Parikh C. K. [19], Modi JP, Subramaniam B. V. [16], K S N Reddy [22], Simpson [23] and

Biswas [2] have reported definite rise in these enzymal levels after death. Garg et al [16] while reporting rise in serum levels with increasing postmortem interval, did not find any statistically significant correlation.

Nandy [17]& Dixit [5] reported peak level in between 36 to 48 hours after death, while Mukherjee [15] noted the rising titre in the first two to three days after death. Reddy [22] reports 20 times increase in Acid Phosphatase level in 48 hours after death.

Enticknap[6] reported rise of serum Acid Phosphatase level from just more than nil just after death to 2.5 King Armstrong unit at 18 hour postmortem then there was transient fall up to 30 hours after death (15 KA Units). Again the enzymal levels registered rise so that at 40 hours the peak was attained at 40 kA unit level and finally the levels fell till 50 hours time at 25 kA units and remained at the same level for well beyond 60 hour time after death.

Alkaline Phosphatase:

Naumann [18] pointed out that Alkaline Phosphatase level reached average concentration of 5.3 Bodansky units in 14 cases 10^{1/2} hours after death (normal antemortem range 1.5 to 4 Bodansky unit). Enticknap [6] used King Armstrong unit and showed that the concentration rose from 8 kA units just after death to 40 kA units after 30 hours and then rose steeply up to 40 hours when it recorded a peak of 70 kA units and afterwards fell downwards. Coe [3] opined that the concentration almost doubled and tripled 8 & 18 hours after death respectively.

Amylase:

Enticknap [6] demonstrated that amylase levels after death showed double peaks or a biphasic rise. It rose steeply from 100 Somoghiunit just after death to 350 units 6 hours after death, and then it declined to the level of 150 units after 30 hours and again registered a peak of more than 350 units 40 hours after death and finally dropped to 200 unit level after 50 hours of death. Reddy [22] reports 3 to 4 times increase in amylase level on second day after death.

Lactate Dehydrogenase:

Enticknap [6] studied changes in Lactate Dehydrogenase levels in serum after death and found that there was almost linear increase in concentration of this enzyme up to well over 60 hours and he suggested that peak may not be attained until fourth day and because of linear rise it may be useful in calculating time since death. Lythgoe [14] did not find a linear relationship in rise in enzyme activity. He suggested that the rise was in three phases. First being a rapid rise immediately after death, then a slower increase up to 30 hours postmortem and then final rise probably reflecting the onset of vascular hemolysis.

Esterase including Cholinesterase:

Petty et al [20] found no significant difference in true blood Cholinesterase level between refrigerated and non refrigerated samples and no significant decrease in activity in samples periodically analyzed up to three weeks after death.

Arnason and Biarnason [1] studied total serum esterase by starch gel electrophoresis on postmortem sera obtained from ¼ hour to 720 hours after death. Out of 5 fractions found in living individuals, several fractions disappear in postmortem serum, one fraction becomes stronger, continuing to increase in strength for at least 1000 hours after death, and at least one new fraction develops which is not found in serum from living patents.

Phosphoglutamutase:

Dixit PC et al [5] studied the relationship of Phosphoglutamutase in postmortem blood with time and cause of death. They concluded that the estimation of time since death depends upon many factors, including environmental conditions.

Stability of Enzymes after Death:

Generally speaking it is best to do enzyme assays within four hours from time of blood collection. All enzymes can be stored overnight at 0-4°C, but Acid Phosphatase may not keep satisfactorily at room temperature. Aldolase and Alanine Aminotransferase are unstable when frozen at -25°C but keeps all right at 4°C.

Effects of Anticoagulants:

Anticoagulants inhibit some enzymes so serum is preferred to plasma. Citrate inhibits amylase; fluoride inhibits many enzymes while Ethylene DiamineTetraacetic Acid inhibits phosphatase. Heparin has been recommended if plasma is to be used but has been said to inhibit creatine kinase and Lactate Dehydrogenase. Oxalates also inhibit several enzymes.

Effect of Hemolysis:

As Red Blood Corpuscles (RBCs) are much richer than the plasma in several enzymes, it is necessary to avoid hemolysis. Also on storing some leakage of enzymes may occur from red cells, leukocytes and platelets. The early separation of serum should be done. However exceptions do exist like Glucose 6 Phosphate Dehydrogenase and Acid Phosphatase.

Garg et al [8] observed that increasing hemolysis of postmortem blood with greater postmortem interval seems to be the single most important confounding factor giving erroneously high values with photoelectric colorimetry. Definite and marked rise in serum enzymal levels after death was noted by them from 2 hours after death onwards.

They also noted that in many cases with increasing time since death enzyme levels register

increasing values but interspersed cases show such abnormality and non regular high or low values that deciphering the graphical pattern thus drawn involving two variables in terms of time since death seems unwisely. The refrigerated bodies and samples gave abnormally low values. The cases dying of multiple injuries involving trauma to liver showed markedly high levels. An interesting finding was that in burn cases the graph was relatively more linear. They summarized that the conventional and routinely used subjective parameters like rigor mortis, hypostasis, cooling of the body, putrefactive changes etc. combined with the experience, acumen and "third eye" of the medicolegal expert and circumstantial evidence remain to be the best available tools for estimation of time since death.

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Review Paper

A Review of Medicolegal Consequences of Gossypiboma

*Monika Garg, **Akash Deep Aggarwal

Abstract

Foreign bodies forgotten in the abdomen include towels, artery forceps, pieces of broken instruments or irrigation sets and rubber tubes. The most common surgically retained foreign body is the laparotomy sponge. Such materials (textilomas or gossypibomas) cause foreign body reaction in the surrounding tissue. The complications caused by these foreign bodies are well known, but cases are rarely published because of medico legal implications. The diagnosis of gossypiboma and the second surgical operation needed for removal of medical problem can lead to start of legal problem between the patient and the surgeon at fault. The medico legal consequences of gossypiboma are significant. Patients may be inadvertently informed that masses might be malignant and may undergo unnecessarily invasive investigations, procedures or operations. Gossypiboma may lead to disappointing and undesired consequences for a surgeon; moreover, it is one of the significant medico-legal problems needs to be solved by specialists of forensic medicine.

Key Words: Gossypiboma, Retained, Sponge, Foreign Body, Legal

Introduction

Forgotten or missed foreign bodies, such as cotton sponges, gauze or instruments, after any surgical procedures are considered a misadventure and is associated with several legal problems. The term “gossypiboma” denotes a mass of cotton retained in the body after any intervention. [1] This term is derived from the Latin gossypium for “cotton” and the Swahili word boma for “a place of concealment.” Other terms used for gossypiboma include “textiloma”, “cottonoid”, “cottonballoma” “muslinomas” or “gauzeoma”. Gossypiboma was rarely reported in literature and the reports of this technical oversight are the tip of an iceberg because the symptoms of gossypiboma are usually nonspecific and some patients remain asymptomatic and are never discovered or documentation is not enough in some diagnosed cases. Data concerning the incidence of gossypiboma tend to fluctuate and the incidence of gossypiboma is difficult to estimate because of a low reporting rate lest medico-legal implication. [2]

PubMed reveals about 300 reported cases of gossypiboma worldwide, out of which about 15 from India. Whilst the date of the arising out of first malpractice suit about gossypibomas was reported to be 1933 in medical literature, this date was reported to be 1897 by some medical authors who researched court records and located judgments. [2]

Some textilomas cause infection or abscess formation in the early stage, whereas others remain clinically silent for many years. Most cases of textiloma in the literature have been connected with abdominal or thoracic surgery; very few have been linked with spinal surgery. Although precautions are taken to avoid leaving such materials behind, mistakes do happen and the resultant foreign bodies can cause various clinical and radiological manifestations. In the early period after surgery, these forgotten materials can lead to infections and abscess formation. However, some remain clinically asymptomatic for many years, and then cause a foreign body reaction in the surrounding tissue, with new clinical signs indicating significant mass effect. Foreign bodies that are left behind during operations may organize and increase in size but such changes are not correlated with time. To date, the case reported with the longest period from surgery to manifestation of symptoms is an intrapulmonary foreign body 43 years after thoracotomy. Civil lawsuits brought against surgeons for surgical complications are becoming more frequent, and this is prompting surgical teams to be even more careful. It is possible to overlook cotton and gauze pads in the surgical field. [3]

The medico-legal consequences of gossypiboma are significant. Patients may be inadvertently informed that masses might be malignant and may undergo unnecessarily invasive investigations such as angiography and unnecessarily radical extirpative surgery. [4]

Corresponding Author:

*Assistant Professor, Pathology

**Assistant Professor, Forensic Medicine

Post Graduate Institute of Medical Sciences, Rohtak,

E-mail: monikakash7@yahoo.co.in

Case illustration:

A 41 year old multi-parous lady presented with pain in abdomen, nausea and vomiting since 3 days and inability to pass stool and flatus since 2 days. The only positive point in her history was an abdominal hysterectomy done two months back. Vital signs were normal except distension of abdomen on examination. All routine investigations were normal. Radiology was inconclusive. Exploratory laparotomy revealed omentum with adherent sallow cotton gauze piece measuring 10 cm x 8 cm x 2 cm, which was removed. Microscopically, the section showed mild fibrosis and granulomatous inflammation with massive multinucleated foreign body type of giant cell infiltration, around the omentum. In the central portion, the whorled stripes of gauze fibres were also seen. Post operative course was uneventful.



Figure 1: Photograph showing the post-operative specimen of the gossypiboma – gauze piece adherent with omentum

Discussion:

Retained surgical sponge or gossypiboma in the abdominal cavity is an infrequent but serious surgical complication that may lead to medicolegal problems. The condition has not been very frequently reported due to possible medicolegal concerns. Surgical sponges are made of cotton that does not stimulate any specific biochemical reaction except adhesion and granuloma formation. They may be a cause of an asymptomatic condition for a long time. The clinical presentation of gossypiboma is variable and depends on the location of the sponge and the type of reaction. Gossypiboma can have two different types of body responses: exudative and aseptic fibrous. Retained sponges may cause no adverse effects in patients and may remain undiscovered for decades. Alternatively, retained sponges may lead to serious sequels, including sepsis, intestinal obstruction, fistulization, perforation and its complications may lead to death with the death

incidence ranging from 15 to 22 %. [2, 5, 6] Inadvertent retention of a foreign body in the abdomen often requires another surgery to recover the material. This increases morbidity and mortality. [7]

It is not easy to say whether cases of gauze left in the abdomen are always due to a real lack of quality on the part of the surgeon or of the theater nurse. Moreover it has been reported that the interval between the probable causative operation and the diagnosis of retained gauze may range from 11 days to 28 years. [8]

In such cases, the diagnosis of gossypiboma and the second surgical operation needed for removal of medical problem can lead to start of legal problem between the patient and the surgeon at fault. In this situation, even if a medical doctor is reluctant for diagnose gossypiboma and reporting a colleague to juridical authorities, the reporting of criminal acts to juridical authorities was defined a responsibility in the penal codes in Turkish Penal Code (Article 280). According to rule, if a healthcare behaves contrary to this responsibility, he/she may face penal sanctions. Gossypiboma was reported as the classic example of medical negligence in which an expert failed to achieve the standard of care required. Standard care is defined to be a care needed for a medical doctor who has same situations and same conditions in consideration of scientific and technique developing level of medicine science, labor conditions, and educational level of medical doctor. [2]

The occurrence of a retained object, such as a surgical sponge, following completion of an operation is the classic example of medical negligence in which an expert to establish the standard of care is not required. It can also rely on a *res ipsa loquitur* or common knowledge approach. There is little question that the standard of care has been breached. However, there can be a heated controversy over who committed the breach. While these cases are difficult, the surgeon can be exonerated or shown to be a minor player in this unfortunate drama. Regrettably, this has the consequence of pitting defendants against each other in the course of the case. Furthermore, in some jurisdictions, the surgeon is held responsible for the errors of other members of the surgical team. [9, 10]

Foreign bodies retained in the peritoneal cavity after surgeries are rarely documented owing to medical, legal and other reasons. Each such incidence acquires major importance because of excessive media hype nowadays which can jeopardize the reputation of a surgeon amongst his professional colleagues and public at large. What happens as in the present case when there is reversal of events i.e. all clinical and radiological features points toward the suspicion of retained intraabdominal foreign body but on reoperation no foreign body is found? This case is

being reported to emphasize the fact that even when there is high index of suspicion for a retained intraabdominal foreign body, the reoperation may be carried out by explaining the indication of resurgery different rather than retained foreign body, as incisional hernia in the present case, to avoid unnecessary embarrassment. [11]

Because these cases are avoidable and frequently injurious, many lead to malpractice claims; given the high likelihood of litigation after such cases, most liability insurers also encourage clinicians and hospitals to report them. Therefore, we used malpractice-insurance files from several institutions to identify cases. Malpractice claims and reports are an imperfect representation of the true incidence and nature of any complication. Some cases of retained foreign bodies undoubtedly did not result in either a claim by a patient or a report by the physician to the insurer. The factors involved in such cases may differ from those in the cases we studied. However, we know of no reason why they would differ in terms of the mechanism of causation. In addition, these mishaps appear to have a high likelihood of leading to litigation, given how injurious and potentially avoidable they are. [12]

It is clear in most recent publications that the rate described is grossly underestimated; reasons for this are related to the possible medico-legal implications, the fear of litigation which could end up in heavy expenses for compensations and adverse publicity for institutions and surgeons; in fact, it is clear that the responsibility of the surgeon and members of the team in the Operation Theatre could be called in case of litigation. Concerning the medico-legal aspect, the local laws define responsibilities and compensation mechanism following what is described as medical negligence; but, despite the fact that all our patients and/or their relatives were informed of the findings, none of our cases resulted in malpractice claim! No rate of retained foreign body can be considered "acceptable" whatever the environment and conditions of work; their consequences in terms of morbidity and mortality can still be too heavy and costly. Their management will still rely for a long time on prevention because in almost all cases, it could be related to human errors; this type of errors will probably never be completely abolished, but the incidence of retained surgical sponge can be reduced to a "minimum" by strict adherence to regulations, especially systematic and rigorous sponge count; this is particularly important during emergency procedures. [13]

In medical literature, there are few articles about the medico-legal evaluation of gossypiboma. One such case from Turkey reports that, the court inquired about possibility of life threatening situation, organ weakness, and fertility. The experts concluded

that the retained sponge was related to procedure and was a serious complication and amounted to medical malpractice and it threatened the life of victim, but did not cause to organ weakness or infertility. [2]

According to the theory of loss-of-chance, the damage of plaintiff is the loss of the chance of survival or recovery; and there would be compensation for this loss. The preexisting condition and the effect of the doctor's tortuous conduct attach within a relatively short time, the burden of providing the extent to which the preexisting condition influenced the health of the patient should be shifted to the doctor. [14]

The claims about medical negligence can be usually subject to trials in both of penal judgment and compensation trial. Gawande et al reported that, in 47 cases from 1985 to 2001 in USA, claims resulted in an average of \$52,581 in costs for compensation and legal-defense expenses. Kaiser et al [15] demonstrating a prevalence of 40 cases from 1988 to 1994 in USA, with an expenditure of \$572,079 for defense costs and \$2,072,319 in indemnity payments, indicate that the issue about retained surgical sponge may reflect a more widespread and significant problem than generally is expected.

A falsely correct gauze count happens in 76% of the re-operated cases. Nevertheless, since this figure derives mainly from forensic literature or from the insurance companies, it may well be that it does not reflect the real incidence of the phenomenon. If all such cases were openly reported, the incidence would most certainly be higher and could be listed among the other possible surgical complications, which though impossible to eliminate completely, and that this could lead to a considerable change in medico-forensic attitudes towards the problem.

In spite of continual improvement in surgical procedures and the technical evolution aimed at protecting patients in the operating theatre, published data report that the problem of residual foreign bodies after surgery is still unresolved and, furthermore, the scarcity of reports regarding this event, probably due to the inevitable medico-forensic implications, means that its incidence is still underestimated. It is therefore to be hoped that cases of retained surgical gauze in the abdomen will be constantly reported in the medical literature in future, in order to make a real estimate of the incidence of this event, to standardize recommended procedures for avoiding it, but above all, in order to modify the medico-forensic implications of the phenomenon. [16]

In some countries, medical negligence cases are often commenced as criminal proceedings, as cases of manslaughter or personal injury. To avoid gossypiboma-related troubles, the operating room team must pay thorough attention to detail, surgical sponges should always be counted at least twice, one

by one (once preoperatively and once postoperatively), radiopaque filaments should be used, the surgeon should completely explore the abdominal cavity before closing the peritoneum, and, if there is doubt about the count of sponges, intraoperative abdominal x-ray must be performed. [2]

Conclusion:

Retained surgical sponge can lead to significant medical and legal problems between the patient and the doctor. It may be incorrectly diagnosed preoperatively, which can lead to unnecessary invasive diagnostic procedures and operations. [17] Possible excuses given for sponge retention are emergency surgery, unexpected change in the surgical procedure, disorganization, hurried sponge counts, long operations, unstable patient condition, inexperienced staff, inadequate staff numbers, and patient with high body mass index; but these cannot be allowed to prevail. [2] Patient-clinician and clinician-radiologist interactions and compliance enhance the possibility of accurate diagnosis. [18] In spite of the diagnostic and therapeutic difficulties, the presence of a foreign body inside the patient can be easily proved and the patient may litigate the responsible surgeon because this is an avoidable problem [19] and the surgeon will face charges of negligence. [20]

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Review paper

Broder Scope of COPRA, 1986 & Medical Profession

*Dr. Mukesh Yadav, **Dr. Pooja Rastogi

Abstract

Negligence is the breach of a duty caused by the omission to do something which a reasonable man, guided by those considerations which ordinarily regulate the conduct of human affairs would do, or doing something which a prudent and reasonable man would not do. The definition involves three constituents of negligence: (1) A legal duty to exercise due care on the part of the party complained of towards the party complaining the former's conduct within the scope of the duty; (2) breach of the said duty; and (3) consequential damage. Cause of action for negligence arises only when damage occurs; for, damage is a necessary ingredient of this tort.

Hon'ble Supreme Court Bench comprising B.N. Agrawal, P.P. Naolekar & Dalveer Bhandari, pronounced a Judgment on **May 8, 2007** on this issue. Other relevant decisions of various Consumer Forums including National Consumer Disputes Redressal Commission are discussed. This paper will help in enlightening medical fraternity on new dimensions of scope of COPRA 1986, meaning and interpretations of term 'service', 'consumer' and 'jurisdiction'.

Key Words: Service, Consumer, Negligence, Legal Duty, Breach of Duty, Damage

Introduction:

In the current scenario, consumer's rights as related to health services need to be addressed and defined precisely. The issues like disregarding for medical ethics, medical negligence, modalities of medico-legal cases, responsibility and accountability of health care professionals and institutions in case of grievances.

Former Judge of Supreme Court Hon'ble Justice V.R. Krishna Ayer has suggested (**Indian express, 26-4-1993**) that "Justice to medical profession is equally important. Every grievance should not lead to prosecution or suit for damages. The Court has to take care to insist on a preliminary screening by other experts before considering the guilt or otherwise of the doctor in question. It is right to say that a board of high-placed medical persons should be consulted before proceeding to punish doctors who are charged with dereliction of duties."

From time to time Supreme Court of India including various High Courts and Consumer Courts broaden the scope of Consumer Courts by redefining the meaning of terms 'service', 'consumer', etc.

Corresponding Author:

*Prof. & HOD,

Forensic Medicine & Toxicology

School of Medical Sciences & Research, Sharda

University, Greater Noida, G.B. Nagar, U.P., PIN:

201308

Mob. No. 9411480753, 0120-2326060

Email: drmukesh65@yahoo.co.in

**Associate Professor

Recently in the month of July 2010 State Consumer Dispute Redressal Commission, New Delhi added new dimension to the definition of 'Consumer' which needs debate for the benefit of medical fraternity and public in large to save the deteriorating patient-doctor relationship. Recent decisions of various courts and consumer forum are dealt with in detail in this study.

Free treatment by Private Doctors brought under COPRA, 1986:

In a case before SCDRC, New Delhi "It was argued by the counsel for Doctor Manocha that since he was a private doctor and there was no payment or promise to pay there was no relationship of consumer and service provider between the two, and as such the Consumer Protection Act 1986 will not be applicable".

However in view of the finding of the Hon'ble Supreme Court as noted above this objection is unsustainable because the Supreme Court has mentioned that the obligation of every doctor whether a Govt. or otherwise for protecting life is a paramount obligation and is total and absolute.

Article 141 of the Constitution of India says that the laws laid down by the Supreme Court will be binding on all. The decision of the Supreme Court casts an absolute liability even on a private doctor to save life and in that manner he becomes a service provider to a dying and injured person who is in need of urgent medical help and the injured person becomes a consumer within the meaning of the Consumer Protection Act 1986. Besides, the remedy under the Consumer Protection Act 1986, it is an

additional remedy and compensation in such matters can therefore be claimed there under. [Para 19]

Every patient has a right to get treatment in case of emergency:

Recently Delhi SCDR Court on 12th July 2010 made following observations:

The Universal Declaration of Human Rights has recognised the inherent dignity and the equal and inalienable rights of all members of the human family. The rights of the patients have developed on the concept of fundamental dignity and equality of all human beings. The World Medical Association declaration on the right of the patient (Amended by the 47th World Medical Association General Assembly Bali Indonesia Sept. 1995) represents the principle rights of patients that should be recognised and respected by physicians and health care institutions. They are as follows:

“(i).....

Every patient has a right to get treatment in case of emergency.

(x).....” [Para 20]

Consumer Court emphasized that Rule No.III of the aforesaid declaration which mentions that every patient has a right to get treatment in case of emergency.

- The case of the injured person in hand was a case of emergency.
- He had a right of treatment.
- A doctor was there at hand, who could render first aid and save life, but he turned his face the other side and refused to render first aid.

Court further emphasized that “There was as such violation of this specific condition and in this manner also liability is cast on Doctor Manocha”. [Para 22]

India is a signatory to this declaration and this declaration is therefore binding on India. These conditions have therefore the Force of Law and are enforceable. It has been clarified by the Supreme Court in the case of PUCL Vs Union of India 1997-1-SCC 301 that Rules of International Law which are not contrary to Municipal Law shall be applicable in India. [Para 21]

On the issue of Compensation:

As regards the quantum of compensation awarded by District Forum against Doctor Manocha, Court observed “we are not inclined to accept the plea of his counsel that the compensation is excessive and oppressive”.

Court further added “No amount of compensation can be considered as adequate where life is lost, because fatalities are irreversible. Looking into the enormity of callousness, displayed by the doctor the compensation can in no way be deemed excessive”.

Court concluded on this issue and the appeal of Orchid Hospital was allowed and the award made against it by the District Forum is set aside while the award made by the District Forum against Doctor Manocha is maintained and his appeal stands dismissed.

Facts of ESI Case:

The appellant was insured with the respondent-**Employees' State Insurance Corporation (ESIC)** and his contribution towards the insurance scheme under the **Employees' State Insurance Act, 1948** ("the ESI Act") was being deducted regularly from his salary and deposited by his employer with the Corporation. In **1993**, the appellant's wife was admitted in the **ESI dispensary at Sonapat, Haryana** for her treatment for diabetes. However, the condition of his wife continued to deteriorate. Para 1] [1]

As alleged by the appellant, there were instances when the doctors were not available even during emergencies. Later, the appellant got his wife medically examined in a private hospital.

The tests done revealed that his wife had been diagnosed incorrectly in the ESI dispensary; and that the deterioration in the condition of the appellant's wife was a direct result of the wrong diagnosis. The appellant filed a complaint under the Consumer Protection Act, 1986 ("the CP Act") before the District Consumer Disputes Redressal Forum seeking:

1. **Compensation towards mental agony, harassment, physical torture, pains, sufferings and monetary loss for the negligence of the authorities;**
2. **Direction for removal of, and improvement in, the deficiencies; and**
3. **Direction for payment of interest on the amount of reimbursement bills.** [Para 1] [1]

Objections raised by The ESI Corporation:

The Corporation raised certain preliminary objections, namely,

- (i) That the complaint filed is **not maintainable in the District Consumer Forum** and is liable to be dismissed as the wife of the complainant was **treated in the ESI dispensary, Sonapat, which is a government dispensary and the complainant cannot be treated as a consumer;** and
- (ii) That the **complainant is not a consumer within the definition of 'consumer' in the CP Act** and he is not entitled to file a complaint against the **ESI dispensary.**

It was also contended that the **facility of medical treatment in government hospital cannot be regarded as a 'service' hired for consideration,**

apart from the other defenses raised in the written statement. [Para 1] [1]

The District Consumer Forum relied on the ratio of a case [3] [Birbal Singh v. ESI Corporation, 1993 II CPJ 1028], wherein on a complaint filed for compensation for being aggrieved by poor medical attention received by the late wife of the complainant at an ESI hospital, the Haryana State Commission had held that the complainants did not come within the ambit of the definition of 'consumer' under the CP Act because of the gratuitous nature of the medical services provided. On this basis, the District Forum held that the services rendered by the ESI dispensary are gratuitous in nature and, therefore, out of the purview of the CP Act. [Para 2] [1]

Appeal was preferred to the Haryana State Consumer Disputes Redressal Commission and it was urged by the appellant that ESI is a scheme of insurance and hence the service rendered by the Corporation was not gratuitous. The State Commission relying on the judgment in a case [3] [Birbal Singh (supra)] and [4] [Indian Medical Association v. V.P. Shantha and Others, (1995) 6 SCC 651] held that free medical services were not covered by the CP Act and upheld the judgment of the District Forum.

Appellant preferred a revision before the National Consumer Disputes Redressal Commission, but the same was also dismissed in limine. Hence, appeal by special leaves preferred before the Hon'ble Supreme Court. [Para 2] [1]

Questions for consideration by the Supreme Court:

By second counter affidavit filed in August, 2000, the respondent-Corporation has also raised the question of the jurisdiction of a consumer forum. The respondent contended that by virtue of Section 75 of the ESI Act [2], the dispute raised by the appellant is covered and is to be decided by the Employees' Insurance Court established under Section 74 of the ESI Act [2] and it being a special Act the jurisdiction of the consumer forum is ousted. [Para 3] [1]

From the decisions rendered by the District Forum, the State Commission and the National Commission, and the questions raised by the appellant and the respondent, the question that falls for our consideration is two-fold:

1. Whether the service rendered by an ESI hospital is gratuitous or not, and consequently whether it falls within the ambit of 'service' as defined in the CP Act, [14]?

2. Whether Section 74 read with Section 75 of the ESI Act, [2] ousts the jurisdiction of the consumer forum as regards the issues involved for consideration? [Para 4] [1]

It is contended by the learned counsel for the appellant, that in the case of IMA [4] although it was held that the free medical service was not covered under the CP Act, includes any medical service given under the scheme of insurance within the scope of the CP Act and, therefore, the claim made by the appellant squarely falls within the jurisdiction of the consumer forum, the appellant being a consumer and the respondent's dispensary having rendered a service to him for consideration. [Conclusion No. (11) in Para 55] [4] [Para 5] [1]

Meanings and interpretations of term 'consumer':

The definition of 'consumer' in the CP Act [14] is apparently wide enough and encompasses within its fold not only the goods but also the services, bought or hired, for consideration. Such consideration may be paid or promised completely or partly under any system of deferred payment and includes any beneficiary of such person other than the person who hires the service for consideration.

The Act being a beneficial legislation, aims to protect the interests of a consumer as understood in the business parlance. The important characteristics of goods and services under the Act are that they are supplied at a price to cover the costs and generate profit or income for the seller of goods or provider of services. The comprehensive definition aims at covering every man who pays money as the price or cost of goods and services. However, by virtue of the definition, the person who obtains goods for resale or for any commercial purpose is excluded, but the services hired for consideration even for commercial purposes are not excluded. [Para 7] [1]

Meanings and interpretations of term 'service':

The term 'service' unambiguously indicates in the definition that the definition is not restrictive and includes within its ambit such services as well which are specified therein. However, a service hired or availed, which does not cost anything or can be said free of charge, or under a contract of personal service, is not included within the meaning of 'service' for the purposes of the CP Act [14].

A three Judges Bench of Apex Court in case of IMA [4] has extensively considered the provisions of the CP Act and particularly what shall be a 'service' within the meaning of Section 2(1) (o) of the said Act. The Court was considering whether the service rendered by the doctors would fall within the purview of the CP Act, it being a service rendered for the charges; and whether the patients, who are treated by the doctors, are 'consumers' as defined in Section 2(1)(d) of the CP Act. The Court said that the definition of 'service' in Section 2(1) (o) can be split into three parts: the main part, the inclusionary part

and the **exclusionary part**. The **main part** is **explanatory in nature** and defines service to mean service of any description which is made available to the potential users. The **inclusionary part** expressly includes the provision of facilities in connection with banking, financing, insurance, transport, processing, supply of electrical or other energy, board or lodging or both, housing construction, entertainment, amusement or the purveying of news or other information, whereas the exclusionary part excludes rendering of any service free of charge or under a contract of personal service. **The exclusionary part** in Section 2(1) (o) excludes from the main part service rendered (i) free of charge; or (ii) under a contract of personal service. The expression '**contract of personal service**' in the exclusionary part of Section 2(1) (o) must be construed as excluding the services rendered by an employee to his employer under the contract of personal service from the ambit of the expression 'service'. [Para 8] [1]

Meanings and interpretations of terms 'contract of service' and a 'contract for service':

There is a distinction between a '**contract of service**' and a '**contract for service**'. A '**contract for service**' implies a contract whereby one party undertakes to render service e.g. Professional or technical service, to or for another in the performance of which he is not subject to detailed direction and control and exercises professional or technical skill and uses his own knowledge and discretion, whereas a '**contract of service**' implies **relationship of master and servant** and involves an obligation to obey orders in the work to be performed and as to its mode and manner of performance. **A contract of service is excluded for consideration from the ambit of definition of 'service' in the CP Act**, whereas a **contract for service** is included. As regards service rendered free of charge under Section 2(1) (o), the **Court held that the medical practitioners, government hospitals /nursing homes and private hospitals / nursing homes, who render service without any charge whatsoever to every person availing of the service would not fall within the ambit of 'service' under Section 2(1)(o) of the Act**. The payment of a token amount for registration purposes only would, however, not alter the position in respect of such doctors and hospitals, but the service rendered for which charges are required to be paid by everybody availing the service would fall within the purview of the expression 'service' as defined in Section 2(1)(o) of the Act. [Para 8] [1]

On the issue of Doctor-Patient Relationship:

The Court held that the **relationship between a medical practitioner and a patient carries within it a certain degree of mutual confidence and trust** and, therefore, the **service rendered by the medical practitioners can be regarded as a service of personal nature**, but since there is no relationship of master and servant between the doctor and the patient the contract between the medical practitioner and his patient cannot be treated as a contract of personal service and **it is a contract for service** and the **service rendered by the medical practitioner to his patient under such contract is not covered by the exclusionary part of the definition of 'service' contained in Section 2(1) (o) of the CP Act**. [Para 8] [1]

In paragraph 55 of the judgment, the Court summarized its conclusions. We are really concerned in this case with conclusions Nos. (9), (10), (11) and (12). Conclusion No. (9) Is in regard to the service rendered at a government Hospital / health center / dispensary where no charges whatsoever are made from any person and they are given free service, which would not be a service under Section 2(1)(o) of the CP Act. [Para 8] [1]

Conclusion No. (10) Lays down that where the **service is rendered at a government hospital /health center / dispensary on payment of charges and also rendered free of charge**, then it would fall within the ambit of the expression '**service**'. [Para 8] [1]

Conclusion No. (11) says that if a patient or his relation availed of the service of a medical practitioner or hospital / nursing home **where the charges for consultation, diagnosis and medical treatment are borne by the insurance company**, then such service would fall within the ambit of service. [Para 8] [1]

Similarly, under conclusion No. (12), where **as a part of the conditions of service the employer bears the expenses of medical treatment of an employee and his family members dependent on him**, then the service rendered by a medical practitioner or a hospital / nursing home would not be treated to be free of charge and would constitute 'service' under Section 2(1) (o). [Para 8] [1]

In the case of **Laxman Thamappa Kotgiri [5] [v. G.M. Central Railway & Ors., 2005 (1) Scale 600]**, where an employee of the railways had filed a complaint on the ground that his wife had been negligently treated at a hospital of the Central Railway as a result of which she had died, the State Commission concluded that since the hospital had been set up to treat railway employees predominantly and the service provided was free of charge it did not come within the definition of 'service' under the CP Act and hence the complaint was not maintainable. On appeal to the National Commission, the judgment

of the State Commission was upheld and the appeal filed by the employee was rejected. Thereafter, appeal was preferred to this Court. [Para 9] [1]

Allowing the appeal, Supreme Court has held as under:

"There is no dispute that the Hospital in question has been set up for the purpose of granting medical treatment to the Railway employees and their dependents. **Apart from the nominal charges which are taken from such an employee, this facility is part of the service conditions of the Railway employees.** V.P. Shantha's case [4] has made a distinction between non-Governmental hospital / nursing home where no charge whatsoever was made from any person availing of the service and all patients are given free service (vide Para 55(6) at page 681) and services rendered at Government Hospital / Health Centre / Dispensary where no charge whatsoever is made from any person availing of the services and all patients are given free service (vide Para 55(9) on the other hand and service rendered to an employee and his family members by a medical practitioner or a hospital / nursing home which are given as part of the conditions of service to the employee and where the employer bears expenses of the medical treatment of the employee and his family members, (paragraph 55(12) on the other. [Para 6] [5]

In the first two circumstances, it would not be free service within the definition of the Sec. 2(1) (o) of the Act. In the third circumstance it would be. [Para 6] [5]

Since it is not in dispute that the medical treatment in the said Hospital is given to employees like the appellant and his family members is part of the conditions of service of the appellant and that the Hospital is run and subsidized by the appellants employer, namely, the Union of India, the appellant's case would fall within the parameters laid down in paragraph 55(12) of the judgment in V.P. Shantha's case [4] and not within the parameters of either Para 55(6) or Para 55(9) of the said case". [Para 7] [5] [Para 9] [1]

Further, the appellant has brought to our notice a judgment of this Court in the case of **Regional Provident Fund Commissioner** [6] [v. Shiv Kumar Joshi, (2000) 1 SCC 98], wherein the **Employees' Provident Fund Scheme, 1952** [7], framed under **Section 5** of the **Employees' Provident Fund Act** came for consideration of the Court and the **Court held** [Para 10] [1]

"A perusal of the Scheme unambiguously shows that it is for consideration which is applicable to all those factories and establishments covered under the Act and the Scheme who are required to become a member of the fund under the Scheme." The contribution of the employee has to be equal to the

contribution payable by the employer in respect of such employee. [Para 11] [6]

The words "**in respect of**" are significant as they indicate the liability of the employer to pay his part of the contribution in consideration of the employee working with him. But for the employment of the employee there is no obligation upon the employer to pay his part of the contribution to the Scheme. The administrative charges, as required to be paid under **Para 30 of the Scheme** are also paid for consideration of the employee being the member of the Scheme and for the services rendered under the Scheme. **It is immaterial as to whether such charges are deducted actually from the wages of the employee or paid by his employer in respect of the member-employee of the Scheme working for such employer.** It cannot be held that even though the employee is a member of the Scheme, yet the employer would only be deemed to be a consumer for having made payments of the administrative charges. ..." [Para 11] [6] [Para 10] [1]

Meanings and interpretations of 'Jurisdiction' of COPRA:

The Hon'ble Court observed that on a plain reading of the provisions of the ESI Act, [2] it is apparent that the **Corporation is required to maintain and establish the hospitals and dispensaries and to provide medical and surgical services. Service rendered in the hospital to the insured person or his family member for medical treatment is not free**, in the sense that the expense incurred for the service rendered in the hospital would be borne from the contributions made to the insurance scheme by the employer and the employee and, therefore, the principle enunciated in conclusion No. (11) in Para 55 in the case of Indian Medical Association (supra) will squarely apply to the facts of the present case, where the appellant has availed the services under the insurance policy which is compulsory under the statute. Wherever the charges for medical treatment are borne under the insurance policy, it would be a service rendered within the ambit of Section 2(1) (o) of the CP Act. **It cannot be said to be a free service rendered by the ESI hospital / dispensary.** [Para 13] [1]

The **service rendered** by the medical practitioners of Hospitals / nursing homes run by the ESI Corporation **cannot be regarded as a service rendered free of charge.** The person availing of such service under an insurance scheme of medical care, where under the charges for consultation, diagnosis and medical treatment are borne by the insurer, such service would fall within the ambit of 'service' as defined in Section 2(1) (o) of the CP Act. We are of the opinion that the service provided by the ESI hospital/dispensary falls within the ambit of 'service' as defined in Section 2(1) (o)

of the CP Act. ESI scheme is an insurance scheme and it contributes for the service rendered by the ESI hospitals/dispensaries, of medical care in its Hospitals / dispensaries, and as such service cannot be treated as gratuitous. [Para 14] [1]

Hon'ble Court further observed that "We shall now proceed to consider the second question raised by **Shri Vijay K. Mehta**, the learned counsel for the respondent that by virtue of Section 74 read with Section 75, and particularly Section 75(e), of the ESI Act, the claim made by the appellant would exclusively fall for decision within the jurisdiction of the Employees' Insurance Court and that being the position the consumer forum has no jurisdiction to adjudicate upon the issue. [Para 15] [1]

It has been held in numerous cases of this Court that the jurisdiction of a consumer forum has to be construed liberally so as to bring many cases under it for their speedy disposal. In the case of **M/s. Spring Meadows Hospital [8] [and Another v. Harjol Ahluwalia and Another, AIR 1998 SC 1801]**, it was held that the CP Act creates a framework for speedy disposal of consumer disputes and an attempt has been made to remove the existing evils of the ordinary court system. The Act being a beneficial legislation should receive a liberal construction. In another case [9] **[State of Karnataka v. Vishwabarathi House Building Co-op. Society and Others, AIR 2003 SC 1043]**, the Court speaking on the jurisdiction of the consumer fora held that the provisions of the said Act are required to be interpreted as broadly as possible. These judgments have been cited with approval in another case **[Para 16, 17] [10] [of the judgment in Secretary, Thirumurugan Cooperative Agricultural Credit Society v. M. Lalitha and Others, (2004) 1 SCC 305]**.

The trend of the decisions of this Court is that the jurisdiction of the consumer forum should not and would not be curtailed unless there is an express provision prohibiting the consumer forum to take up the matter which falls within the jurisdiction of civil court or any other forum as established under some enactment. [Para 17] [1]

The Court had gone to the extent of saying that if two different fora have jurisdiction to entertain the dispute in regard to the same subject, the jurisdiction of the consumer forum would not be barred and the power of the consumer forum to adjudicate upon the dispute could not be negated. [Para 17] [1]

The submission of the learned counsel for the respondent is that the claim made by the appellant before the consumer forum raises a dispute in regard to damages for negligence of doctors in the ESI hospital / dispensary and would tantamount to claiming benefit and the amount under the ESI Act provisions and would fall within clause (e) of Section

75(1) and, therefore, it is the Employees' Insurance Court alone which has the jurisdiction to decide it. We are afraid that we cannot agree with the submission made by the learned counsel. Section 75 provides for the subjects on which the jurisdiction shall be exercised by the Employees' Insurance Court. Clause (e) of Section 75(1) gives power to the Employees' Insurance Court to adjudicate upon the dispute of the right of any person to any benefit and as to the amount and duration thereof. The benefit which has been referred to has a reference to the benefits under the Act, i.e., the ESI Act.

The "ESI Rules" [11] have been framed in exercise of the powers under Section 95 of the ESI Act [2]. **Rule 56 [11] provides for maternity benefits, Rule 57 [11] for disablement benefits, Rule 58 for dependents' benefits, Rule 60 [11] for medical benefits to insured person who ceases to be in an insurable employment on account of permanent disablement and Rule 61 for medical benefits to retired insured persons. Thus, these are the benefits which are provided under the Rules to the employees and the ex-employees for which claim can be made in the Employees' Insurance Court.** The appellant's claim has no relation to any of the benefits which are provided in the Rules for which the claim can be made in the Employees' Insurance Court. **The appellant's claim is for damages for the negligence on the part of the ESI hospital / dispensary and the doctors working therein.** [Para 18] [1]

A bare perusal of the provisions of clauses (a) to (g) of Section 75(1) [2] clearly shows that **it does not include claim for damages for medical negligence**, like the present case which we are dealing with. Although the question does not directly arise before us, we shall consider what in the ordinary course shall constitute negligence. [Para 19] [1]

Summary and Conclusions:

Therefore, the claimant has to satisfy three ingredients of negligence before he can claim damages for medical negligence of the doctors and that could not be a question which could be adjudicated upon by the Employees' Insurance Courts which have been given specific powers of the issues, which they can adjudicate and decide.

Claim for damages for negligence of the doctors or the ESI hospital / dispensary is clearly beyond the jurisdictional power of the Employees' Insurance Court. An Employees' Insurance Court has jurisdiction to decide certain claims which fall under sub-section (2) of Section 75 of the ESI Act.

A bare reading of Section 75(2) also does not indicate, in any manner, that the claim for damages for negligence would fall within the purview of the decisions being made by the

Employees' Insurance Court. Further, it can be seen that any claim arising out of and within the purview of the Employees' Insurance Court is expressly barred by virtue of sub-section (3) to be adjudicated upon by a civil court, but there is no such express bar for the consumer forum to exercise the jurisdiction even if the subject matter of the claim or dispute falls within clauses (a) to (g) of sub-section (1) of Section 75 or where the jurisdiction to adjudicate upon the claim is vested with the Employees' Insurance Court under clauses (a) to (f) of sub-section (2) of Section 75 if it is a consumer's dispute falling under the CP Act. [Para 20] [1]

Having considered all these aspects, Court was of the view that the appellant is a consumer within the ambit of Section 2(1) (d) of the CP Act, 1986 [14] and the medical service rendered in the ESI hospital / dispensary by the respondent Corporation falls within the ambit of Section 2(1) (o) of the Consumer Protection Act and, therefore, the consumer forum has jurisdiction to adjudicate upon the case of the appellant. Court further hold that the jurisdiction of the consumer forum is not ousted by virtue of sub-section (1) or (2) or (3) of Section 75 of the Employees' State Insurance Act, 1948. [Para 21] [1]

SCDR made it clear that doctor has to attend the emergency irrespective to fees paid or not by the patient or relative and render at least first aid, stabilise the patient and the person reaches the proper expert as early as possible, failing which he may be sued under the Consumer Court for deficiency in service to the patient.

Court further added "No amount of compensation can be considered as adequate where life is lost, because fatalities are irreversible. Looking into the enormity of callousness, displayed by the

doctor the compensation can in no way be deemed excessive".

Court concluded on this issue and the appeal of Orchid Hospital was allowed and the award made against it by the District Forum is set aside while the award made by the District Forum against Doctor Manocha is maintained and his appeal was dismissed. Copy of this judgment was sent to the Medical Council of India for such action against Doctor Manocha if any, as may be considered appropriate.

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Review paper

Medical Audit and Death Audit

*Somnath Das, **Surendra Kumar Pandey, ***Prabir Chakraborty

Abstract

A good death is not a single event; a good death is a series of events, relationships and preparation that takes place over time (Evans and Walsh, 2002). [1] There is no gold standard for what constitutes a good death, the definition varies between individuals and therefore quality care must be negotiated to incorporate the individual patient values and preferences (Steinhauser et al, 2000). [2] Death audit meetings are infrequent in Government hospitals in India to analyse the circumstances which led to death of patients and what are the possible steps if taken might have prevented the death (Times of India 2004). [3] Medical audit determines the quality of medical care provided to patients from analyzing the clinical records and hospital services. In the present article we have given Idea about history, purpose, and maintenance record and analysis process. Government is planning to make infant and maternal death audit by clinical team compulsory as a part of efforts to ensure that no women and child will died in state (Andhra Pradesh) in want of medical attention (The Hindu 2010). [4]

Key Words: Medical Audit, Death Audit, Maternal Death, Infant Death, Clinical Records

Introduction:

It was Mac Eachern who stated, "That financial deficiencies can eventually be met but medical deficiencies may cost lives & loss of health which can never be retrieved. The aspect of 'dealings' in medical care, along with examination & verification in a hospital is termed as medical audit". The main objective of evaluation of medical care in retrospect through qualitative analysis of clinical records, including analysis of hospital services is a simpler way to look into the meaning of Medical Audit. In relation to this another term "Death Audit" came in to force, which means a technique or process of quantitative death record analysis & compiling the information pertaining to the professional activities of the hospital, as well as the qualitative analysis & evaluation of the data so collected.

Corresponding Author:

**Assistant Professor

Department of Forensic Medicine,

Institute of Medical Sciences,

Banaras Hindu University

Varanasi -221005 Uttar Pradesh

Email: pandeyskforensic@gmail.com

*Assistant Professor

Department of Forensic & State Medicine,

Midnapore Medical College, Paschim Medinipur

West Bengal

***Assistant Professor

Department of Forensic & State Medicine

Bankura Sammilani Medical College

Bankura, West Bengal

History of Medical Audit and Death Audit:

The history of medical audit dates back to 18th century in England where the system came in to force for the first time. In India however, the process is slow and apart from some specified area of maternal mortality or infant mortality medical or death audit is truly lacking.

Purpose:

The primary purpose of such an audit is to elevate the quality & efficiency of medical care, & for so doing, to seek the cause for poor results.

Pre Requisites:

- **Formation of a Committee:**

When a committee is chosen to audit the records, major departments should be represented & there should be rotation of members to give various persons an opportunity to contribute to the programmer. Of course, the members must be experienced physicians who have good judgment & are frank, fearless, & without prejudices. Essentially among the members of the committee there must be one Forensic Expert, a Pathologist and the Doctor who was in charge of the patient during his or her treatment.

- **Medical Record Librarian:**

A trained medical record librarian with a good background of medical knowledge is essential to carry out medical accounting or quantitative case record analysis, which is the first step of death audit. In the absence of such a person it is considered that an intern or a house surgeon should be able to supervise & guide the staff to carry out the analysis.

• **Medical Record:**

Last, but the most important item is the source of information for medical audit, i.e. the medical record kept by the hospital. These must be complete & accurate, for obviously, analysis or an audit can be no better than the medical records from which it is compiled. However, sooner the audit is established, realizing that their records are being scrutinized, better will be the physicians' records.

Mechanics of the Audit:

1. Preparatory Phase:

- See the completeness, accuracy, & adequacy of components of the record.
- Agreement or lack of agreement between provisional & final diagnosis and that cause of death identified by the Post Mortem Examination, i.e. the history & physical findings & the end results;
- Whether the final & pathological diagnosis and the cause of death agree;
- Whether a consultation was requested or not, and if so, recorded or not.
- Whether P.M. Examination was done or not and what was the result.

2. Analysis of Recorded Data:

- The other phase of the death audit is the actual analysis of the recorded data in the clinical records, the field reports pertaining to the professional work of the hospital & other related information. These are of two kinds:-
 - (i) External (ii) Internal

3. Duties of the Committee:

- i) To detect possible errors in diagnosis, treatment, judgment or technique.
- ii) To check the statement of prognosis & results (discharge or death). If he agrees with the statement of the physician he will approve the record for indexing; if disagrees, the committee will:
 - a) Confer with the attending physician & arrive at a decision.
 - b) Return the records to the physician for elaboration & correction, or
 - c) If the results are entirely out of line (confirmed by P.M. Examination), make necessary suggestions & recommendations so that the error is not repeated.
- iii) To indicate if a case is of educational value for inclusion in the staff meetings.
- iv) After the auditor or the audit committee has finished with the record, it is sent to the medical record librarian for filing.

Before filing, the observation of audit is transferred to the physician's index card, & also indexes for diseases & death are prepared.

Methodology of Medical and Death Audit:

- 1) **Criteria Development:** Criteria development for the audit depends on the indications for admission, hospital services recommended for optimal care, range of length of stay & indications for discharge, & complications or cause of death.
- 2) **Selection of Cases with Diagnosis**
- 3) **Post Mortem report statement regarding the cause of death**
- 4) **Worksheet preparation**
- 5) **Case evaluation**
- 6) **Tabulation of evaluation**
- 7) **Presentation of reports**

Criticism:

Poor result may be due to:

- Incompetent administration of the hospital
- Inadequately equipped physical plant
- Lack of essential supporting services
- Lack of competent personnel
- Poor technical support after P.M. examination

Conclusion:

It should be remembered that patient care includes elements that may be examined objectively or subjectively or both. The objective elements can be measured by statistical documentation & analysis to serve as a point of departure from which qualitative judgment can be made, where as the subjective elements require qualitative judgment through clinical evaluation. Continuous evaluation provides stimulation for improvement of clinical services, professional education, hospital administration & better patient care. Medical and Death audit, when practiced together can go long way in improving the quality of patient care in our hospitals, which at present is far below the expectation of the community.

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