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## From the Editor's Desk

# JIAFM

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Dear Friends,

*It gives me great pleasure to present the 4th and the last Issue of 2018 to the Hon'ble Members of the Academy. I wish to thank all the authors and contributors of the scientific material published in this issue. I am thankful to all the members of the Editorial Board and the reviewers for the immense support in getting the Journal Published. Every person does this task in addition to his professional job and commitments. My Special thanks to Joint Editor Prof Manish Nigam and Drs. Amandeep Singh & Mandar R Sane, for their selfless devotion to the Journal.*

*These three years, the Editorial Team has strived hard, to the best of their capacity, despite the tight schedule of their respective departments and institutes to improve the standard of the Journal and the Journey is still continuing. The progress made by the Journal has been documented in the Editorial of this issue. We request you to spare some time and go through it.*

*Any suggestions for further improving the quality of the Journal are most welcome.*

*Jai Hind & Long Live IAFM*

*Dr. Dasari Harish  
Editor*

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**In the Governing Council page, the name of the Treasure of the Academy, Prof. S. K. Dadu. was inadvertently written as Prof . S. K. Daddu. The Editorial Team sincerely appolozises for the same.**

## Editorial

# Progress of the Journal of the Indian Academy of Forensic Medicine

<sup>1</sup>Dasari Harish, <sup>2</sup>Manish Nigam

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### ***Dear Friends, Colleagues and Esteemed Members of the Family of the Academy,***

First and foremost, we wish to put on record our heartfelt and sincere thanks for your faith in us and giving us the opportunity to serve the Academy as its Editor and Joint Editor. These three years and through the 12 issues that we have brought out, we have strived hard to live up to your expectations. We were helped in this endeavour by many colleagues from all over the country, both in the official capacity as the Reviewers and informally. We have had tremendous support from our two members of the editorial team - Drs. Amandeep Singh & Mandar R Sane, Associate & Assistant Professor, respectively, of the GMCH, Chandigarh. We are indebted to all of them.

We have made several changes in the Journal in our endeavour to further upgrade the standard of our reputed Journal. The first was to **improve the content of the manuscripts** being submitted. This was done through:

- Publishing a detailed "Instructions to the Authors", which specified how to frame various manuscripts and their word and reference limits. The proper way of writing references (Vancouver Style) was also explained with examples. A "Contributor's Form" was also included, wherein all the authors define their roles, agree to the "No Conflict of Interest" clause and then transfer the rights of the manuscript to the Journal.
- Constituting a 'Panel of Reviewers' and developing a detailed 'Reviewer's Performa', to guide the reviewers in properly and thoroughly completing their assignments on time. The manuscript, along with the

remarks of the reviewers would then be sent to the corresponding author to get the corrections done. The corrected manuscript would again be sent to the reviewers for final review.

- The manuscript, once okayed by the reviewers would then be corrected for grammar and syntax errors, Bibliography errors, etc.
- The photos, tables, graphs, etc. have been placed adjacent to the text, so that the article becomes more reader friendly.
- Font of both the Text and the Bibliography have been enhanced, photos and charts have been printed in colour.
- Once every year, the complete list of the Reviewers is published for information to all.
- Plagiarism detection software was tried on some of the manuscripts. Free credits were offered by one of the vendors for us to test the software. However, the software is costly and further negotiations have to be carried out.

The Editorial Team applied for indexing with the PUBMED. After preliminary assessment of the Journal's issues, the team from PUBMED instructed us to make several changes and then apply **after 24 months**. The 24 month period gets over in June 2019 and whoever is the Next Editor, will have to apply to the PUBMED citing all the changes that have been made, in compliance to the instructions. The present editorial team will give their whole-hearted support. This will be the greatest gift to the Academy. We have been able to get the indexing from Index Copernicus too. We



requested for fast-tracking of the whole process. That cost us money, but we were able to get the work done and the Index Copernicus gave us the No: **ICV 2017: 114.07**.

At present, our Journal is indexed with Scopus, IndMed, Indian Citation Index and Index Medicus for South-East Asia Region (IMSEAR), in addition to the Index Copernicus. It has been **approved by the UGC** and the Serial No. issued is 28596. As for the **Impact Factor**: it is [i (Thomson Reuters) metric] 0.212 for the year 2017.

#### **Finances:**

When the present team took the charge of the Journal, we were given a zero balance. However, the previous editor, Dr. Mukesh Yadav, informed us that owing to certain subscriptions and Manuscript Handling Charges, an amount of approximately 50,000/- Rupees was due to us and that was transferred, the moment the account of the Editor IAFM was opened. With the increase in the number of subscriptions, (presently, we have 170 institutional and agency subscriptions) and increase in the Manuscript Handling Charges of the non-members, the Journal has net balance of 5,50,000/- Rupees. [The charges for printing this issue, packing and transport to Jodhpur have to be deducted and 40,000/- that is to be paid to the account of the Editor by the Treasurer, has to be added.]

It is because of the balance that we were able to fast-track the indexing with Copernicus, buy PDF Professional and WinZip software for the editing and other works related to the Journal. We would also be going for **online submission of the manuscripts** for the Journal. The subscription charges for the year 2019 have been enhanced to INR 7500/-, both for the institutions and the Agencies. The agencies get a discount of 10% per subscription. However, the personal subscriptions for non members remains the same: 1000/-Rupees.

#### **Offers for Partnership with Publishing Houses:**

Many publishing houses approached us for rights to publish our Journal through them.

Their M O Us uniformly asked one thing: we hand over the charge of the Journal to them and their team. We would not have any say in the acceptance, review, publishing etc. Many of these houses were against free distribution of the Journal to the Life Members or hosting the Journal on the Academy's website. When they were told that the Constitution of the Academy stipulated that the Life Members receive the Journal free, they insisted on payment of about 200 Rupees per issue, i.e., it would cost the Academy about 800 Rupees per member per year for the "Free distribution". These were put to the EC as well as the GB and the unanimous mandate received was that the publishing and printing would remain with the Editorial Team. In compliance of this mandate, all the offers were rejected.

#### **The Road Ahead:**

- The most important goal ahead now is to **apply again to PUBMED** for indexing. The present editorial team has fulfilled almost all the pre-requisites that were asked of us. Let's hope that this time, we are successful.
- **Online submission of manuscripts**, as is mandated by most of the international and many of the National Journals. Talks are on with a vendor for the same.
- **Increasing the institutional subscriptions** - both online and print. There are about 500 medical colleges in our country but we have only 170 subscriptions. All the members are earnestly requested to ensure that the Journal is subscribed to by their college. It costs only 7500/-Rupees per year, which is almost nothing.
- **Plagiarism detecting software** - it can either be rented from the vendor or the agency with which online submission of manuscripts is being negotiated with, can be asked to provide that service. Anti-Plagiarism certificate is mandatory for PUBMED indexing.

Once again, we sincerely thank one and all for the opportunity to serve the Academy and the Journal as the Editor & the Joint Editor.

Jai Hind!!

## Original Research Paper

# Distribution of Injuries in Fall from Height and its Relation to Height of Fall and Primary Impact

<sup>1</sup>S. R. Saritha, <sup>2</sup>C. S. Sreedevi

### Abstract:

In fall from height, the patterns of external injuries and the types of internal injuries may, together, indicate the primary site of impact and the height from which the fall had occurred. They may therefore be applied to the reconstruction of the fatal events.

This descriptive study was conducted on 102 cases of fall from height brought for autopsy to the mortuary of the department of Forensic Medicine, Government Medical College, Thiruvananthapuram. Fracture of skull and brain injuries were in a lesser proportion, when compared to the reference studies. Subarachnoid haemorrhage was the most common type of intracranial bleed. Chest and various abdominal visceral organ injuries were found. There was no case of primary upper limb impact in the present series.

None of the victims who fell from a height less than 1 metre showed skull fracture or brain contusion. Primary head, neck and buttock impacts were commonly seen in falls from less than 15 metres height. Trunk, lowerlimb and multiple primary impacts were seen in height less than 30 meters. No case of primary lowerlimb impact was present in fall from less than 5 metres height.

**Key Words:** Fall, Distribution of Injuries, Primary Impact, Height of Fall, Autopsy Study

### Introduction:

The medico-legal autopsy in a case of fall from height is directed to find the reason for the fall and to decide whether the death was attributable purely to the height. The patterns of external injuries and the types of internal injuries may, together, indicate the primary site of impact and the height from which the fall had occurred; they may therefore be applied to the reconstruction of the fatal events. Regardless of the position on landing, for falls more than 5 metre, there is a high incidence of deceleration

injuries to the intra-thoracic and inter-abdominal structures, particularly where these are relatively immobile or tethered . for example, the aortic root and the mesenteric arteries. Over all, a fall on to unyielding surfaces from 15 to 20 metre has more than 50% mortality.<sup>1</sup>

As per Knight's Forensic Pathology, falls are extremely common; the severity not necessarily being directly related to the distance that the person falls. Many people die after falling from a standing position, yet others sometimes survive a fall of many meters. Fatal head injury from a fall usually requires a drop of a number of feet.<sup>2</sup>

The primary impact is usually the site which first comes in contact with the ground.<sup>3,4</sup> Determination of the anatomical site which first impacts the ground may be useful in the reconstruction of the death. However, this is not usually an easy task because of the multiplicity of injuries; and when great heights are involved, collision with intermediate objects protruding from the building often occurs.<sup>5</sup> The interpretation of the circumstances in which the

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fracture was sustained may be facilitated when the point of impact is apparent as in fall from height especially in cases of homicides and suspicious deaths.<sup>6,7</sup>

This study was undertaken with the objective to find the distribution of injuries in victims of fall from height and also to describe the injuries with respect to height of fall and site of primary impact.

### Materials and Methodology:

The present study was a descriptive study on 102 cases of fall from height brought for autopsy during the period from May 2006 to April 2008 to the mortuary of the Department of Forensic Medicine, Govt. Medical College, Thiruvananthapuram. Approval for the study was obtained from the Institutional Ethics Committee. The data was collected in a semi structured questionnaire. Decomposed and unknown bodies were excluded from the study. Data was entered in 'Epi info statistical package' and analysis was done using the package and Microsoft Excel work sheet.

### Observations and Results:

#### Distribution of injuries

The skull was fractured in 36 cases (35.3%). Dural tear was found in 2.9% and features of raised intracranial tension in 58.8% of cases. The most frequent combination of head injury was fracture of the skull with brain injury and intracranial haemorrhage (25.5%). Brain injury was present in 33.3% cases. Intracranial haemorrhage was present in 60.8% (Table 1); the most common being a combination of subdural and subarachnoid haemorrhage (28.4%), followed by isolated subarachnoid haemorrhage (16.7%). Isolated extradural haemorrhage was not found; but was observed with other types of haemorrhages in 3.9% of cases.

Table 1: Distribution of head injury

| Type of injury                 | Number | Percentage |
|--------------------------------|--------|------------|
| Fracture skull                 | 36     | 35.3%      |
| Brain injury (BI)              | 34     | 33.3%      |
| Intracranial haemorrhage (ICH) | 62     | 60.8%      |
| Tear of dura matter            | 3      | 2.9%       |
| Raised intra cranial tension   | 60     | 58.8%      |
| Fracture skull + BI            | 6      | 5.9%       |
| BI + ICH                       | 5      | 4.9%       |
| Fracture skull + BI + ICH      | 26     | 25.5%      |

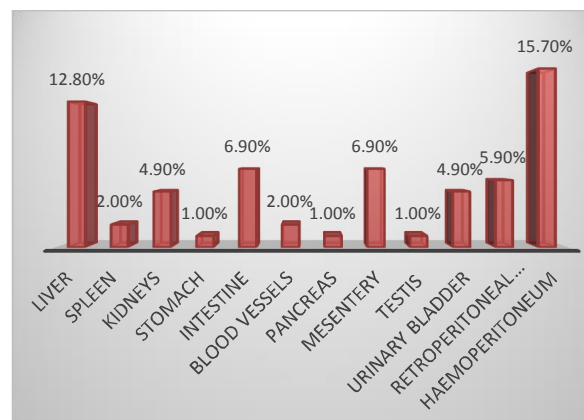
Fracture of sternum was observed in 13 cases (12.7%), the most common site being between 2<sup>nd</sup> and 3<sup>rd</sup> pieces (3.9%). Fracture of clavicle was present in 7 cases (6.9%), ribs in 52 cases (51%). Lung was found injured in 23 cases (22.5%) and heart in 8 (7.8%). Injury to aorta was found in 3 cases, varying from complete transection of proximal descending aorta in one to intimal tear in two. Haemothorax was seen in 41 cases (40.2%). (Table. 2)

Table 2: Distribution of chest injury.

| Type of injury    | Number | Percentage |
|-------------------|--------|------------|
| Fracture sternum  | 13     | 12.7%      |
| Fracture clavicle | 7      | 6.9%       |
| Fracture of ribs  | 52     | 51.0%      |
| Injury to lung    | 23     | 22.5%      |
| Injury to heart   | 8      | 7.8%       |
| Injury to aorta   | 3      | 2.9%       |
| Haemothorax       | 41     | 40.2%      |

Liver was injured in 13 cases (12.8%); all were lacerations, except one subcapsular haematoma. Splenic injuries were found in 2% cases, including laceration in one and contusion with laceration in another. Injury to the kidney was seen in 5 victims, and included laceration and perirenal haematoma. Stomach had laceration in one case. injury to intestine and mesentery was noted in 7 cases, each, in the form of contusions and lacerations. Transection of pancreas with partial tear of portal vein was observed in one, retroperitoneal haematoma in 6 cases. Hepatic vein rupture and contusion of testis was present in one case, each. Urinary bladder was found contused in 5 victims (Figure. 1).

Figure 1: Distribution of injury to abdominal and pelvic visceral organs



Pelvic bones were found fractured in 12 (11.8%) cases. Fractures at multiple sites were seen in 7 (6.8%) cases. Isolated fracture separation of pubic symphysis and sacroiliac joint was seen in 2 cases each and of left pubic ramus in one case (**Table. 3**).

**Table 3: Distribution of fractures and dislocation bones of pelvis.**

| Distribution of fractures    | Number     | Percentage    |
|------------------------------|------------|---------------|
| No fracture                  | 90         | 88.2%         |
| Pubic symphysis alone        | 2          | 2.0%          |
| Left pubic ramus alone       | 1          | 1.0%          |
| Right sacroiliac joint alone | 2          | 2.0%          |
| Multiple sites               | 7          | 6.8%          |
| <b>Total</b>                 | <b>102</b> | <b>100.0%</b> |

Fracture of bones of upper limb was seen in 14 (13.8%) cases and of lower limb in 17 (16.8%) cases. Isolated fracture of right humerus and left radius were seen in 2 cases, each and fracture of right radius and ulna in one case, each. Fractures at multiple sites were seen in 8 cases (7.8%) (**Table. 4**).

**Table 4: Distribution of fractures and dislocations of bones in the upper limbs**

| Fractures and dislocations | Number     | Percentage    |
|----------------------------|------------|---------------|
| No fracture                | 88         | 86.2%         |
| Right humerus alone        | 2          | 2.0%          |
| Right radius alone         | 1          | 1.0%          |
| Right ulna alone           | 1          | 1.0%          |
| Left radius alone          | 2          | 2.0%          |
| Multiple sites             | 8          | 7.8%          |
| <b>Total</b>               | <b>102</b> | <b>100.0%</b> |

There was isolated fracture of right femur in 2 cases (2%), and of left femur in 4 cases (3.9%). calcaneum and tarsal bones were fractured in 2 (2%) cases and were in primary lower limb impact. Fractures at multiple sites were found in 6 cases (5.9%) (**Table. 5**).

#### **Distribution of site of primary impact in relation to height of fall and region of injuries**

With regard to site of primary impact, head ranked first (49%), compared to multiple areas (20.7%), trunk (8.8%), neck (3.9%), lower limb (3.9) and buttocks (2.9%) cases. No case of primary upper limb impact was present in this series. In 10.8% cases, site of primary impact could not be made out either from history or from the postmortem findings.

**Table 5: Distribution of fractures and dislocations of bones in the lower limbs**

| Distribution of fractures   | Number     | Percentage    |
|-----------------------------|------------|---------------|
| No fracture                 | 85         | 83.2%         |
| Right femur alone           | 2          | 2.0%          |
| Left femur alone            | 4          | 3.9%          |
| Left tibia alone            | 1          | 1.0%          |
| Calcaneum & tarsal bones    | 2          | 2.0%          |
| Dislocation right hip joint | 1          | 1.0%          |
| Dislocation left ankle      | 1          | 1.0%          |
| Multiple sites              | 6          | 5.9%          |
| <b>Total</b>                | <b>102</b> | <b>100.0%</b> |

Most of the victims fell from a height of 1 to 5 meters (39.2%) cases, followed by 5 to 10 metres (36.3%). Eight (7.8%) victims died on falling from less than one metre height. All falls were within 30 metres height.

Among the primary head impacts, 5 fell from less than 1 metre, including 4 head and 1 each having sustained neck and abdomen injury. Regarding primary neck impact, 4 sustained injuries to spine and 1 to head. All of them fell from height less than 10 metres. All cases of primary trunk impact had chest injury (9 cases), while 1 sustained head injury, 3 showed abdominal injury; lower limb and spine were injured in 4 cases, each. Majority of the victims fell from a height of 5-10 meters and the maximum height of fall was less than 30 metres. Among the primary buttock impacts, 2 had abdominal injuries and 1 each sustained spine and pelvic injuries. All fell from less than 10 metres.

Of the 4 cases of primary lower limb impact, 3 had fracture of lower limb bones, including fracture calcaneum and tarsal bones. There was fracture fragmentation of patella in 1 indicating knee impact. Head, chest, abdomen, spine and pelvic injuries seen in 2 cases, each. Upper limb was fractured in 1 case. All fell from height of 5 to 15 metres. In multiple primary impacts, head and chest were most commonly affected (18 cases each), followed by spine (10 cases), abdomen and upper limb (9 cases each), pelvis (5 cases) and lower limb (5 cases). Height of fall ranged from 1 to 25 metres. In 11 cases the site of primary impact was uncertain, majority of them showed chest injuries (8 cases) followed by head and spine (5 cases each), lower limb (2 cases) and abdomen (1 case) (**Table. 6**).

Table 6: Distribution of site of primary impact in relation to height of fall and region of injuries

| Site of primary impact | Height of fall (metre) | Body region involved |          |         |          |        |            |            |        | Number of cases |
|------------------------|------------------------|----------------------|----------|---------|----------|--------|------------|------------|--------|-----------------|
|                        |                        | Head                 | Chest    | Abdomen | Spine    | Pelvis | Upper limb | Lower limb | Neck   |                 |
| Head (50 cases)        | ≤ 1                    | 4                    | 0        | 1       | 0        | 0      | 0          | 0          | 1      | 5               |
|                        | 1-5                    | 24                   | 9        | 3       | 8        | 1      | 1          | 0          | 1      | 25              |
|                        | 5-10                   | 13                   | 10       | 4       | 4        | 1      | 3          | 2          | 0      | 14              |
|                        | 10-15                  | 6                    | 3        | 3       | 2        | 0      | 1          | 1          | 0      | 6               |
|                        | 20-25                  | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
|                        | 25-30                  | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
| Total (percentage)     |                        | 47(46.1)             | 22(21.6) | 10(9.8) | 14(13.7) | 2(1.9) | 5(4.9)     | 3(2.9)     | 2(1.9) | 50 (49.0)       |
| Neck (4 cases)         | ≤ 1                    | 0                    | 0        | 0       | 1        | 0      | 0          | 0          | 0      | 1               |
|                        | 1-5                    | 0                    | 0        | 0       | 1        | 0      | 0          | 0          | 0      | 1               |
|                        | 5-10                   | 1                    | 0        | 0       | 2        | 0      | 0          | 0          | 0      | 2               |
|                        | 10-15                  | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
|                        | 20-25                  | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
|                        | 25-30                  | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
| Total (percentage)     |                        | 1(1.0)               | 0(0.0)   | 0(0.0)  | 4(3.9)   | 0(0.0) | 0(0.0)     | 0(0.0)     | 0(0.0) | 4 (3.9)         |
| Trunk (9 cases)        | ≤ 1                    | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
|                        | 1-5                    | 0                    | 1        | 0       | 0        | 0      | 0          | 0          | 0      | 1               |
|                        | 5-10                   | 1                    | 6        | 2       | 2        | 1      | 0          | 1          | 0      | 6               |
|                        | 10-15                  | 0                    | 1        | 1       | 0        | 0      | 0          | 1          | 0      | 1               |
|                        | 20-25                  | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
|                        | 25-30                  | 0                    | 1        | 0       | 2        | 0      | 0          | 2          | 0      | 1               |
| Total (percentage)     |                        | 1(1.0)               | 9(8.8)   | 3(2.9)  | 4(3.9)   | 1(1.0) | 0(0.0)     | 4(3.9)     | 0(0.0) | 9 (8.8)         |
| Buttock (3 cases)      | ≤ 1                    | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
|                        | 1-5                    | 0                    | 0        | 1       | 0        | 1      | 0          | 0          | 0      | 2               |
|                        | 5-10                   | 0                    | 0        | 1       | 1        | 0      | 0          | 0          | 0      | 1               |
|                        | 10-15                  | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
|                        | 20-25                  | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
|                        | 25-30                  | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
| Total (percentage)     |                        | 0(0.0)               | 0(0.0)   | 2(1.9)  | 1(1.0)   | 1(1.0) | 0(0.0)     | 0(0.0)     | 0(0.0) | 3 (2.9)         |
| Lower limb (4 cases)   | ≤ 1                    | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
|                        | 1-5                    | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
|                        | 5-10                   | 1                    | 1        | 1       | 2        | 1      | 1          | 1          | 0      | 2               |
|                        | 10-15                  | 1                    | 1        | 1       | 0        | 1      | 0          | 2          | 0      | 2               |
|                        | 20-25                  | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
|                        | 25-30                  | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
| Total (percentage)     |                        | 2(1.9)               | 2(1.9)   | 2(1.9)  | 2(1.9)   | 2(1.9) | 1(1.0)     | 3(2.9)     | 0(0.0) | 4 (3.9)         |
| Multiple (21 cases)    | ≤ 1                    | 1                    | 1        | 0       | 1        | 0      | 0          | 0          | 0      | 1               |
|                        | 1-5                    | 6                    | 5        | 3       | 2        | 2      | 3          | 1          | 0      | 8               |
|                        | 5-10                   | 7                    | 8        | 2       | 3        | 1      | 3          | 2          | 0      | 8               |
|                        | 10-15                  | 2                    | 2        | 2       | 2        | 1      | 2          | 1          | 0      | 2               |
|                        | 20-25                  | 2                    | 2        | 2       | 2        | 1      | 0          | 1          | 0      | 2               |
|                        | 25-30                  | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
| Total (percentage)     |                        | 18(17.6)             | 18(17.6) | 9(8.8)  | 10(9.8)  | 5(4.9) | 8(7.8)     | 5(4.9)     | 0(0.0) | 21 (20.7)       |
| Uncertain (11 cases)   | ≤ 1                    | 1                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 1               |
|                        | 1-5                    | 2                    | 2        | 0       | 2        | 0      | 0          | 0          | 0      | 3               |
|                        | 5-10                   | 1                    | 4        | 0       | 2        | 0      | 0          | 0          | 0      | 4               |
|                        | 10-15                  | 1                    | 2        | 1       | 1        | 0      | 0          | 2          | 0      | 3               |
|                        | 20-25                  | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
|                        | 25-30                  | 0                    | 0        | 0       | 0        | 0      | 0          | 0          | 0      | 0               |
| Total (percentage)     |                        | 5(4.9)               | 8(7.8)   | 1(1.0)  | 5(4.9)   | 0(0.0) | 0(0.0)     | 2(1.9)     | 0(0.0) | 11 (10.8)       |

**Discussion:**

In Albert Goonetilleke's study, skull was fractured in 58.7% cases, ring fracture was seen in 2 cases. Brain damage was found in 73.7% of cases. Isolated sub arachnoid haemorrhage was found in 24% of cases, while 20.5% cases presented with laceration or bruise brain.<sup>8</sup> Laceration was more commonly present brain injury, as observed by Lau .G. et al and others (37%).<sup>3,4,6</sup>

Buckman stated that sternal fracture was seen in 'feet first' or buttock first impact.<sup>9</sup> Sternal fractures were found in 17 cases by Goonetillke.<sup>8</sup> According to Guharaj, fracture of clavicle can occur in fall on to out stretched hand.<sup>10</sup> Fracture of ribs was noted in 80% of cases by Lau, et al and others,<sup>3,4,6</sup> and Lau, et al was also stated that laceration or rupture was the commonest type of lung injury found in 54% of cases,<sup>6</sup> severe injuries to heart were found in more than 48% of cases, ruptures of thoracic aorta were found in 51% subjects, of which complete rupture was seen in 70% and partial in the remaining 30% and about 70% of victims presented with haemothorax at autopsy.<sup>2,4,6</sup> According to Goonetilleke,<sup>8</sup> lung was found injured in 30.8% of cases, which included contusion (19 cases), laceration (13 cases) and collapse (2 cases). He also recorded fatal injury to heart and aorta in 24 cases.

Observations similar to the present study were made by Goonetilleke,<sup>8</sup> where liver was seen injured in 16 cases, spleen in 2 cases, kidney in 10 cases. More common involvement of abdominal organs was found in the study conducted by Lau G. et al, liver involved in 60%, spleen in 43%, kidney in 27% and stomach and intestine in 2% of cases each. Haemoperitoneum was seen in 40% of cases, much more than the present series. Fracture of the pelvic girdle ranged from solitary fracture to marked disruption with severe haemorrhage in 55% of cases.<sup>3,4,6</sup>

Lau G. et al also observed that majority (59%) fell from a height of 20 to 40 metres and that almost all of them from multistoried high rise buildings.<sup>6</sup> Field, kenningham, et al reported on fatal injury - worker's compensation claims from 1<sup>st</sup> December 1996 to 31<sup>st</sup> March 1998 for all claims coded as fall from height. They observed

that transport and storage represented 12% of the falls claims analyzed, of which, 14% of fall claims in transport were falls from height greater than 2 meters (16 cases) while a further 10% (12 cases) were falls from ladders and by far the largest percentage of fall claims were falls from less than 2 meters (76% or 90 claims).<sup>11</sup>

According to Goonetillekke, of 66 cases of primary head impact, all, except one, showed head injury. No case of multiple primary impacts was found in that study.<sup>8</sup>

In a retrospective study conducted by John ferris, et al, on fall from ladders, among patients admitted at Liver Pool Hospital between January 2000 and December 2003 on 107 patients, they observed 10 limb fractures in falls under 3 meters, 2 dislocated limbs in falls between 2 & 4 meters. One fell over 4 meters and sustained only minor lacerations. Major injury occurred in falls less than 2 meters, with lower limb fractures being the most frequent injury.<sup>12</sup>

**Conclusion:**

To conclude, fractures of the skull and brain injuries were present in a lesser proportion as compared to the reference studies. No case with ring fracture of skull was seen in the present series. Subarachnoid haemorrhage was the most common type of intracranial bleed, similar to other studies. Intimal tears in the present study were not in the form of classical stepladder tears. Complete transection and intimal tear were seen just below the arch of aorta in one case each, which was the classically described site of rupture according to Brian et al and Fiddler.<sup>3</sup> Increased prevalence of chest injury, as recorded by Lau, et al,<sup>4</sup> can be attributed to the difference in the height compared to the present study. Various abdominal visceral organ injuries were found injured in the present series. Liver injury ranked first in the present study, as in the reference studies. There was no case of primary upper limb impact in the present series. None of the victims, who fell from less than 1 metre, showed skull fracture or brain contusion. Injuries to chest and abdomen, seen in lower limb impact, could be attributed to indirect forms of violence, such as jack knife effect, hydraulic ram effect,

compression and vibration of the internal organs. Primary head, neck and buttock impacts were commonly seen in falls from less than 15 metres height. Trunk, lower limb and multiple primary impacts were seen in height less than 30 meters. No case of primary lower limb impact was detected in fall from less than 5 metres height.

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## Original Research Paper

# Uniqueness of Craniometric and Capulometric Landmark Analysis Using Cone Beam Computed Tomography for Individual Identification: A Pilot Study

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### Abstract:

**Background:** As crimes are committed with highly sophisticated methods and procedures, newer techniques need to be developed and improved in Forensic as well as crime scene investigations by applying the benefits of newly emergent and appropriate technological resources. Facial approximations, developed using 3D sculpting technique, would be enhanced by the availability of modern, well-defined, consistent, and statistically robust soft tissue data- a situation which is still emerging in craniofacial soft tissue depth research. In such scenario Cone Beam Computed Tomography offers distinct advantages over other technology in developing facial approximations for forensic identification utility as it is non-invasive and economical. **Materials and Methodology:** The study has been carried out by measuring the Facial Soft Tissue Thickness using craniometric and capulometric landmarks that covers anatomical landmarks of the skull, among 20 subjects, aged between 18 to 30 years. **Results:** The results of this study revealed a set of unique Facial Soft Tissue Thickness measurements of the Coastal Karnataka and North Kerala population that might be useful for facial reconstruction purposes and also to establish sexual dimorphism in relation to Facial Soft Tissue Thicknesses. The study results also imply that Cone Beam Computed Tomography can be positively used to record facial soft tissue thickness measurements for forensic utility. **Conclusion:** In forensic cases, where identification has been difficult due to non-availability of ante-mortem records, efforts will be made for reconstruction of the face of a bare skull devoid of soft tissue. This study is useful to assess the correlation between craniofacial shape and soft-tissue profile from data analyzed by Cone Beam Computed Tomography imaging, so as to determine the extent to which it might be possible to digitally predict the latter from the former.

**Key Words:** Facial Soft Tissue Thickness, Identification, Facial Reconstruction, Cone-Beam Computed Tomography, Forensic Anthropology Population Data

### Introduction:

Over the recent years, numerous

approaches have been employed in attempts to make identification from an unknown human skull. Of these, one method is the three dimensional forensic facial reconstruction, where soft tissues of the face of an unknown skull are rebuilt in an attempt to reproduce the simulated facial features of its original owner for the purpose of identification.<sup>1</sup>

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Basically two methods of facial reconstruction are followed:<sup>2</sup>

- 1) Morphoscopic method, which uses an anatomical approach of reconstruction of the fat, musculature and skin as practiced by Gerasimov.<sup>3</sup>
- 2) Morphometric method, which rest largely on the application of average measurements of



facial soft tissue thicknesses that have been gathered by various researchers.<sup>4</sup>

Various methods used for facial reconstruction are drawings, sculpture and computer aided image building though radiographic imaging which is mainly based on facial soft tissue thickness measurement have been evolved to aid in facial anthropologic studies by measuring the Facial Soft Tissue Thickness (FSTT).<sup>5</sup> Each method experimented for these purposes has certain limitations. A number of methods have been employed for taking these measurements like tissue puncture using needles, computed tomographic images, lateral cephalometric radiographs, ultrasonography imaging and magnetic resonance imaging.<sup>6-10</sup> More recently, a new imaging technique and a variant of medical Computed Tomography (CT) called Cone-Beam Computed Tomography (CBCT) is used for head and neck imaging.<sup>11</sup> It is applied exclusively in dentistry using lower levels of radiation which produces almost similar resolution in skull imaging and digitization. At present, it is also being used in forensic anthropology for contemporary facial reconstruction studies.<sup>12</sup>

Forensic facial reconstruction is derived by a combination of art and science where the reconstruction of faces on unknown skulls is attempted for the purpose of identification of an individual.<sup>13</sup> The prime purpose of any forensic facial approximation is to reproduce the facial features of a deceased individual depending on the anatomy of his/her skull at the time of death. In cases where there is lack of ante mortem data, this method can be considered as a last attempt to identify the deceased.<sup>14</sup>

Hence, for an accurate facial reconstruction of any human face, it is of great necessity to know the average FSTT of various specific spots on the face. This is required for the purpose of establishing a Forensic Anthropology Population Database related to population based on age, sex, ethnicity and race.<sup>12</sup> We conducted a pilot study using CBCT images for marking various Craniometric and Capulometric landmarks. The FSST data thus accumulated has been analyzed as Forensic Anthropology Population Data for the coastal

Karnataka and north Kerala population for the purpose of individual forensic identification.

### **Materials and Methodology:**

As a part of the pilot study, the CBCT data of 20 subjects visiting Department of Oral Medicine and Radiology from our institution was collected. Approval of the Institutional Ethics Committee was taken and Informed consent was obtained from all the subjects who were included in the study. The subjects aged between 18 to 30 years from Coastal Karnataka and North Kerala population were selected as per inclusion and exclusion criteria of study. Patients with Congenital anomalies/syndromes, oro-facial pathologies, orthodontic corrections, history of trauma, surgical intervention and exposure to radiotherapy were excluded from the study.

Following this, thorough case history was recorded to rule out subjects who fall under exclusion criteria. Weight and height of the subject was recorded. Basal metabolic index (BMI) was evaluated. CBCT data was collected, which was obtained using ProMax 3D Mid (Planmeca, Helsinki, Finland). Standard protocol used was: Full field of view 200 x 170 cm; voxel size 400 mm; exposure time 4.7 seconds. Craniometric (skull) and Capulometric (soft tissue face) landmarks (**Table 1**) were marked and analysed using NEMOCEPH 3D-- the exclusive Cephalometric and Orthodontic software of Nemostudio: The Digital Medical Company.

To minimize intra-observer variability, the landmarks were marked thrice in a week and mean values were taken into consideration. The average measurement was recorded as the data for Statistical Analysis.

### **Method of Statistical Analysis:**

The Mean, Standard deviation and standard error along with confidence interval of the different Craniometric (skull) and Capulometric (soft tissue face) measurements was documented. Independent two tailed t-test was used to analyze the level of significance.  $p < 0.05$  was considered to be statistically significant. Data was analyzed by using statistical SPSS software.

Table 1: Standardized Craniometric (Skull) And Capulometric (Soft Tissue Face) Landmarks Used In The Studies Were As Follows:<sup>15</sup>

| SI No. | Skeletal Landmark               |  | Corresponding Paired Soft Tissue Landmark |  |
|--------|---------------------------------|--|---|--|
|        | Name (Abbr.)                    | Definition   | Name (Abbr.)                              | Definition   |
| 1.     | <b>Metopion (m)</b>             | Median point, instrumentally determined on the frontal bone as the greatest elevation from a cord between nasion (see below) and bregma.                 | <b>Metopion (m')</b>                      | Furthest chord length perpendicular to the nasion-bregma chord.  |
| 2.     | <b>Supra-glabella (sg)</b>      | Median point immediately above the forward glabella projection on the smooth upward rising slope of the frontal bone.                                    | <b>Supra-glabella (sg')</b>               | Median soft tissue point overlaying sg.  |
| 3.     | <b>Glabella (g)</b>             | Most projecting anterior median point on lower edge of the frontal bone, on the brow ridge, in between the superciliary arches and above the nasal root. | <b>Glabella (g')</b>                      | Most anterior midline point on the forehead, in the region of the superciliary ridges.                                   |
| 4.     | <b>Nasion (n)</b>               | Intersection of the nasofrontal sutures in the median plane.   | <b>Sellion (se')</b>                      | Deepest midline point of the nasofrontal angle.  |
| 5.     | <b>Rhinion (rhi)</b>            | Most rostral (end) point on the internasal suture.   | <b>Rhinion (rhi')</b>                     | Point overlying rhinion, at the end of the internasal suture, where bone ends and cartilage begins                       |
| 6.     | <b>Mid-philtrum (mp)</b>        | Median point midway between subspinale and pr (see below).   | <b>Mid-philtrum (mp')</b>                 | Point midway between subspinale and ls (see below), in the median plane  |
| 7.     | <b>Prosthion (pr)</b>           | Median point between the central incisors on the anterior most margin of the maxillary alveolar rim.   | <b>Labiale superius (ls')</b>             | Midpoint of the vermilion border of the upper lip (not identical to and not to be confused for Labrale superius).        |
| 8.     | <b>Infradentale (id)</b>        | Median point at the superior tip of the septum between the mandibular central incisors.  | <b>Labiale inferius (li')</b>             | Midpoint of the vermilion border of the lower lip (identical to labrale inferius).                                       |
| 9.     | <b>Supramentale (sm)</b>        | Deepest median point in the groove superior to the mental eminence (orthodontic point B).  | <b>Supramentale (sm')</b>                 | Deepest midline point of the mentolabial sulcus.   |
| 10.    | <b>Pogonion (pg)</b>            | Most anterior median point on the mental eminence of the mandible.   | <b>Pogonion (pg')</b>                     | Most anterior midpoint of the chin, located on the skin surface anterior to the identical bony landmark of the mandible. |
| 11.    | <b>Menton (me)</b>              | Most inferior median point of the mental symphysis (may not be the inferior point on the mandible as the chin is often clefted on the inferior margin).  | <b>Menton (me')</b>                       | Most inferior median point of the chin.  |
| 12.    | <b>Mid-supraorbital (mso)</b>   | Point on the anterior aspect of the superior orbital rim, at a line that vertically bisects the orbit.   | <b>Mid-supraorbital (mso')</b>            | Point anteriorly adjacent to the superior orbital rim, at a line that vertically bisects the orbit.                      |
| 13.    | <b>Mid-infraorbital (mio)</b>   | Point on the anterior aspect of the inferior orbital rim, at a line that vertically bisects the orbit.   | <b>Mid-infraorbital (mio')</b>            | Point anteriorly adjacent to the inferior orbital rim, at a line that vertically bisects the orbit.                      |
| 14.    | <b>Alare curvature pt. (ac)</b> | Hard tissue approximation of soft tissue ac, approximately 5 mm lateral to the alare landmark.   | <b>Alare curvature pt. (ac')</b>          | The most posterolateral point of the curvature of the base line of each nasal ala.                                       |
| 15.    | <b>Zygion (zy)</b>              | Instrumentally determined as the most lateral point on the zygomatic arch.   | <b>Zygion (zy')</b>                       | Most lateral point overlying each zygomatic arch, identified as the  |

|             |   |  |   |  |
|-------------|---|--|---|--|
|             |   |  |   | point of maximum bizygomatic breadth of the face.  |
| 16.         | <b>Gonion (go)</b>                            | Point on the rounded margin of the angle of the mandible, bisecting two lines one following vertical margin of ramus and one following horizontal margin of corpus of mandible.                          | <b>Gonion (go')</b>                               | Most lateral point on the mandibular angle, adjacent to go, identified by palpation.   |
| 17.         | <b>Supracanine (sC)</b>                       | Point on the maxillary alveolar margin centrally above the maxillary canine.   | <b>Supracanine (sC')</b>                          | The soft tissue projection of sC.  |
| 18.         | <b>Infracanine (iC)</b>                       | Point on the mandibular alveolar margin centrally below the maxillary canine.  | <b>Infracanine (iC')</b>                          | The soft tissue projection of iC   |
| 19. And 20. | <b>Ectomolares (ecm2 and ecm<sub>2</sub>)</b> | Most lateral point on the buccal alveolar margin, at the center of the second molar position. Superscript number designates the maxillary landmark; subscript number designates the mandibular landmark. | <b>Supra-2nd-molar (sM2' and iM<sub>2</sub>')</b> | Point overlying ecm, the midpoint of the alveolus of the second maxillary molar.   |
| 21.         | <b>Mid-ramus (mr)</b>                         | Midpoint along the shortest antero-posterior depth of the ramus, in the masseteric fossa, and usually close to the level of the occlusal plane.  | <b>Mid-ramus (mr')</b>                            | Point directly overlying mr, best determined by X-ray but can be extrapolated from surface anatomy features including the masseter muscle mass, the posterior margin of the mandible and the zygomatic arch. |
| 22.         | <b>Mid-mandibular border (mmb)</b>            | Point on the inferior border of the corpus of the mandible midway between pg and go.   | <b>Mid-mandibular border (mmb')</b>               | Point directly overlying mmb, midway between pg and go.  |

### Results:

This paper represents results of pilot study comprising of only 20 patients. With this study we aim to correlate the findings of the study finally and arrive at formula for facial identification by possibly incorporating the dataset into digital software for the purpose of facial reconstruction. Hence further analysis of FSTT of the same population set is being conducted with a larger sample size for better result verification and documentation. This will also add to the FSTT dataset of the population belonging to coastal Karnataka and north Kerala population.

The data recorded has been depicted in **Table 2** to **Table 7**.

### Descriptive statistics:

The sample size of this pilot study comprised of 8 male subjects (40%) and 12 female Subjects (60%) (**Table 2**). Of these, 10 belonged to coastal Karnataka and the other 10

to North Kerala population (50% each) (**Table 3**).

**Table 2: Sex Distribution**

| Sex          | Frequency | Percentage   |
|--------------|-----------|--------------|
| Male         | 8         | 40.0         |
| Female       | 12        | 60.0         |
| <b>Total</b> | <b>40</b> | <b>100.0</b> |

**Table 3: Statewise Distribution**

| State Frequency |           | Percent      |
|-----------------|-----------|--------------|
| Karnataka       | 10        | 50.0         |
| Kerala          | 10        | 50.0         |
| <b>Total</b>    | <b>20</b> | <b>100.0</b> |

The level of significance was analysed by Independent two tailed t-test.

1. The group statistics between the two states showed no significant results (**Table 4**).
2. Statistically significant results were seen with respect to Group Statistics for Sex Distribution (**Table 5**) under the variables height (ht); FSTT measurements at mp\_mp ,

mso\_mso\_L and mso\_mso\_R were p value was observed to be 0.025, 0.002, 0.001 and 0.001 respectively.

3. The Statistics for Coastal Karnataka Group between the sexes shows FSTT measurement at sm\_sm p value to be highly significant which was 0.043 (**TABLE 6**) suggestive of sexual dimorphism.

4. The North Kerala Group Statistics between the sexes shows highly significant p value with respect to FSTT values at n\_se, mp\_mp, mso\_mso\_R and ac\_ac\_L which was 0.050, 0.006, 0.004 and 0.050 respectively (**Table 7**) suggestive of sexual dimorphism with respect to these FSTTs.

Table 4: Group statistics between states

| States Group Statistics |           |    |          |                |                 |                 |
|-------------------------|-----------|----|----------|----------------|-----------------|-----------------|
|                         | State     | N  | Mean     | Std. Deviation | Std. Error Mean | Sig. (2-tailed) |
| HT                      | Karnataka | 10 | 162.3000 | 6.99285        | 2.21133         | .212            |
|                         | Kerala    | 10 | 167.1000 | 9.43339        | 2.98310         |                 |
| WT                      | Karnataka | 10 | 59.1900  | 7.24254        | 2.29029         | .092            |
|                         | Kerala    | 10 | 70.6000  | 18.95140       | 5.99296         |                 |
| BMI                     | Karnataka | 10 | 22.5000  | 2.71211        | .85765          | .271            |
|                         | Kerala    | 10 | 25.4100  | 7.63740        | 2.41516         |                 |
| m_m'                    | Karnataka | 10 | 3.9680   | .79734         | .25214          | .253            |
|                         | Kerala    | 10 | 4.3750   | .74302         | .23496          |                 |
| sg_sg'                  | Karnataka | 10 | 4.8860   | .81145         | .25660          | .976            |
|                         | Kerala    | 10 | 4.8740   | .92703         | .29315          |                 |
| g_g'                    | Karnataka | 10 | 5.3250   | 1.12947        | .35717          | .860            |
|                         | Kerala    | 10 | 5.2450   | .85412         | .27010          |                 |
| n_se'                   | Karnataka | 10 | 6.9270   | 1.46688        | .46387          | .325            |
|                         | Kerala    | 10 | 6.3040   | 1.28037        | .40489          |                 |
| rhi_rhi'                | Karnataka | 10 | 1.9070   | .74134         | .23443          | .549            |
|                         | Kerala    | 10 | 2.0880   | .57290         | .18117          |                 |
| mp_mp'                  | Karnataka | 10 | 12.1250  | 1.71282        | .54164          | .225            |
|                         | Kerala    | 10 | 13.3180  | 2.44848        | .77428          |                 |
| pr_ls'                  | Karnataka | 10 | 12.4860  | 1.78069        | .56310          | .786            |
|                         | Kerala    | 10 | 12.7300  | 2.16116        | .68342          |                 |
| id_li'                  | Karnataka | 10 | 15.7830  | 2.15605        | .68180          | .436            |
|                         | Kerala    | 10 | 16.4350  | 1.43063        | .45240          |                 |
| sm_sm'                  | Karnataka | 10 | 11.8490  | 1.80300        | .57016          | .872            |
|                         | Kerala    | 10 | 11.7340  | 1.29187        | .40853          |                 |
| pg_pg'                  | Karnataka | 10 | 12.1130  | 1.94429        | .61484          | .678            |
|                         | Kerala    | 10 | 11.6010  | 3.30899        | 1.04640         |                 |
| me_me'                  | Karnataka | 10 | 10.2670  | 1.31234        | .41500          | .323            |
|                         | Kerala    | 10 | 9.2670   | 2.82119        | .89214          |                 |
| mso_mso_L'              | Karnataka | 10 | 7.2370   | 1.61889        | .51194          | .147            |
|                         | Kerala    | 10 | 8.4430   | 1.92294        | .60809          |                 |
| mso_mso_R'              | Karnataka | 10 | 7.6490   | 1.27954        | .40463          | .326            |
|                         | Kerala    | 10 | 8.3320   | 1.71592        | .54262          |                 |
| mio_mio_L'              | Karnataka | 10 | 5.6280   | .88962         | .28132          | .388            |
|                         | Kerala    | 10 | 6.0700   | 1.30519        | .41274          |                 |
| mio_mio_R'              | Karnataka | 10 | 5.3860   | 1.23689        | .39114          | .114            |
|                         | Kerala    | 10 | 6.2120   | .97093         | .30704          |                 |
| sC_Sc_L'                | Karnataka | 10 | 10.1570  | 1.33207        | .42124          | .071            |
|                         | Kerala    | 10 | 11.3850  | 1.52313        | .48166          |                 |
| sC_sC_R'                | Karnataka | 10 | 10.3630  | 1.48556        | .46978          | .199            |
|                         | Kerala    | 10 | 11.3330  | 1.75717        | .55567          |                 |
| ic_L'                   | Karnataka | 10 | 10.8740  | 1.43642        | .45424          | .882            |
|                         | Kerala    | 10 | 10.9930  | 2.05452        | .64970          |                 |

|             |           |    |         |         |         |      |
|-------------|-----------|----|---------|---------|---------|------|
| lc_R'       | Karnataka | 10 | 11.0880 | 1.44533 | .45705  | .693 |
|             | Kerala    | 10 | 11.3690 | 1.68204 | .53191  |      |
| zy_zy_L'    | Karnataka | 10 | 8.6000  | 2.01723 | .63790  | .954 |
|             | Kerala    | 10 | 8.6660  | 2.90306 | .91803  |      |
| zy_zy_R'    | Karnataka | 10 | 8.6450  | 1.92565 | .60894  | .906 |
|             | Kerala    | 10 | 8.7690  | 2.66459 | .84262  |      |
| mr_mr_L'    | Karnataka | 10 | 20.2070 | 3.81919 | 1.20773 | .635 |
|             | Kerala    | 10 | 20.9650 | 3.17152 | 1.00292 |      |
| mr_mr_R'    | Karnataka | 10 | 20.1610 | 3.15787 | .99861  | .452 |
|             | Kerala    | 10 | 21.1860 | 2.79378 | .88347  |      |
| ac_ac_L'    | Karnataka | 10 | 11.0240 | 2.56004 | .80956  | .517 |
|             | Kerala    | 10 | 10.3360 | 2.07457 | .65604  |      |
| ac_ac_R'    | Karnataka | 10 | 10.8680 | 2.88374 | .91192  | .533 |
|             | Kerala    | 10 | 10.1540 | 2.06749 | .65380  |      |
| ecm2_Sm2_L' | Karnataka | 10 | 27.1550 | 3.83566 | 1.21294 | .555 |
|             | Kerala    | 10 | 28.4320 | 5.51811 | 1.74498 |      |
| ecm2_Sm2_R' | Karnataka | 10 | 26.8350 | 4.04961 | 1.28060 | .517 |
|             | Kerala    | 10 | 28.1210 | 4.63785 | 1.46662 |      |
| ecm2_lm2_L' | Karnataka | 10 | 25.5030 | 3.24627 | 1.02656 | .572 |
|             | Kerala    | 10 | 24.4920 | 4.50488 | 1.42457 |      |
| ecm2_lm2_R' | Karnataka | 10 | 25.3700 | 3.17708 | 1.00468 | .573 |
|             | Kerala    | 10 | 24.4500 | 3.94327 | 1.24697 |      |
| mmb_mmb_L'  | Karnataka | 10 | 15.9790 | 2.95257 | .93369  | .672 |
|             | Kerala    | 10 | 15.2320 | 4.63003 | 1.46415 |      |
| mmb_mmb_R'  | Karnataka | 10 | 15.6830 | 3.70781 | 1.17251 | .615 |
|             | Kerala    | 10 | 14.6400 | 5.26320 | 1.66437 |      |
| Go_L'       | Karnataka | 10 | 13.3300 | 2.43886 | .77123  | .514 |
|             | Kerala    | 10 | 14.4610 | 4.77991 | 1.51154 |      |
| Go_R'       | Karnataka | 10 | 13.5760 | 2.37415 | .75077  | .569 |
|             | Kerala    | 10 | 14.4680 | 4.24161 | 1.34131 |      |

Table 5: Group statistics for sex distribution

| Group Statistics For Sex Distribution |        |    |          |                |                 |                 |
|---------------------------------------|--------|----|----------|----------------|-----------------|-----------------|
|                                       | Sex    | N  | Mean     | Std. Deviation | Std. Error Mean | Sig. (2-tailed) |
| HT                                    | Male   | 8  | 169.7500 | 10.08181       | 3.56446         | .025            |
|                                       | Female | 12 | 161.3333 | 5.26279        | 1.51924         |                 |
| WT                                    | Male   | 8  | 69.6250  | 7.24938        | 2.56304         | .199            |
|                                       | Female | 12 | 61.7417  | 18.31355       | 5.28667         |                 |
| BMI                                   | Male   | 8  | 24.2875  | 3.07731        | 1.08799         | .816            |
|                                       | Female | 12 | 23.7333  | 7.17158        | 2.07026         |                 |
| m_m'                                  | Male   | 8  | 4.4013   | .77560         | .27422          | .293            |
|                                       | Female | 12 | 4.0183   | .77483         | .22367          |                 |
| sg_sg'                                | Male   | 8  | 5.0387   | .90261         | .31912          | .509            |
|                                       | Female | 12 | 4.7742   | .83243         | .24030          |                 |
| g_g'                                  | Male   | 8  | 5.4050   | 1.02856        | .36365          | .665            |
|                                       | Female | 12 | 5.2050   | .97614         | .28179          |                 |
| n_se'                                 | Male   | 8  | 7.1875   | 1.22300        | .43240          | .125            |
|                                       | Female | 12 | 6.2342   | 1.38918        | .40102          |                 |
| rhi_rhi'                              | Male   | 8  | 1.9738   | .75405         | .26660          | .898            |
|                                       | Female | 12 | 2.0133   | .60874         | .17573          |                 |
| mp_mp'                                | Male   | 8  | 14.4050  | 1.81451        | .64153          | .002            |
|                                       | Female | 12 | 11.5992  | 1.55619        | .44923          |                 |
| pr_ls'                                | Male   | 8  | 13.4450  | 1.87235        | .66197          | .116            |

|             |        |    |         |         |         |      |
|-------------|--------|----|---------|---------|---------|------|
|             | Female | 12 | 12.0500 | 1.83378 | .52937  |      |
| id_li'      | Male   | 8  | 16.6213 | 2.03405 | .71914  | .315 |
|             | Female | 12 | 15.7675 | 1.64931 | .47611  |      |
| sm_sm'      | Male   | 8  | 12.4213 | 1.68553 | .59592  | .136 |
|             | Female | 12 | 11.3717 | 1.32009 | .38108  |      |
| pg_pg'      | Male   | 8  | 11.5775 | 3.28286 | 1.16067 | .712 |
|             | Female | 12 | 12.0433 | 2.28426 | .65941  |      |
| me_me'      | Male   | 8  | 9.2838  | 2.57955 | .91201  | .438 |
|             | Female | 12 | 10.0892 | 1.96423 | .56702  |      |
| mso_mso_L'  | Male   | 8  | 9.3075  | 1.56335 | .55273  | .001 |
|             | Female | 12 | 6.8617  | 1.29040 | .37251  |      |
| mso_mso_R'  | Male   | 8  | 9.2663  | 1.48040 | .52340  | .001 |
|             | Female | 12 | 7.1400  | .77022  | .22234  |      |
| mio_mio_L'  | Male   | 8  | 5.8300  | 1.36255 | .48173  | .952 |
|             | Female | 12 | 5.8617  | .97377  | .28110  |      |
| mio_mio_R'  | Male   | 8  | 5.8250  | 1.39330 | .49261  | .937 |
|             | Female | 12 | 5.7817  | 1.04737 | .30235  |      |
| sC_Sc_L'    | Male   | 8  | 11.2825 | 1.11680 | .39485  | .194 |
|             | Female | 12 | 10.4300 | 1.71012 | .49367  |      |
| sC_sC_R'    | Male   | 8  | 11.4575 | 1.58478 | .56031  | .186 |
|             | Female | 12 | 10.4417 | 1.64652 | .47531  |      |
| ic_L'       | Male   | 8  | 11.0963 | 1.84521 | .65238  | .741 |
|             | Female | 12 | 10.8250 | 1.71738 | .49577  |      |
| lc_R'       | Male   | 8  | 11.1738 | 1.44133 | .50959  | .898 |
|             | Female | 12 | 11.2650 | 1.65356 | .47734  |      |
| zy_zy_L'    | Male   | 8  | 7.7375  | 2.03957 | .72110  | .167 |
|             | Female | 12 | 9.2300  | 2.57052 | .74204  |      |
| zy_zy_R'    | Male   | 8  | 7.9863  | 2.07854 | .73488  | .246 |
|             | Female | 12 | 9.1875  | 2.33903 | .67522  |      |
| mr_mr_L'    | Male   | 8  | 20.4413 | 3.19477 | 1.12952 | .879 |
|             | Female | 12 | 20.6825 | 3.72888 | 1.07644 |      |
| mr_mr_R'    | Male   | 8  | 20.8875 | 2.78432 | .98441  | .794 |
|             | Female | 12 | 20.5308 | 3.16762 | .91441  |      |
| ac_ac_L'    | Male   | 8  | 11.3237 | 1.32331 | .46786  | .259 |
|             | Female | 12 | 10.2508 | 2.73533 | .78962  |      |
| ac_ac_R'    | Male   | 8  | 11.1188 | 1.48877 | .52636  | .325 |
|             | Female | 12 | 10.1058 | 2.94531 | .85024  |      |
| ecm2_Sm2_L' | Male   | 8  | 26.7288 | 4.31642 | 1.52608 | .408 |
|             | Female | 12 | 28.5033 | 4.94583 | 1.42774 |      |
| ecm2_Sm2_R' | Male   | 8  | 27.0550 | 3.93048 | 1.38963 | .720 |
|             | Female | 12 | 27.7600 | 4.66051 | 1.34537 |      |
| ecm2_lm2_L' | Male   | 8  | 23.3663 | 2.96248 | 1.04740 | .103 |
|             | Female | 12 | 26.0850 | 4.10860 | 1.18605 |      |
| ecm2_lm2_R' | Male   | 8  | 23.5975 | 2.89984 | 1.02525 | .159 |
|             | Female | 12 | 25.7850 | 3.73179 | 1.07728 |      |
| mmb_mmb_L'  | Male   | 8  | 14.2013 | 4.03456 | 1.42643 | .184 |
|             | Female | 12 | 16.5417 | 3.48957 | 1.00735 |      |
| mmb_mmb_R'  | Male   | 8  | 13.0912 | 3.78679 | 1.33883 | .081 |
|             | Female | 12 | 16.5417 | 4.48186 | 1.29380 |      |
| Go_L'       | Male   | 8  | 12.8388 | 3.17601 | 1.12289 | .292 |
|             | Female | 12 | 14.6000 | 4.04583 | 1.16793 |      |
| Go_R'       | Male   | 8  | 13.0913 | 2.52763 | .89365  | .289 |
|             | Female | 12 | 14.6425 | 3.81809 | 1.10219 |      |

Table 6: Coastal Karnataka-Independent T-Test

| Coastal Karnataka Group Statistics |        |   |          |                |                 |                 |
|------------------------------------|--------|---|----------|----------------|-----------------|-----------------|
|                                    | Sex    | N | Mean     | Std. Deviation | Std. Error Mean | Sig. (2-tailed) |
| HT                                 | Male   | 2 | 165.5000 | 13.43503       | 9.50000         | .502            |
|                                    | Female | 8 | 161.5000 | 5.78174        | 2.04416         |                 |
| WT                                 | Male   | 2 | 65.5000  | 3.53553        | 2.50000         | .099            |
|                                    | Female | 8 | 57.6125  | 7.17186        | 2.53563         |                 |
| BMI                                | Male   | 2 | 24.2500  | 5.16188        | 3.65000         | .336            |
|                                    | Female | 8 | 22.0625  | 2.13470        | .75473          |                 |
| m_m'                               | Male   | 2 | 4.1050   | 1.27986        | .90500          | .804            |
|                                    | Female | 8 | 3.9338   | .75940         | .26849          |                 |
| sg_sg'                             | Male   | 2 | 5.0600   | 1.23037        | .87000          | .756            |
|                                    | Female | 8 | 4.8425   | .78709         | .27828          |                 |
| g_g'                               | Male   | 2 | 5.6800   | 2.10718        | 1.49000         | .647            |
|                                    | Female | 8 | 5.2363   | .98023         | .34656          |                 |
| n_se'                              | Male   | 2 | 7.9600   | 2.14960        | 1.52000         | .291            |
|                                    | Female | 8 | 6.6688   | 1.31351        | .46439          |                 |
| rhi_rhi'                           | Male   | 2 | 1.2900   | .72125         | .51000          | .205            |
|                                    | Female | 8 | 2.0613   | .70450         | .24908          |                 |
| mp_mp'                             | Male   | 2 | 13.1200  | 2.53144        | 1.79000         | .390            |
|                                    | Female | 8 | 11.8763  | 1.58206        | .55934          |                 |
| pr_ls'                             | Male   | 2 | 13.3950  | 1.09602        | .77500          | .353            |
|                                    | Female | 8 | 12.2588  | 1.90003        | .67176          |                 |
| id_li'                             | Male   | 2 | 16.3600  | 3.86080        | 2.73000         | .698            |
|                                    | Female | 8 | 15.6388  | 1.93090        | .68268          |                 |
| sm_sm'                             | Male   | 2 | 14.0650  | 1.37886        | .97500          | .043            |
|                                    | Female | 8 | 11.2950  | 1.46772        | .51892          |                 |
| pg_pg'                             | Male   | 2 | 12.2650  | 3.57089        | 2.52500         | .910            |
|                                    | Female | 8 | 12.0750  | 1.74083        | .61548          |                 |
| me_me'                             | Male   | 2 | 10.2850  | .19092         | .13500          | .968            |
|                                    | Female | 8 | 10.2625  | 1.48627        | .52548          |                 |
| mso_mso_L'                         | Male   | 2 | 8.6000   | 2.53144        | 1.79000         | .199            |
|                                    | Female | 8 | 6.8963   | 1.33815        | .47311          |                 |
| mso_mso_R'                         | Male   | 2 | 8.9200   | 2.41831        | 1.71000         | .120            |
|                                    | Female | 8 | 7.3312   | .83223         | .29424          |                 |
| mio_mio_L'                         | Male   | 2 | 4.9400   | 1.76777        | 1.25000         | .242            |
|                                    | Female | 8 | 5.8000   | .63408         | .22418          |                 |
| mio_mio_R'                         | Male   | 2 | 4.3250   | 1.57685        | 1.11500         | .190            |
|                                    | Female | 8 | 5.6513   | 1.09989        | .38887          |                 |
| sC_Sc_L'                           | Male   | 2 | 11.0300  | 1.54149        | 1.09000         | .328            |
|                                    | Female | 8 | 9.9388   | 1.29219        | .45686          |                 |
| sC_sC_R'                           | Male   | 2 | 11.1900  | 1.76777        | 1.25000         | .411            |
|                                    | Female | 8 | 10.1563  | 1.46518        | .51802          |                 |
| ic_L'                              | Male   | 2 | 11.7000  | 2.24860        | 1.59000         | .395            |
|                                    | Female | 8 | 10.6675  | 1.29879        | .45919          |                 |
| Ic_R'                              | Male   | 2 | 11.5550  | 2.05768        | 1.45500         | .638            |
|                                    | Female | 8 | 10.9713  | 1.41530        | .50038          |                 |
| zy_zy_L'                           | Male   | 2 | 8.0300   | 3.69110        | 2.61000         | .681            |
|                                    | Female | 8 | 8.7425   | 1.78031        | .62943          |                 |
| zy_zy_R'                           | Male   | 2 | 8.6400   | 3.86080        | 2.73000         | .997            |
|                                    | Female | 8 | 8.6463   | 1.62424        | .57426          |                 |
| mr_mr_L'                           | Male   | 2 | 22.8850  | 5.55079        | 3.92500         | .293            |
|                                    | Female | 8 | 19.5375  | 3.43376        | 1.21402         |                 |

|             |        |   |         |         |         |      |
|-------------|--------|---|---------|---------|---------|------|
| mr_mr_R'    | Male   | 2 | 23.2250 | 3.93858 | 2.78500 | .131 |
|             | Female | 8 | 19.3950 | 2.69303 | .95213  |      |
| ac_ac_L'    | Male   | 2 | 11.2450 | .28991  | .20500  | .901 |
|             | Female | 8 | 10.9688 | 2.89774 | 1.02451 |      |
| ac_ac_R'    | Male   | 2 | 11.1800 | .50912  | .36000  | .876 |
|             | Female | 8 | 10.7900 | 3.25885 | 1.15218 |      |
| ecm2_Sm2_L' | Male   | 2 | 27.2950 | 4.51841 | 3.19500 | .958 |
|             | Female | 8 | 27.1200 | 3.99902 | 1.41387 |      |
| ecm2_Sm2_R' | Male   | 2 | 27.3350 | 5.60736 | 3.96500 | .858 |
|             | Female | 8 | 26.7100 | 4.06249 | 1.43631 |      |
| ecm2_lm2_L' | Male   | 2 | 25.8450 | 1.76070 | 1.24500 | .824 |
|             | Female | 8 | 25.4175 | 3.61449 | 1.27792 |      |
| ecm2_lm2_R' | Male   | 2 | 26.2500 | 3.53553 | 2.50000 | .687 |
|             | Female | 8 | 25.1500 | 3.30387 | 1.16809 |      |
| mmb_mmb_L'  | Male   | 2 | 17.0300 | 4.93561 | 3.49000 | .604 |
|             | Female | 8 | 15.7162 | 2.70813 | .95747  |      |
| mmb_mmb_R'  | Male   | 2 | 15.8050 | 4.23557 | 2.99500 | .962 |
|             | Female | 8 | 15.6525 | 3.88686 | 1.37421 |      |
| Go_L'       | Male   | 2 | 13.8250 | 3.52846 | 2.49500 | .769 |
|             | Female | 8 | 13.2063 | 2.40445 | .85010  |      |
| Go_R'       | Male   | 2 | 12.9550 | 1.60513 | 1.13500 | .637 |
|             | Female | 8 | 13.7313 | 2.59639 | .91796  |      |

Table 7: North Kerala-Independent T-Test

| North Kerala Group Statistics |        |   |          |                |                 |                 |
|-------------------------------|--------|---|----------|----------------|-----------------|-----------------|
|                               | Sex    | N | Mean     | Std. Deviation | Std. Error Mean | Sig. (2-tailed) |
| HT                            | Male   | 6 | 171.1667 | 9.82683        | 4.01179         | .063            |
|                               | Female | 4 | 161.0000 | 4.83046        | 2.41523         |                 |
| WT                            | Male   | 6 | 71.0000  | 7.87401        | 3.21455         | .940            |
|                               | Female | 4 | 70.0000  | 31.19829       | 15.59915        |                 |
| BMI                           | Male   | 6 | 24.3000  | 2.81567        | 1.14949         | .604            |
|                               | Female | 4 | 27.0750  | 12.47461       | 6.23730         |                 |
| m_m'                          | Male   | 6 | 4.5000   | .68393         | .27921          | .547            |
|                               | Female | 4 | 4.1875   | .89358         | .44679          |                 |
| sg_sg'                        | Male   | 6 | 5.0317   | .91519         | .37363          | .542            |
|                               | Female | 4 | 4.6375   | 1.02854        | .51427          |                 |
| g_g'                          | Male   | 6 | 5.3133   | .74347         | .30352          | .776            |
|                               | Female | 4 | 5.1425   | 1.11533        | .55766          |                 |
| n_se'                         | Male   | 6 | 6.9300   | .92282         | .37674          | .050            |
|                               | Female | 4 | 5.3650   | 1.24071        | .62036          |                 |
| rhi_rhi'                      | Male   | 6 | 2.2017   | .66532         | .27162          | .435            |
|                               | Female | 4 | 1.9175   | .42696         | .21348          |                 |
| mp_mp'                        | Male   | 6 | 14.8333  | 1.56434        | .63864          | .006            |
|                               | Female | 4 | 11.0450  | 1.55736        | .77868          |                 |
| pr_ls'                        | Male   | 6 | 13.4617  | 2.16018        | .88189          | .198            |
|                               | Female | 4 | 11.6325  | 1.88624        | .94312          |                 |
| id_li'                        | Male   | 6 | 16.7083  | 1.66575        | .68004          | .452            |
|                               | Female | 4 | 16.0250  | 1.06863        | .53431          |                 |
| sm_sm'                        | Male   | 6 | 11.8733  | 1.46838        | .59946          | .686            |
|                               | Female | 4 | 11.5250  | 1.14724        | .57362          |                 |
| pg_pg'                        | Male   | 6 | 11.3483  | 3.50510        | 1.43095         | .786            |
|                               | Female | 4 | 11.9800  | 3.47172        | 1.73586         |                 |
| me_me'                        | Male   | 6 | 8.9500   | 2.96205        | 1.20925         | .689            |



|             |        |   |         |         |         |      |
|-------------|--------|---|---------|---------|---------|------|
|             | Female | 4 | 9.7425  | 2.95838 | 1.47919 |      |
| mso_mso_L'  | Male   | 6 | 9.5433  | 1.36860 | .55873  | .015 |
|             | Female | 4 | 6.7925  | 1.38481 | .69240  |      |
| mso_mso_R'  | Male   | 6 | 9.3817  | 1.35448 | .55296  | .004 |
|             | Female | 4 | 6.7575  | .51623  | .25811  |      |
| mio_mio_L'  | Male   | 6 | 6.1267  | 1.24568 | .50854  | .878 |
|             | Female | 4 | 5.9850  | 1.58376 | .79188  |      |
| mio_mio_R'  | Male   | 6 | 6.3250  | 1.01020 | .41241  | .679 |
|             | Female | 4 | 6.0425  | 1.03122 | .51561  |      |
| sC_Sc_L'    | Male   | 6 | 11.3667 | 1.11216 | .45404  | .966 |
|             | Female | 4 | 11.4125 | 2.21282 | 1.10641 |      |
| sC_sC_R'    | Male   | 6 | 11.5467 | 1.68908 | .68956  | .665 |
|             | Female | 4 | 11.0125 | 2.06874 | 1.03437 |      |
| ic_L'       | Male   | 6 | 10.8950 | 1.88708 | .77040  | .866 |
|             | Female | 4 | 11.1400 | 2.58458 | 1.29229 |      |
| Ic_R'       | Male   | 6 | 11.0467 | 1.40857 | .57505  | .491 |
|             | Female | 4 | 11.8525 | 2.15905 | 1.07952 |      |
| zy_zy_L'    | Male   | 6 | 7.6400  | 1.74738 | .71336  | .185 |
|             | Female | 4 | 10.2050 | 3.86406 | 1.93203 |      |
| zy_zy_R'    | Male   | 6 | 7.7683  | 1.68505 | .68792  | .156 |
|             | Female | 4 | 10.2700 | 3.40018 | 1.70009 |      |
| mr_mr_L'    | Male   | 6 | 19.6267 | 2.22303 | .90755  | .103 |
|             | Female | 4 | 22.9725 | 3.60325 | 1.80163 |      |
| mr_mr_R'    | Male   | 6 | 20.1083 | 2.19929 | .89785  | .143 |
|             | Female | 4 | 22.8025 | 3.08989 | 1.54495 |      |
| ac_ac_L'    | Male   | 6 | 11.3500 | 1.55932 | .63659  | .050 |
|             | Female | 4 | 8.8150  | 1.92822 | .96411  |      |
| ac_ac_R'    | Male   | 6 | 11.0983 | 1.74619 | .71288  | .073 |
|             | Female | 4 | 8.7375  | 1.81184 | .90592  |      |
| ecm2_Sm2_L' | Male   | 6 | 26.5400 | 4.67224 | 1.90743 | .200 |
|             | Female | 4 | 31.2700 | 6.08827 | 3.04414 |      |
| ecm2_Sm2_R' | Male   | 6 | 26.9617 | 3.91124 | 1.59676 | .363 |
|             | Female | 4 | 29.8600 | 5.68441 | 2.84220 |      |
| ecm2_lm2_L' | Male   | 6 | 22.5400 | 2.89654 | 1.18251 | .093 |
|             | Female | 4 | 27.4200 | 5.27704 | 2.63852 |      |
| ecm2_lm2_R' | Male   | 6 | 22.7133 | 2.34953 | .95919  | .086 |
|             | Female | 4 | 27.0550 | 4.72944 | 2.36472 |      |
| mmb_mmb_L'  | Male   | 6 | 13.2583 | 3.69447 | 1.50826 | .099 |
|             | Female | 4 | 18.1925 | 4.69961 | 2.34981 |      |
| mmb_mmb_R'  | Male   | 6 | 12.1867 | 3.54401 | 1.44683 | .066 |
|             | Female | 4 | 18.3200 | 5.66360 | 2.83180 |      |
| Go_L'       | Male   | 6 | 12.5100 | 3.33363 | 1.36095 | .118 |
|             | Female | 4 | 17.3875 | 5.56674 | 2.78337 |      |
| Go_R'       | Male   | 6 | 13.1367 | 2.90160 | 1.18457 | .245 |
|             | Female | 4 | 16.4650 | 5.57489 | 2.78744 |      |

5. Among the states the Coastal Karnataka Group showed significantly higher mean FSTT values than the North Kerala Group with respect to sg\_sg, g\_g, n\_se, sm\_sm, pg\_pg, me\_me, ac\_ac\_L, ac\_ac\_R, ecm2\_lm2\_L, ecm2\_lm2\_R, mmb\_mmb\_L and mmb\_mmb\_R (Table 4).

6. Among the sexes, the female sex showed increased mean FSTT values at the following points when compared to the male sex which is as follows: rhi\_rhi, pg\_pg, me\_me, mio\_mio\_L, Ic\_R, zy\_zy\_L, zy\_zy\_R, mr\_mr\_L, ecm2\_Sm2\_L, ecm2\_Sm2\_R,

ecm2\_lm2\_L, ecm2\_lm2\_R, mmb\_mmb\_L, mmb\_mmb\_R, Go\_L and Go\_R (**Table 5**).

With increasingly sophisticated crimes, new investigation techniques in forensic science need to be developed as well as existing technology is required to be improvised, and hence, applying the benefits of the emergence of new technological resources for the same.<sup>16</sup>

Facial approximations, developed using 3D sculpting technique, would be enhanced by the availability of modern, well-defined, consistent, and statistically robust soft tissue data a situation which is still emerging in craniofacial soft tissue depth research.<sup>17</sup> In such scenario CBCT offers distinct advantages over other technology in developing facial approximations for forensic identification utility as it is non-invasive as well as economical.

Since the ancient times, anthropologists worldwide have been collecting FSTT data by using various techniques. Artists have played an important role in reconstructing unknown face based on the FSTT data collected at various specific specific craniometric and capulometric landmarks. The FSTT depends largely on the surface anatomical contour and associated surface landmarks of hard tissue to that of the corresponding soft tissue surface.

CBCT can record both craniometric and capulometric on various sections of the three dimensional images of an individual with precision. This three dimensional analysis helps in collection of data from all the various angles which will help in more effective facial reconstruction. Most of the studies have been conducted on two dimensional imaging which is already used for individual identification and facial reconstruction. CBCT provides three dimensional imaging and the data collected in our study provides three dimensional statistics which will further aid in an enhanced precision in reconstruction of face for individual identification. In the past, many faces have been constructed by using lateral profile of an individual only. This will benefit further when three dimensional data and statistics of a face are used for facial reconstruction. Thus it is of great importance to record FSTT in all three dimensions. Further, we have selected down the population to Coastal

Karnataka and North Kerala to have a better picture of the ethnic variations in the above groups of population. Also data is collected for age group between 18 to 30 years as maximum growth takes place during this age group after which there is a lag phase. Thus, this present study was aimed to derive mean FSTT in males and females of Coastal Karnataka and North Kerala using CBCT measuring 30 different landmarks.

In the present study, significantly higher mean FSTT values were observed in the North Kerala Group when compared to Coastal Karnataka Group with respect to sg\_sg, g\_g, n\_se, sm\_sm, pg\_pg, me\_me, ac\_ac\_L, ac\_ac\_R, ecm2\_lm2\_L, ecm2\_lm2\_R, mmb\_mmb\_L and mmb\_mmb\_R (**Table 7**).

Significantly higher mean FSTT values were seen among females than in males with respect to rhi\_rhi, pg\_pg, me\_me, mio\_mio\_L, lc\_R, zy\_zy\_L, zy\_zy\_R, mr\_mr\_L, ecm2\_Sm2\_L, ecm2\_Sm2\_R, ecm2\_lm2\_L, ecm2\_lm2\_R, mmb\_mmb\_L, mmb\_mmb\_R, Go\_L and Go\_R suggestive of sexual dimorphism (**Table 5**). Similar findings were observed in the study conducted by Kharoshah M, et al<sup>18</sup> to evaluate sexual dimorphism by using images obtained by spiral CT on anthropometric measurements of mandible. Five linear measurements and one angular measurement of gonion gnathion length, ramus length, minimum ramus breadth, bicondylar breadth, bigonial breadth and gonial angle were used respectively for the sexual dimorphism analysis, of which three measurements showed significantly higher mean values in males which were bicondylar breadth, minimum ramus breadth and gonial angle. These findings are in tandem to another Egyptian study where FSTT was assessed by Ultrasonics, females showed increased FSTT thickness than males.<sup>3</sup> The mean FSTT of males was higher than that of females in studies conducted by various other researchers using various other modalities of imaging.<sup>18-21</sup> But our present study has data analysed from CBCT which has definite advantages over the other techniques of recording FSTT data as mentioned previously.

Another study was conducted by Halazonetis DJ, et al<sup>22</sup> on 170 Lateral

cephalograms obtained from consecutive orthodontic patients. Total of 17 skeletal landmarks, out of which 2 dental and 22 soft-tissue landmarks were digitized and processed by using Procrustes superimposition and principal component analysis. The principal components of the skeletal and soft-tissue shapes were entered into the correlation analysis. Correlations between skeletal and the soft-tissue components were found to be significant. Their study concluded that anterior skeletal and dental landmarks can be used to predict soft-tissue profile shape among children and adolescents with 50% power. The present study is carried out on CBCT data which will give a 3 dimensional view. We have also included multiple bilateral measurements around the face for better results and higher accuracy.

A study conducted by Parks CL et al<sup>17</sup> consisted of FBI sample of cranial CT scans of 388 living adults collected from 2003-2009. The scans included both males and females from four self-identified ancestry groups from the United States aged between 18 to 62 years. The dataset presented in their study was represented the modern American adult population and was, therefore, appropriate for use in reconstructing contemporary facial approximations. The dataset of our study will be representative of adults belonging to coastal Karnataka and north Kerala population which will aid in future facial reconstructions; which as a result will facilitate individual identification.

In another study by Gamba TDO et al,<sup>23</sup> using anthropometric measurements of mandibular images obtained from CBCT imaging, on sample consisting of 159 scans of Brazilian population aged from 18. 60 years, out of which 74 were males and 85 females. They considered six measurements namely gonion gnathion length, ramus length, minimum ramus breadth, bigonial breadth, bicondylar breadth and gonial angle for analysis of sexual dimorphism. They found that the rate of correct sex classification was 95.1% using these four variables. Our study also compared sexual dimorphism analysis in coastal Karnataka and north Kerala population. This pilot study also shows highly statistical significance (p value < 0.05) with FSTT in relation to sm\_sm' which was

0.043 among coastal Karnataka group and n\_se', mp\_mp', mso\_mso\_R' and ac\_ac\_L' which was 0.050, 0.006, 0.004 and 0.050 respectively among north Kerala group.

Similarly, the dataset of our study will be representative of adults belonging to coastal Karnataka and north Kerala population which will aid in future facial reconstructions; as a result this will facilitate individual identification primarily for forensic purposes.

### **Conclusion:**

A constant challenge in routine forensic investigation in India is the personal identification of unknown human skeletal remains. In such cases ante-mortem medical records are required to compare and fix the identity of the unknown human skeletal remains. But in those many cases where identification is difficult, due to non-availability of ante mortem records, efforts will be made to reconstruct the face of a bare skull devoid of soft tissue. In scenarios where only skulls are found, probable facial recognition is made possible digitally by reconstructing the contours of the skull & soft tissues by the application of these FSTT data sets, based on individual type of populations. The significance of this art of Forensic facial reconstruction or forensic facial approximation using CBCT is to serve as a very important tool in forensic identification due to these very specific advantages.

**Conflict of interest:** None

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## Original Research Paper

# Unnatural Deaths Among Female Children and Adolescents in Western India

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### Abstract:

**Background & Aim:** Burns is the leading cause of death in married females, while unintentional injuries are more common in female children. The aim of this study was to determine the various causes of unnatural deaths among female children in a tertiary health center of western India. **Materials & Methodology:** The present autopsy based prospective study was conducted in a tertiary health center of Gujarat and the cases of death of female children, which were brought to us for autopsy examination during the one year period from January to December 2008 were analyzed. **Results:** The incidences of female children death were 3.5% of the total autopsies conducted during the one year period of this study. The most susceptible age group was between 16-19 years of age and burns (31.6% cases) were the leading cause of death followed by RTAs (26.6% cases). In majority of the cases, the manner of death was accidental (63.3%) and suicidal (31.6%) in nature. **Conclusion:** The present study revealed that the incidences of unnatural deaths in female children were found to increase with the age, especially in teenage girls and most of them suffered from an accidental injury due to burns and RTAs, which are preventable.

**Key Words:** Female Children Death, Burn, RTA, Autopsy.

### Introduction:

As per census 2011, India is having a population of around 1.21 billion people.<sup>1</sup> Though burns is the leading cause of death among adult women (15-44 years), but self inflicted injuries and road injuries are more common in the younger age group.<sup>2</sup> Deaths due to burns are significantly more in women due to cooking accidents or as a result of close partner and family violence. The causes of unnatural deaths among female children and adolescent are increasing and to arrive at a targeted prevention of mortality in this group, one should

be aware of the different unnatural causes of death in this population. Various studies have been conducted on unnatural deaths of adult females in different parts of India,<sup>3-5</sup> but the causes of female child deaths have not much been discussed, and hence this study was undertaken with the aim to highlight the unnatural causes of death in the female children and adolescents in the western part of India.

### Materials & Methodology:

The present observational study was conducted in a tertiary health center of western India at Vadodara, Gujarat. The data of cases, which were brought to the mortuary of department for the medico-legal postmortem examination during the period of one year from January to December 2008 were analyzed retrospectively, after taking approval from the Institutional Ethics Committee. A total 1712 medico-legal autopsies were conducted during this period and of them, 60 (3.5%) cases, which were coming under the category of female

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children (<19 years of age) were selected for detailed study. The female children were classified into 4 groups: 0-5 years, 6-10 years, 11-15 years and 16-19 years. The manner of death was decided after taking a detailed history, circumstantial evidences and post-mortem findings. In all the cases, various causes of death in female children and manner of death was determined after autopsy examination and relevant reports of investigations. The data were analyzed and compared with observations of other authors.

### Results:

The present autopsy based study was conducted during the one year period in which total 1712 medico-legal autopsies were performed and of them, 60 cases (3.5%) were female children (<19 years of age). The most vulnerable age group was 11-19 years (71.7%). Burns was the leading cause of death amongst the female children, consisting of 31.6% cases, followed by RTAs, accounting for 26.6% cases. As per history, circumstantial evidence and post-mortem findings, the manner of death was concluded and we noticed that in the majority of the female children, the manner of death was accidental, 38 cases (63.3%), followed by suicides, 19 cases (31.6%) and homicide, 1(1.7%) case. Natural deaths were also observed in two cases (3.3%). In the present study, correlation of age with the manner of death showed that accidental deaths due to RTAs or due to burns, poisoning, electrocution or snake bites were higher in children less than 5 years of age, and then amongst the 11 - 15 yrs & 16 - 19 yrs age groups. Incidence of suicide were surprisingly higher in 11-19 years age, especially in teenage girls, while homicides and natural deaths were less common as expected.

Table-1: Age Wise Distribution of Causes of Death in Female Children

| Causes of Death | Age of the Victim |                  |                   |                 | Total            |
|-----------------|-------------------|------------------|-------------------|-----------------|------------------|
|                 | 0-5 yrs           | 6-10 yrs         | 11-15 yrs         | 16-19 yrs       |                  |
| Burns           | 02 (3.3%)         | 00 (0%)          | 05 (8.3%)         | 12 (20.0%)      | 19 (31.6%)       |
| Poisoning       | 00 (0%)           | 00 (0%)          | 03 (5.0%)         | 08 (13.3%)      | 11 (18.3%)       |
| RTA             | 07 (11.6%)        | 02 (3.3%)        | 06 (10.0%)        | 01 (1.7%)       | 16 (26.6%)       |
| Hanging         | 00 (0%)           | 00 (0%)          | 02 (3.3%)         | 03 (5.0%)       | 05 (8.3%)        |
| Snake Bite      | 01 (1.7%)         | 01 (1.7%)        | 01 (1.7%)         | 00 (0%)         | 03 (5.0%)        |
| Electrocution   | 02 (3.3%)         | 00 (0%)          | 01 (1.7%)         | 00 (0%)         | 03 (5.0%)        |
| Pathology       | 01 (1.7%)         | 01 (1.7%)        | 00 (0%)           | 00 (0%)         | 02 (3.3%)        |
| Assault         | 00 (0%)           | 00 (0%)          | 01 (1.7%)         | 00 (0%)         | 01 (1.7%)        |
| <b>Total</b>    | <b>13 (21.7%)</b> | <b>04 (6.7%)</b> | <b>19 (31.7%)</b> | <b>24 (40%)</b> | <b>60 (100%)</b> |

Table-2: Age Wise Distribution of Manner of Death in Female Children

| Manner of Death  | Age of the Victim |                  |                   |                   | Total            |
|------------------|-------------------|------------------|-------------------|-------------------|------------------|
|                  | 0-5 yrs           | 5-10 yrs         | 11-15 yrs         | 16-19 yrs         |                  |
| Accidental Death | 12 (20.0%)        | 03 (5.0%)        | 14 (23.3%)        | 09 (15.0%)        | 38 (63.3%)       |
| Suicidal Death   | 00 (0%)           | 00 (0%)          | 06 (10.0%)        | 13 (21.7%)        | 19 (31.6%)       |
| Homicidal Death  | 00 (0%)           | 00 (0%)          | 01 (1.7%)         | 00 (0%)           | 01 (1.7%)        |
| Natural Death    | 01 (1.7%)         | 01 (1.7%)        | 00 (0%)           | 00 (0%)           | 02 (3.3%)        |
| <b>Total</b>     | <b>13 (21.7%)</b> | <b>04 (6.7%)</b> | <b>21 (35.0%)</b> | <b>22 (36.6%)</b> | <b>60 (100%)</b> |

### Discussion:

The present study was conducted at a tertiary health center of western India and it showed that the most vulnerable group of female children belonged to the age group of 11-19 years of age (71.7%), followed by the children of less than 5 years of age (21.7%). Debata et al<sup>6</sup> analyzed the postmortem data in the northern part of India and found almost similar data. In the present study, burns was the main contributor of unnatural death amongst the female children and RTAs were the second commonest cause, which is similar to the observations of Debata et al<sup>6</sup> and Kanchan et al.<sup>7,8</sup>

Holakouie-Naieni<sup>9</sup> found RTA as the number one cause of death in their study done in Iran on unnatural deaths among children and adolescents, followed by deaths due to burns. Analysis of various causes of deaths in contrast with age shows that in lower age groups (0-15 yrs), RTA is the leading cause of death, as compared to the burns and other causes.

The data showed that the incidence of burns, poisoning and hanging are higher in the teenage groups, as compared to the other age group; with maximum during the age of 16-19 years. The first systematic review of community-based surveys on child injuries was conducted by Pant, et al<sup>10</sup> in the countries of the South East Asia Region to summarize evidence from child injury.

In this study, the analysis of the cases was also done according to the manner of death and it was observed that in the majority of the female children, the manner of death was accidental (63.3%), followed by suicides (31.6%), which is in agreement with the observations of other authors.<sup>6,8,11</sup> Though, the children are more vulnerable to accidental injuries, but the incidence of suicides (31.6%) are also not negligible and distressing among this particular age group. It might be due to the increasing tendency of self harm among teenagers and young adolescents. Suicide rates of self harm are still high in western countries and about 5-9% of adolescents have a history of self harm within the previous years.<sup>12</sup> The correlation of age with the manner of death shows that different types of accidental deaths due to RTAs or due to burns, poisoning, electrocution or snake bites are more commonly involved in the younger girls, while incidences of suicide were surprisingly higher in 11-19 years age, especially in teenage girls and homicides and natural deaths were less common.

### Conclusion:

The observations of present study revealed that the incidence of unnatural deaths in female children were found to increase with the age, especially in teenage girls, and most of them suffered from an accidental injury due to burns and RTAs, which are preventable. This study may be helpful to reduce the targeted prevention of mortality and morbidity by unnatural means in female children.

**Conflict of Interest :** None

**Financial Assistance:** None

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## Original Research Paper

# Screening of Hepatitis C Virus Antibody among Claimed and Unclaimed Dead Bodies during Medico-legal Autopsy

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### Abstract:

**Background:** HCV is spread by contact with blood or body fluids of an infected person. Most of the unclaimed dead bodies brought for medico-legal autopsies at Department of Forensic Medicine, Lady Hardinge Medical College, New Delhi are beggars and destitute, who indulge in drug addiction and unsafe sex, and thus are more prone to HCV infection than the general population. The HCV can survive outside the body for at least two weeks. During this time, the virus can still cause infection if it enters the body of a person. **Aims:** To evaluate whether unclaimed dead bodies pose more risk of transmitting HCV infection than claimed dead bodies. **Materials and Methodology:** The present study was conducted on 100 claimed and 100 unclaimed dead bodies brought for medico-legal autopsies, using anti HCV Ab at Department of Microbiology, Lady Hardinge Medical College, New Delhi. **Results:** Of the total 200 cases, 4(2%) cases were found positive for HCV antibody and hence were HCV infected. In case of claimed dead bodies, none of the cases were found positive for HCV antibody whereas in unclaimed dead bodies, 4% cases were positive. Thus, the chance of HCV infection is more among the unclaimed bodies than the claimed bodies brought for medico-legal autopsies at Lady Hardinge Medical College, New Delhi. **Conclusion:** Unclaimed dead bodies brought for medico-legal autopsy should be screened for HCV antibody prior to autopsy so that all the precautions can be taken to avoid contracting HCV infection.

**Key Words:** Mortuary, Hazards, HCV, Screening

### Introduction:

HCV infection is responsible for the majority of cases of parenterally transmitted non A, non B hepatitis and is known to produce a persistent infection that is often associated with chronic liver disease.<sup>1</sup>

The population prevalence of HCV infection in India is 1%.<sup>2</sup> Epidemics due to unsafe injection practices have been documented in India (hepatitis C infection is 38%), such as among injecting drug users and healthcare workers caring for infected people.<sup>2</sup>

India has an estimated 1.1 million intravenous drug users (IDUs).<sup>3</sup> Mehta et al found high burden of HCV among IDUs in south India. HCV antibody prevalence was 55% and was associated with older age, being unmarried, longer injection history and tattooing.<sup>4</sup>

The time for which a dead body remains infectious for the above agents is controversial. The hepatitis C viruses can survive outside the body for at least sixteen days at 25°C.<sup>5</sup> During this time, they can still cause infection if they enter the body of a person. The infectivity of HCV in samples decays slowly with time. This decay in infectivity is variable, depending on environmental and viral factors.

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Most of the unclaimed dead bodies brought for autopsies at LHMC and Associated Hospitals, New Delhi are of beggars or destitute, who are addicted to drugs or involved in unsafe sexual activities, thus they have more chance of contracting HCV infection, than general population. As a routine, such unclaimed dead bodies are stored in mortuary at 4°C for a minimum period of three days, for possible identification by near and dear ones. Therefore, the possibility of transmission of HCV to the medical and non-medical staffs involved in autopsies cannot be ruled out. Considering the risk of contracting HCV infection while conducting medico-legal autopsies, the present study was conducted to weigh the actual risk of exposure to HCV infection during routine dissection of unclaimed dead bodies compared to claimed dead bodies.

### Objectives of the Research:

- 1) To screen HCV infections in all the claimed and unclaimed dead bodies brought for medico-legal autopsies.
- 2) To evaluate whether autopsy on unclaimed dead bodies pose more risk of transmitting HCV infection than claimed dead bodies.

### Materials and Methodology:

After obtaining clearance from Institutional Ethics Committee, the present study was conducted on 100 claimed and 100 unclaimed dead bodies brought for medico-legal autopsies at Department of Forensic Medicine and Toxicology and Department of Microbiology, Lady Hardinge Medical College, New Delhi, during the period between October 2014 to March 2016, excluding decomposed dead bodies. Before conducting the autopsy, written informed consent regarding the study were taken from the relatives of the deceased and police in cases of claimed and unclaimed dead bodies, respectively.

The selected cases were subjected to standard autopsy procedure. 5 ml of blood sample was collected in a disposable sterile plastic vials from either femoral vein or cardiac chambers, depending upon the availability of blood. The sample was centrifuged at room temperature (4000 rpm for 10 min.) and serum

was withdrawn. Samples were then screened for HCV by ELISA kits as per the manufacturer's guidelines.

### Results:

The present study was conducted on 200 cases, of which 100 cases were of known identity and 100 cases were of unknown identity. The individuals with unknown identity were mostly beggars, destitute, and vagabonds, residing in New Delhi and Central Delhi areas, having no one to claim their dead bodies. 173 were male.

Again, 4 (2%) cases were positive for HCV antibody and hence HCV infected, whereas the rest of 196 were negative for the same. In case of claimed dead bodies, none of the cases were found positive for HCV antibody, whereas in unclaimed dead bodies, 4% cases were positive. Thus chance of HCV infection is more among the unclaimed dead bodies than the claimed dead bodies brought for medico-legal autopsies at Lady Hardinge Medical College and Associated Hospitals, New Delhi. **(Table-1)**

**Table-1: Distribution of HCV Antibody Positive cases as per the Identity of Individuals**

| Identity       | No. of Cases | HCV Antibody Positive Cases | Percentage |
|----------------|--------------|-----------------------------|------------|
| Claimed Case   | 100          | 0                           | 0          |
| Unclaimed Case | 100          | 4                           | 4          |
| <b>Total</b>   | <b>200</b>   | <b>4</b>                    | <b>2</b>   |

Of the 173 male cases, 4 (2.3%) cases were positive for HCV antibody, whereas out of 27 female cases, none of the cases were found positive. **(Table-2)**

**Table-2: Gender-wise Distribution of HCV Antibody Positive Cases**

| Gender       | Number of Cases | HCV Antibody Positive Cases | Percentage |
|--------------|-----------------|-----------------------------|------------|
| Male         | 173             | 4                           | 2.31       |
| Female       | 27              | 0                           | 0          |
| <b>Total</b> | <b>200</b>      | <b>4</b>                    | <b>2</b>   |

None of the cases from claimed category were positive for HCV antibody and hence, for HCV infection. Of the 95 unclaimed male cases, 4(4.2%) cases were positive for

HCV antibody whereas of the 5 unclaimed female cases, none of the cases were found positive. **(Table-2)**

In the present study, maximum percentage of cases with HCV antibody positivity was found in the age group of 41-50 years, constituting 3.4%, i.e. of 59 cases 2 were positive. Next in the series were age groups 21-30 years with 2.7% and 31-40 years with 2.2%. In the rest of age groups, no HCV antibody positive case was present. **(Table-3)**

**Table-3: Age- wise distribution of HCV Antibody Positive Cases**

| Age Group (Years) | Number of Cases | HCV Antibody Positive Cases | Percentage |
|-------------------|-----------------|-----------------------------|------------|
| 1-10              | 5               | 0                           | 0          |
| 11-20             | 7               | 0                           | 0          |
| 21-30             | 37              | 1                           | 2.70       |
| 31-40             | 45              | 1                           | 2.22       |
| 41-50             | 59              | 2                           | 3.39       |
| 51-60             | 26              | 0                           | 0          |
| 61-70             | 18              | 0                           | 0          |
| 71-80             | 2               | 0                           | 0          |
| 81-90             | 1               | 0                           | 0          |
| <b>Total</b>      | <b>200</b>      | <b>4</b>                    | <b>2</b>   |

HCV antibody was found positive in 4 (5.63%) cases among 71 cases with positive history of drug abuse. All those 71 cases with positive history of drug abuse were from unclaimed category. **(Table-4)**

**Table-4: Distribution of HCV Antibody Positive Cases as per documented risk factors (Drug Abuse) among Claimed and Unclaimed Cases**

| H/o Drug Abuse | Claimed Cases               |                             | Total      | Unclaimed Cases             |                             | Total      |
|----------------|-----------------------------|-----------------------------|------------|-----------------------------|-----------------------------|------------|
|                | HCV Antibody Positive Cases | HCV Antibody Negative Cases |            | HCV Antibody Positive Cases | HCV Antibody Negative Cases |            |
| Present        | 0                           | 0                           | 0          | 4                           | 67                          | 71         |
| Absent         | 0                           | 100                         | 100        | 0                           | 29                          | 29         |
| <b>Total</b>   | <b>0</b>                    | <b>100</b>                  | <b>100</b> | <b>4</b>                    | <b>96</b>                   | <b>100</b> |

## Discussion:

Li L, et al. collected a total of 414 serum samples from autopsy cases at the office of the Chief Medical Examiner for the State of Maryland. All samples were tested for the presence of HCV antibody, using ELISA. Of the

414 cases, 19.1% were positive for HCV antibody. Intravenous drug users showed significant increased prevalence of HCV. Their data indicated that the overall prevalence of HCV seropositivity in the autopsy population was much higher than that of the general population.<sup>6</sup> du Plessis R, et al randomly took blood from 263 bodies examined at the Medico-legal Laboratory in Pretoria. Serologic tests were performed to detect antibodies to HCV and positive results were confirmed using conventional serologic assays. There was a low overall HCV seroprevalence of 1%.<sup>7</sup> Sanaei-Zadeh conducted a research to identify the seroprevalence of HCV in a low risk forensic autopsy population in Tehran. A total of 173 blood samples were collected from cases autopsied at the Tehran Legal Medicine Organization. Of these, 83.2% were males. Their age ranged from 2 to 78 and 74.4% were between 20-49 years old. 7 (4%) serum samples were positive for HCV antibody. The highest percentage of HCV antibody positive cases were found among the 30-39 years as well as 50-59 years of age group. The prevalence was lower than those of the previous mentioned studies in forensic autopsy cases, but still higher than that of normal population.<sup>8</sup> Bakri, et al conducted screening of HCV antibody among 242 dead bodies brought for autopsy and HCV antibody was detected in 5.9% cases.<sup>9</sup> In the present study, prevalence of HCV by using ELISA on post-mortem serum samples was found to be 2% (4 positive cases out of 200 cases, respectively). In case of claimed dead bodies, none of the cases were found positive for HCV antibody whereas in unclaimed dead bodies, 4% cases were positive. Thus, the chance of HCV infection was more among the unclaimed bodies. No similar study was found to compare the present study. **(Table 5)**

Of the 173 males, 4 (2.3%) cases were positive for HCV antibody whereas of the 27 females, none of the cases were found positive. None of the cases from claimed category were positive for HCV antibody and hence for HCV infection. Of the 95 unclaimed male cases, 4 (4.2%) cases were positive for HCV antibody whereas of the 5 unclaimed female cases, none of the cases were found positive.

Table- 5: Sero-positive HCV cases at Forensic Autopsy by different Authors

| Seropositive Cases | Li L et al., 1993 | du Plessis R et al., 1999 | H Sanaei-Zadeh, 2001 | Bakri FG et al., 2016 | Present Study |
|--------------------|-------------------|---------------------------|----------------------|-----------------------|---------------|
| HCV                | 19.1%             | 1%.                       | 4.04%                | 2.1%                  | 2%            |

In the present study, maximum percentage of cases with HCV antibody positivity was found in the age group of 41-50 years constituting 3.4 %. Next in the series were the age groups 21-30 years with 2.7% and 31-40 years with 2.2%. In the rest of age groups, no HCV antibody positive case was present. In the claimed cases category, no HCV antibody positive case was present.

In the unclaimed category, maximum percentage of cases with HCV antibody positivity was found in the age group of 21-30 and 31-40 years constituting 5.6% each i.e. out of 18 cases 1 was positive. Next in the series was age group 41-50 years with 5.1% i.e. of the 39 cases, 2 were positive. In the rest of age groups, no HCV antibody positive case was present. Thus the present study is more or less in agreement with the study conducted by H Sanaei-Zadeh.<sup>8</sup>

All the 71 cases with positive history of drug abuse were from unclaimed category. Of these, 4 (5.6%) cases were found positive for HCV antibody. Thus the unclaimed bodies with history of drug abuse had more risk of HCV infections. However, details of nature of drug abuse could not be elicited from the available histories of unclaimed dead bodies. The present study is more or less in agreement with study conducted by Li L et al.<sup>6</sup>

### Conclusion:

The prevalence of HCV infection among unclaimed dead bodies brought for medico-legal autopsy at Lady Hardinge Medical College and Associated Hospitals, New Delhi was found to be more than among claimed dead bodies. Therefore, all the unclaimed dead bodies should be screened for HCV infection prior to autopsy so that necessary preventive measures can be followed. As no vaccine is available against HCV till date, all the staffs involved in autopsy should be screened periodically so that treatment can be initiated at the earliest to avoid major complications of HCV infection. Alternatively, all

the unclaimed dead bodies who are either beggars or vagabonds, in the absence of any foul play should be waived off from post-mortem examinations.

**Conflict of interest:** None

**Financial Assistance:** None

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## Original Research Paper

# A Study of Estimation of Stature by Foot Length among Students and Staff of Al-Ameen Medical College, Vijayapur

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### Abstract:

Stature is one of the important parameters in identification of any individual. Estimating stature using various parts of body is important in medico-legal investigations since correlation has been found between stature and different parts of body by many studies. Stature estimation using foot length has been done by many studies in different age groups and different regions. Since stature varies among individuals of different sex, race and regions, present study was done to obtain data of this region. It was cross-sectional study carried out on 200 subjects of both sexes (100 male and 100 female), between 21-40 years from the medical college. Stature was measured using standard height measuring instrument and both right and left foot length was measured using Vernier calipers. The correlation coefficient (r), and regression equation for correlation between right and left foot length and stature in males was found to be 0.677, Stature =  $89.297 + 3.158\text{RFL}$  and 0.707, Stature =  $89.163 + 3.189\text{LFL}$ , respectively. The correlation coefficient (r), and regression equation for correlation between right and left foot length and stature in females was 0.592, Stature =  $84.203 + 3.087\text{RFL}$  and 0.582, Stature =  $82.477 + 3.203\text{LFL}$ , respectively. The correlation coefficient (r), and regression equation for correlation between right and left foot length and stature in pooled subjects was 0.811, Stature =  $53.591 + 4.489\text{RFL}$  and 0.823, Stature =  $55.195 + 4.469\text{LFL}$ , respectively.

**Key Words:** Stature, Right Foot Length, Left Foot Length, Correlation, Regression.

### Introduction:

Identification is the determination of the individuality of a person based on certain characteristics with exact fixation of personality.<sup>1</sup> Personal identification means determination of individuality of a person. It may be complete (absolute) or incomplete (partial). Complete identification means absolute fixation of individuality of a person.

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It may be complete (absolute) or incomplete (partial). Complete identification means absolute fixation of individuality of a person. Partial identification implies ascertainment of only some facts about the identity of the person while others still remain unknown. Age, sex and stature are the primary characteristics of identification.<sup>2</sup>

Identification becomes necessary in the living, recently dead persons, decomposed bodies, mutilated and skeletal remains and is required in civil and criminal cases.<sup>3</sup> Among different parameters of identification, stature estimation of an individual is a basic and key part in identification.

Stature is a primary character for the identification of the person. It increases progressively and becomes maximum at the age of 21 years and then remains constant. It is well known that there is a definite relationship between the height of the person and various parts of the body like head, trunk and lengths of

the upper and lower limbs. Assessing the height of an individual, from measurements of different parts, has always been of immense interest to the anatomists, anthropologists and forensic medicine experts.

Like other parts of the body, such as head, trunk, lengths of upper and lower limb, the foot size also displays a definite biological correlation with stature. On the basis of this relationship, it is possible to predict the stature from the foot and its segments.

A forensic specialist is often required to estimate the stature of a person from dismembered body parts and bones. Length of different body parts bears constant relationship with the body length. In view of this, the present study is undertaken to know the approximate relationship between foot length and stature of a person in this region.

Foot prints are often found in crime scene investigation and stature estimation by foot length is helpful in identification of the suspect. Several studies have been conducted to estimate stature using various parameters like-head length, hand and phalangeal length, long bone length superior and inferior extremity length, foot length and foot breadth.<sup>4</sup>

These studies are important but many factors like racial, ethnic, and nutritional factors play an important role in human growth and development and therefore different normograms become necessary for different population. There have been several studies conducted on different population groups in different parts of the world, to estimate stature from different parts of the body. Several workers have shown a significant correlation between foot measurements and stature in different parts of the country.<sup>5</sup>

Such studies have been carried out by anatomists, forensic medicine experts and anthropologists. They have used either the somato-metric measurements of the foot using anthropometric instruments or foot outline measurements by contour tracing method or the foot print measurements to correlate the foot measurements with stature and reconstruct height. Many studies derived several multiplication factors and regression formulae to estimate stature using different foot

measurements. These normograms, which were derived, are known to vary from one population group to another, so separate studies for each population group becomes necessary.

### **Materials and Methodology:**

The present study was conducted among the consenting students and staff of the Medical College, Vijayapur, among the age group of 21-40 years, after approval from the Institutional Ethics Committee. Individuals suffering from chronic illness, endocrine disorders (Dwarfism, Gigantism, Cretinism etc), individuals with deformities of foot (Flat Foot), lower limbs (Knock-Knee), and vertebral column (Scoliosis, Kyphosis) were excluded.

**Equipment:** Vernier Caliper, Standing height measuring instrument, calculator

**Methodology:** The study group was divided in to two groups based on age. Group A consisted of 100 subjects (50 male and 50 female) of age group 21-30 yrs, and Group B consisted of 100 subjects (50 male and 50 female) of age group 31-40 yrs, Stature and foot length of each subject is taken as follows:

**Recording of Foot length:** The aim and objective of the study was explained and informed consent was taken. Measurements made on the standing subject, his right leg being slightly bent and drawn backwards so that the body rested mainly on the left foot, to measure left foot and vice versa. The vernier calipers was horizontally placed along the medial border of the foot, the fixed part of the outer jaw of the caliper was applied to the most prominent point of the back of the heel (pternion) and the mobile part of the outer jaw was approximated to the tip of the hallux or the tip of the second toe (acropodian) when the second toe was larger than hallux, and it was measured in centimeters approximated to the nearest millimeter.<sup>5,6</sup>

**Recording of the stature:** The stature of each subject was recorded by asking him/her to stand erect with bare foot on the base of the standard height measuring instrument<sup>7</sup> in a standing position. Then the subjects were asked to stand without support, with arms by the side of the body, head in steady position. The height was measured from the ground to the highest point

on the subjects head with the help of horizontal thin plate in close contact with the scalp in centimeters to the nearest millimeters.

The data was tabulated, analyzed and subjected to statistical calculations for each group and paired sample t-test was applied to known difference of means in two groups. If there was statistically significant difference ( $p < 0.01$ ) in means between the two groups, then further correlation and regression was analyzed separately in each group. If there was no statistically significant difference ( $p > 0.01$ ) in means between two groups then both groups data was combined and further correlation and regression was analyzed as a whole group.

### Results:

A Cross-sectional study was carried out on 200 students and staff of medical college, Vijayapur. The individuals of both the sexes, aged between 21-40 years, were included in the study. The subjects were later divided in two groups: Group A (21-30yrs) and Group B (31-40yrs). The stature and foot length of the individuals were assessed and an attempt was made to correlate foot length with stature and derive regression equations to calculate stature from foot length.

The age distribution of the study Group A included individuals aged between 21-30 years, with a mean age of  $24.32 \pm 2.19$  years, of both the sexes, i.e., 50 males and 50 females. The Stature of males varied in a range of 155.1 . 183.0 cm with a mean of  $170.74 \pm 5.71$  cm and that of females ranged from 143.5 . 174.5 cm, with a mean of  $155.69 \pm 5.50$  cm. The Right foot length in males ranged from 21.71 . 29.55 cm, with a mean of  $25.56 \pm 1.33$  cm and that of females ranged from 21.24 . 25.41 cm, with a mean of  $23.15 \pm 1.03$  cm. The Left foot length in males ranged from 20.63 . 27.51 cm, with a mean of  $25.19 \pm 1.39$  cm and that of females ranged from 20.41 . 25.21 cm, with a mean of  $22.80 \pm 1.03$  cm.

The Stature of pooled subjects in group A varied in range from 143.50 . 183.00 cm, with a mean of  $163.22 \pm 9.40$  cm. The Right foot length of pooled subjects varied from 21.24-29.55cm, with a mean of  $24.36 \pm 1.69$  cm. The Left foot length of pooled subjects varied from 20.41 - 27.51cm, with a mean of  $23.99 \pm 1.71$  cm.

The age distribution of the study Group B included individuals aged between 31- 40 years, with a mean age of  $35.89 \pm 3.03$  years, of both the sexes, i.e., 50 males and 50 females. The stature of males varied in a range of 150.5 . 181.4 cm, with a mean of  $168.12 \pm 6.92$  cm and that of females ranged from 142.5 . 171.6 cm, with a mean of  $156.19 \pm 5.88$  cm. The Right foot length in males ranged from 22.1 . 27.8 cm, with a mean of  $25.19 \pm 1.42$  cm and that of females ranged from 21.37 . 25.61 cm, with a mean of  $23.32 \pm 1.15$  cm. The Left foot length in males ranged from 22.11 . 27.91 cm, with a mean of  $25.14 \pm 1.48$  cm and that of females ranged from 21.14 . 25.12 cm, with a mean of  $23.08 \pm 1.02$  cm.

The Stature of pooled subjects in Group B varied in range from 142.5 . 181.4 cm, with a mean of  $162.15 \pm 8.76$  cm. The Right foot length of pooled subjects varied from 21.37-27.81cm, with a mean of  $24.25 \pm 1.59$  cm. The Left foot length of pooled subjects varied from 21.14 - 27.91cm, with a mean of  $24.11 \pm 1.64$  cm.

**Table 1** shows the Comparison of means of two age Groups i.e., Group A and Group B by Paired Sample T-test. It shows that P-value is  $> 0.05$  for all the pairs except for male stature i.e., p-value is  $> 0.01$  suggesting that there is no statistical significance between Means of Group A and Group B.

Since there is no statistical significance in making two study group, both the groups were combined as a whole study group of 200 subjects between 21-40yrs age group.

The Stature of pooled subjects (Group A + Group B) varied in range from 142.5 . 183.0 cm, with a mean of  $162.69 \pm 9.08$  cm. The Right foot length of pooled subjects varied from 21.24 . 29.55 cm, with a mean of  $24.30 \pm 1.64$  cm. The Left foot length of pooled subjects varied from 20.41 -27.95 cm, with a mean of  $24.05 \pm 1.67$  cm. The Stature of males varied in a range of 150.5 . 183.0 cm, with a mean of  $169.43 \pm 6.45$  cm and that of females ranged from 142.50 . 174.50 cm, with a mean of  $155.94 \pm 5.67$  cm. The Left foot length in males ranged from 20.63 . 27.91 cm, with a mean of  $25.17 \pm 1.43$  cm and that of females ranged from 20.41 . 25.21 cm with a mean of  $22.94 \pm 1.03$  cm (**Table 2, 3**). (**Graphs 1&2**)

Table: 1 Comparison of means of two age Groups i.e., Group A and Group B by Paired Sample T-test

| Pairs  | Groups           | Mean   | Std. Deviation | Std. Error Mean | t-value | Significance P-value |
|--------|------------------|--------|----------------|-----------------|---------|----------------------|
| Pair1  | A-Stature        | 163.22 | 9.40           | 0.94            | 0.816   | 0.417                |
|        | B-Stature        | 162.15 | 8.76           | 0.88            |         |                      |
| Pair2  | A-RFL            | 24.36  | 1.69           | 0.17            | 0.455   | 0.650                |
|        | B-RFL            | 24.25  | 1.59           | 0.16            |         |                      |
| Pair 3 | A-LFL            | 23.99  | 1.71           | 0.17            | -0.500  | 0.618                |
|        | B-LFL            | 24.11  | 1.64           | 0.16            |         |                      |
| Pair 4 | A-Male stature   | 170.74 | 5.71           | 0.81            | 2.192   | 0.033                |
|        | B-Male stature   | 168.12 | 6.92           | 0.98            |         |                      |
| Pair 5 | A-Male RFL       | 25.56  | 1.33           | 0.19            | 1.332   | 0.189                |
|        | B-Male RFL       | 25.19  | 1.42           | 0.20            |         |                      |
| Pair 6 | A-Male LFL       | 25.19  | 1.39           | 0.20            | 0.175   | 0.862                |
|        | B-Male LFL       | 25.14  | 1.48           | 0.21            |         |                      |
| Pair 7 | A-Female stature | 155.69 | 5.50           | 0.78            | -0.448  | 0.656                |
|        | B-Female stature | 156.19 | 5.88           | 0.83            |         |                      |
| Pair 8 | A-Female RFL     | 23.15  | 1.03           | 0.15            | -0.805  | 0.425                |
|        | B-Female RFL     | 23.32  | 1.15           | 0.16            |         |                      |
| Pair 9 | A-Female LFL     | 22.80  | 1.03           | 0.15            | -1.566  | 0.124                |
|        | B-Female LFL     | 23.08  | 1.02           | 0.14            |         |                      |

Table: 2 Comparison of Stature, Right foot length, and Left Foot Length between males and females (Group A + Group B)

|                | Variables | Minimum | Maximum | Mean $\pm$ S.D    |
|----------------|-----------|---------|---------|-------------------|
| Total (Pooled) | Stature   | 142.50  | 183.00  | 162.69 $\pm$ 9.08 |
|                | RFL       | 21.24   | 29.55   | 24.30 $\pm$ 1.64  |
|                | LFL       | 20.41   | 27.95   | 24.05 $\pm$ 1.67  |
| Male           | Stature   | 150.50  | 183.00  | 169.43 $\pm$ 6.45 |
|                | RFL       | 21.71   | 29.55   | 25.37 $\pm$ 1.38  |
|                | LFL       | 20.63   | 27.91   | 25.17 $\pm$ 1.43  |
| Female         | Stature   | 142.50  | 174.50  | 155.94 $\pm$ 5.67 |
|                | RFL       | 21.24   | 25.61   | 23.24 $\pm$ 1.09  |
|                | LFL       | 20.41   | 25.21   | 22.94 $\pm$ 1.03  |

Table: 3 Comparison of Mean of Stature, RFL and LFL between Male and Female (Group A +Group B)

| Variables    | Stature in cm          | RFL in cm              | LFL in cm              |
|--------------|------------------------|------------------------|------------------------|
| Male         | 169.43 $\pm$ 6.45      | 25.37 $\pm$ 1.38       | 25.17 $\pm$ 1.43       |
| Female       | 155.94 $\pm$ 5.67      | 23.24 $\pm$ 1.09       | 22.94 $\pm$ 1.03       |
| Significance | t=16.380;<br>p<0.001** | t=12.264;<br>p<0.001** | t=12.886;<br>p<0.001** |

\*\*P-value<0.001 shows strong significance of Mean between Male and Female.

The Right foot length versus stature correlation coefficient in males was 0.677 and in females, it was 0.592. When both sexes were put together, the correlation was 0.811, at p<0.001 which is strongly significant. The Left foot length versus stature correlation coefficient in males was 0.707 and a female was 0.582. When both sexes were put together the correlation was 0.823, at p<0.001 which is strongly significant (Table 4)

Table 4: Correlation Coefficient (r), Regression coefficient (b), and value of Constant (b) between foot lengths and stature (Group A +Group B)

|                 |                             | Total  | Male   | Female | P-value  |
|-----------------|-----------------------------|--------|--------|--------|----------|
| RFL Vs. Stature | Correlation Coefficient (r) | 0.811  | 0.677  | 0.592  | p<0.001* |
|                 | Regression Coefficient(b)   | 4.489  | 3.158  | 3.087  | p<0.001* |
|                 | Value of constant (a)       | 53.591 | 89.297 | 84.203 | p<0.001* |
| LFL Vs. Stature | Correlation Coefficient (r) | 0.823  | 0.707  | 0.582  | p<0.001* |
|                 | Regression Coefficient(b)   | 4.469  | 3.189  | 3.203  | p<0.001* |
|                 | Value of constant (a)       | 55.195 | 89.163 | 82.477 | p<0.001* |

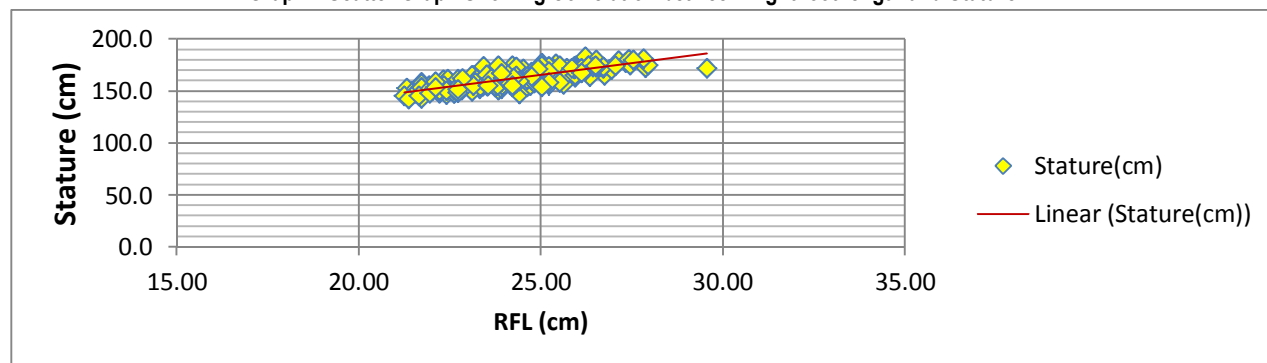
The Table 5 shows regression equations to calculate stature from right and left foot length by substituting values of foot length in males, and females, as well as when both sexes are combined.

Table 5: Regression equation for the prediction of Stature by Right and Left foot length (Group A + Group B)

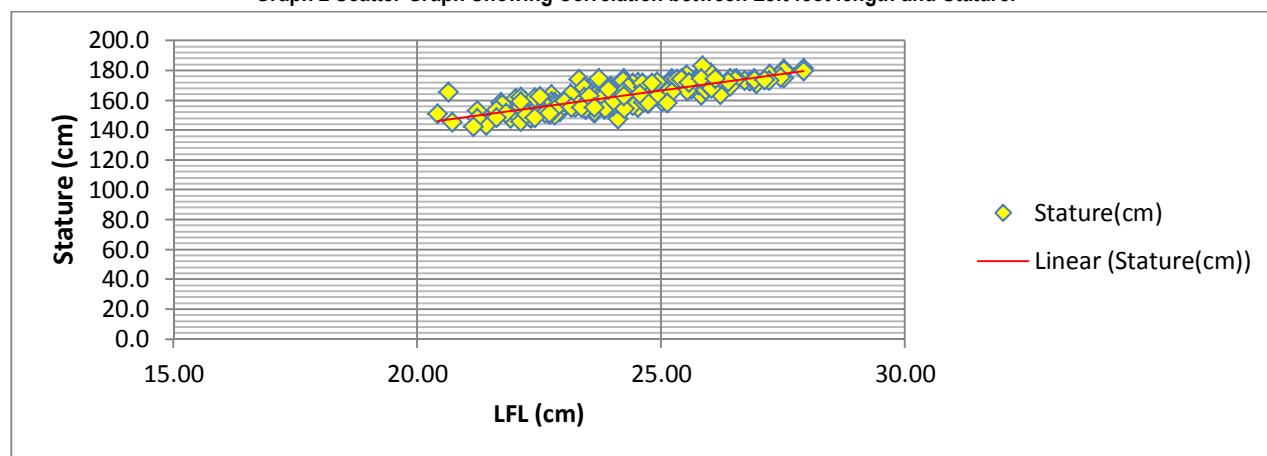
|                | RFL  | LFL  |
|----------------|--|--|
| Total (Pooled) | Stature=53.591+4.489 $\times$ RFL<br>( $r^2 = 0.657$ p<0.001*) | Stature=55.195+4.469 $\times$ LFL<br>( $r^2 = 0.678$ p<0.001*) |
| Male           | Stature=89.297+3.158 $\times$ RFL<br>( $r^2 = 0.459$ p<0.001*) | Stature=89.163+3.189 $\times$ LFL<br>( $r^2 = 0.500$ p<0.001*) |
| Female         | Stature=84.203+3.087 $\times$ RFL<br>( $r^2 = 0.351$ p<0.001*) | Stature=82.477+3.203 $\times$ LFL<br>( $r^2 = 0.338$ p<0.001*) |

\*P-value<0.001 is strongly significant

Graph 1 Scatter Graph Showing Correlation between Right foot length and Stature.



Graph 2 Scatter Graph Showing Correlation between Left foot length and Stature.



### Discussion:

Stature estimation is one of the important parameters in the process of identification. Every biometric analysis starts with stature. For years, anthropologists, forensic experts, have carried out various studies to calculate stature using various body parts.

Stature of a person shows definitive correlation between different body parts of body and this was utilized for estimating stature. Among the different body parts, foot length provides significant correlation which is shown in different studies conducted in different parts of the world.<sup>4</sup>

There are several studies conducted to estimate stature by different parameters; like Brenda et al,<sup>5</sup> Kairulmazidah, et al,<sup>8</sup> Eugene, et al<sup>9</sup> used shoe length and foot length, for estimating stature, but concluded that foot length was more reliable for estimating stature. Ebimobo, et al,<sup>4</sup> Jaydip, et al<sup>10</sup> Jitendar Pratap, et al<sup>11</sup>, Rahul Rai, et al,<sup>12</sup> Rajesh, et al,<sup>13</sup> Arti, et al,<sup>14</sup> Geetha, et al,<sup>15</sup> Chikhalkar, et al,<sup>16</sup> Dayananada, et al,<sup>17</sup> used foot length and foot

breadth for correlating stature and found foot breadth to be moderately significant for estimating stature, compared to foot length, which is strongly significant.

Few studies like Moshkdanian, et al<sup>18</sup> and Sumita Agarwal, et al,<sup>19</sup> Chikhalkar, et al<sup>16</sup> used lower limb length, knee length, knee-ankle length, respectively, for estimating stature.

Sonali, et al<sup>20</sup> used hand length and head length, Geetha, et al,<sup>15</sup> Chikhalkar, et al,<sup>16</sup> used hand length dimension for estimating stature, and found mixed significance for estimating stature.

In the present study, only foot length of both sexes was noted and an attempt was made to find the relation between stature and foot length in the study group, using statistical analysis.

Several study groups used different age group ranging from 17-25 years<sup>6</sup> to 18 to 72 years,<sup>21</sup> accounting for difference in stature as age progresses.

In the present study, initially study group was divided in two groups Group A (21-30years)



and Group B (31-40 years), since after age of 30 years there is gradual decrease in stature by about 0.6mm per year.<sup>1</sup> Later Paired sample T-test was done on the both age groups, as shown in **Table 1** and it was found that Mean difference of both age groups was not statistically significant ( $p>0.01$ ). Hence, both the age groups were combined and a single study group of 200 subjects (100 male and 100 female) was used for further analysis of foot length and stature.

The paired sample t-test was done by Kemo, et al,<sup>4</sup> Parekh, et al<sup>22</sup> and Geetha, et al<sup>15</sup> for statistical difference between means of male and female and they found that it is highly significant  $p<0.001$ .

Similar results were found in present study, as shown in **Table 1**, where the difference in male and female mean was highly significant ( $p<0.001$ ).

It is a known fact that there is difference in development in males and females, and hence, several studies compared their findings between males and females; although few studies like Ghazaleh, et al<sup>18</sup> and Karaddi, et al<sup>23</sup> used only male subjects, and Jitendra Singh, et al<sup>11</sup> used only female subjects for their analysis. Several studies gave equal importance to both sexes, like Arif, et al,<sup>6</sup> Keme, et al,<sup>4</sup> Rameswarapu, et al,<sup>25</sup> Verma, et al,<sup>26</sup> Nivedita, et al,<sup>27</sup> Geetha, et al,<sup>15</sup> Sumita, et al,<sup>19</sup> Vinay, et al,<sup>30</sup> using equal number of male and female subjects, where as other studies like Mansue, et

al,<sup>6</sup> Mehul, et al,<sup>31</sup> Sonali, et al,<sup>20</sup> Mohanty, et al,<sup>32</sup> Rahul, et al,<sup>12</sup> Seema, et al,<sup>33</sup> and Utsav, et al,<sup>22</sup> used variable number of male and female subjects. In the present study, among the total subjects, 100 males and 100 females were used and separate correlation was obtained between foot length and stature for both male and female.

Many factors influence the foot-length in the same individuals of both limbs such as developmental factors, wearing of footwear, nutrition, weight bearing. Hence length of foot in both may differ. Hence, several studies like Mansul, et al,<sup>6</sup> Mehul, et al,<sup>31</sup> Rahul, et al,<sup>12</sup> Rameswarapu, et al,<sup>25</sup> Rajesh, et al,<sup>13</sup> Rakhee, et al,<sup>26</sup> Nivedita, et al,<sup>27</sup> Chavan et al,<sup>26</sup> and Vinay, et al<sup>30</sup> used both the lower limbs in their studies. However, few studies like Neetu, et al,<sup>21</sup> Patel, et al,<sup>7</sup> Dayananda, et al<sup>17</sup> used only left foot as per the recommendation of the international agreement for paired measurements at Geneva (1910). Few workers like Utsav, et al<sup>22</sup> found no statistical difference between right and left foot ( $p>0.005$ ), hence used only right foot. In the present study, considering variation in right and left foot, both the limbs in both sexes were used and correlation was analyzed separately for both the right and left side.

The observations made by the various studies and the results obtained have been presented in the tables. (**Tables 6 - 11**)

**Table 6: The Correlation coefficient (r), coefficient of determination ( $r^2$ ) and regression equation to estimate Stature(y) from right foot length(x) in males of different study groups**

| Study                    | Study Group            | RFL vs Stature, In Male Subjects |       |                     |
|--------------------------|------------------------|----------------------------------|-------|---------------------|
|                          |                        | r                                | $r^2$ | Regression Equation |
| Mehul et al 2015         | Jamnager, Gujarat      | 0.752                            | 0.566 | $y=86.96+3.40x$     |
| Rahul et al 2014         | Moradabad UP           | 0.433                            | 0.187 | $y=116.51+2.07x$    |
| Utsav et al 2014         | Ahmedabad              | 0.979                            | 0.958 | $y=74.75+3.42x$     |
| Rameswarapu et al 2013   | Ghanapur AP            | 0.583                            | 0.340 | $y=82.830+3.468x$   |
| Rajesh et al 2015        | Puducherry             | 0.821                            | 0.674 | $y=98.159+3.746x$   |
| Rakhee et al 2015        | Ghaziabad              | 0.877                            | 0.769 | $y=53.918+4.497x$   |
| Niveditha et al 2011     | NaviMumbai, Maharastra | 0.451                            | 0.203 | $y=128.951+1.695x$  |
| Arti et al 2013          | Nagpur                 | 0.97                             | 0.941 | $y=90.1+5.96x$      |
| Sumita et al 2015        | Moradabad UP           | 0.7025                           | 0.494 | $y=69.99+3.93x$     |
| K.D.Chavan et al         | Ahmednagar, Maharastra | 0.63                             | 0.397 | $y=167.9+1.145x$    |
| Jitender et al           | Rohtak, Haryana        | 0.527                            | 0.278 | $y=86.620+3.414x$   |
| Vijayakumar et al 2013   | Davangere              | 0.37                             | 0.137 | $y=88.39+3.27x$     |
| Saranabasappa et al 2013 | Raichur                | 0.82                             | 0.672 | $y=86.9+3.40x$      |
| Vinay et al 2014         | Bagalkot               | 0.65                             | 0.423 | $y=92.5+3.0x$       |
| Present Study            | Vijayapur              | 0.677                            | 0.458 | $y=89.297+3.158x$   |

Table 7: The Correlation coefficient (r), coefficient of determination (r<sup>2</sup>) and regression equation to estimate Stature(y) from right foot length(x) in females of different study groups

| Study                  | Study Group            | RFL vs Stature In Female Subjects |                |                     |
|------------------------|------------------------|-----------------------------------|----------------|---------------------|
|                        |                        | r                                 | r <sup>2</sup> | Regression equation |
| Mehul et al 2015       | Jamnager, Gujarat      | 0.731                             | 0.534          | y=77.35+3.605x      |
| Rahul et al 2014       | Moradabad UP           | 0.728                             | 0.530          | y=14.75+6.39x       |
| Utsav et al 2014       | Ahmedabad              | 0.988                             | 0.976          | y=63.62+3.61x       |
| Rameswarapu et al 2013 | Ghanapur AP            | 0.66                              | 0.436          | y=73.523+3.615x     |
| Rajesh et al 2015      | Puducherry             | 0.837                             | 0.701          | y=91.242+3.284x     |
| Rakhee et al 2015      | Ghaziabad              | 0.7                               | 0.490          | y=78.200+3.427x     |
| Niveditha et al 2011   | NaviMumbai, Maharastra | 0.421                             | 0.177          | y=118.533+1.692x    |
| Arti et al 2013        | Nagpur                 | 0.9869                            | 0.974          | y=53.0+4.26x        |
| Sumita et al 2015      | Moradabad UP           | 0.4846                            | 0.235          | y=89.82+2.95x       |
| K.D.Chavan et al       | Ahmednagar, Maharastra | 0.75                              | 0.563          | y=154.98+3.616x     |
| Jitender et al         | Rohtak, Haryana        | 0.697                             | 0.486          | y=73.132+3.721x     |
| Vijayakumar et al 2013 | Davangere              | 0.47                              | 0.221          | y=81.29+3.32x       |
| Vinay et al 2014       | Bagalkot               | 0.62                              | 0.384          | y=74.27+3.53x       |
| Present Study          | Vijayapur              | 0.592                             | 0.350          | y=84.203+3.087x     |

Table 8: The Correlation coefficient (r), coefficient of determination (r<sup>2</sup>) and regression equation to estimate Stature(y) from right foot length(x) in Pooled subjects of different study groups

| Study                  | Study Group     | RFL vs Stature in Pooled subjects |                |                     |
|------------------------|-----------------|-----------------------------------|----------------|---------------------|
|                        |                 | r                                 | r <sup>2</sup> | Regression equation |
| Rahul et al 2014       | Moradabad UP    | 0.671                             | 0.450          | y=90.32+3.07x       |
| Rameswarapu et al 2013 | Ghanapur AP     | 0.8                               | 0.640          | y=47.971+4.782x     |
| Rakhee et al 2015      | Ghaziabad       | 0.892                             | 0.796          | y=56.910+4.363x     |
| Sumita et al 2015      | Moradabad UP    | 0.7471                            | 0.558          | y=63.00+4.17x       |
| Jitender et al         | Rohtak, Haryana | 0.869                             | 0.755          | y=47.631+4.889x     |
| Present Study          | Vijayapur       | 0.811                             | 0.658          | y=53.591+4.489x     |

Table 9: The Correlation coefficient (r), coefficient of determination (r<sup>2</sup>) and regression equation to estimate Stature(y) from Left foot length(x) in Male subjects of different study groups

| Study                    | Study Group            | LFL vs Stature in Male subjects |                |                     |
|--------------------------|------------------------|---------------------------------|----------------|---------------------|
|                          |                        | r                               | r <sup>2</sup> | Regression equation |
| Arif et al 2015          | Lahore                 | 0.59                            | 0.348          | y=104.455+2.591x    |
| Keme et al 2014          | Western Nigeria        | 0.7                             | 0.490          | y=3.858x+71.19      |
| Ghazaleh et al 2014      | Iran                   | 0.78                            | 0.608          | y=80.693+3.56x      |
| Mehul et al 2015         | Jamnager, Gujarat      | 0.769                           | 0.591          | y=84.63+3.49x       |
| Sonali et al 2012        | Pune, Maharastra       | 0.702                           | 0.493          | y=72.8+3.7x         |
| Rahul et al 2014         | Moradabad UP           | 0.461                           | 0.213          | y=115.45+2.11x      |
| Rameswarapu et al 2013   | Ghanapur AP            | 0.585                           | 0.342          | y=80.955+3.547x     |
| Rajesh et al 2015        | Puducherry             | 0.787                           | 0.619          | y=97.843+3.651x     |
| Rakhee et al 2015        | Ghaziabad              | 0.869                           | 0.755          | y=57.951+4.642x     |
| Niveditha et al 2011     | NaviMumbai, Maharastra | 0.452                           | 0.204          | y=106.265+2.236x    |
| Arti et al 2013          | Nagpur                 | 0.9669                          | 0.935          | y=85.7+5.96x        |
| GN Geetha et al 2015     | Kerala                 | 0.55                            | 0.303          | y=98.51+2.42x       |
| Sumita et al 2015        | Moradabad UP           | 0.7027                          | 0.494          | y=70.93+3.89x       |
| K.D.Chavan et al         | Ahmednagar, Maharastra | 0.61                            | 0.372          | y=167.9+1.063x      |
| Patel et al 2007         | Ahmedabad, Gujarat     | 0.65                            | 0.423          | y=75.45+3.64x       |
| Jitender et al           | Rohtak, Haryana        | 0.525                           | 0.276          | y=80.671+3.648x     |
| Vijayakumar et al 2013   | Davangere              | 0.34                            | 0.116          | y=92.81+3.10x       |
| Saranabasappa et al 2013 | Raichur                | 0.8                             | 0.640          | y=112+2.41x         |
| Vinay et al 2014         | Bagalkot               | 0.72                            | 0.518          | y=85.32+3.3x        |
| Present Study            | Vijayapur              | 0.707                           | 0.500          | y=89.163+3.189x     |

Table 10: The Correlation coefficient (r), coefficient of determination (r<sup>2</sup>) and regression equation to estimate Stature(y) from Left foot length(x) in Female subjects of different study groups

| Study                  | Study Group            | LFL vs Stature in Female subjects |                |                     |
|------------------------|------------------------|-----------------------------------|----------------|---------------------|
|                        |                        | r                                 | r <sup>2</sup> | Regression equation |
| Arif et al 2015        | Lahore                 | 0.63                              | 0.397          | y=88.210+2.93x      |
| Keme et al 2014        | Western Nigeria        | 0.8                               | 0.640          | y=3.578x+73.15      |
| Mehul et al 2015       | Jamnager, Gujarat      | 0.718                             | 0.516          | y=78.92+3.53x       |
| Sonali et al 2012      | Pune, Maharastra       | 0.645                             | 0.416          | y=90.0+3.2x         |
| Jitender et al 2013    | New Delhi              | 0.583                             | 0.340          | y=2.967x+88.235     |
| Rahul et al 2014       | Moradabad UP           | 0.751                             | 0.564          | y=7.23x+3.62        |
| Rameswarapu et al 2013 | Ghanapur AP            | 0.653                             | 0.426          | y=79.83+3.349x      |
| Rajesh et al 2015      | Puducherry             | 0.876                             | 0.767          | y=90.976+3.041x     |
| Rakhee et al 2015      | Ghaziabad              | 0.719                             | 0.517          | y=73.568+3.620x     |
| Niveditha et al 2011   | NaviMumbai, Maharastra | 0.506                             | 0.256          | y=128.233+1.726x    |
| Arti et al 2013        | Nagpur                 | 0.9848                            | 0.970          | y=53.3+4.23x        |
| GN Geetha et al 2015   | Kerala                 | 0.412                             | 0.170          | y=81.978+2.94x      |
| Sumita et al 2015      | Moradabad UP           | 0.3885                            | 0.151          | y=93.17+2.81x       |
| K.D.Chavan et al       | Ahmednagar, Maharastra | 0.71                              | 0.504          | y=154.98+3.481x     |
| Patel et al 2007       | Ahmedabad, Gujarat     | 0.8                               | 0.640          | y=75.41+3.43x       |
| Jitender et al         | Rohtak, Haryana        | 0.719                             | 0.517          | y=65.194+4.068x     |
| Vijayakumar et al 2013 | Davangere              | 0.47                              | 0.221          | y=80.90+3.34x       |
| Vinay et al 2014       | Bagalkot               | 0.6                               | 0.360          | y=73.5+3.56x        |
| Present Study          | Vijayapur              | 0.582                             | 0.339          | y=82.477+3.203x     |

Table 11: The Correlation coefficient (r), coefficient of determination (r<sup>2</sup>) and regression equation to estimate Stature(y) from Left foot length(x) in Pooled subjects of different study groups

| Study                  | Study Group      | LFL vs Stature in Pooled subjects |                |                      |
|------------------------|------------------|-----------------------------------|----------------|----------------------|
|                        |                  | r                                 | r <sup>2</sup> | Regression equation  |
| Arif et al 2015        | Lahore           | 0.807                             | 0.651          | y=58.101+4.261x      |
| Keme et al 2014        | Western Nigeria  | 0.8                               | 0.640          | y=4.671x+47.79       |
| Sonali et al 2012      | Pune, Maharastra | 0.849                             | 0.721          | y=55.5+1.5x          |
| Rahul et al 2014       | Moradabad UP     | 0.679                             | 0.461          | y=91.74+3.02x        |
| Rameswarapu et al 2013 | Ghanapur AP      | 0.602                             | 0.362          | y=50.350+4.691x      |
| Rakhee et al 2015      | Ghaziabad        | 0.991                             | 0.982          | y=56.088+4.393x      |
| Sumita et al 2015      | Moradabad UP     | 0.7434                            | 0.553          | y=64.99+4.09x        |
| Chikhalkar et al 2009  | Byculla, Mumbai  | 0.6102                            | 0.372          | y=79.72379+3.650632x |
| Jitender et al         | Rohtak, Haryana  | 0.969                             | 0.939          | y=43.852+5.047x      |
| Dayananda et al 2014   | Kolar            | 0.636                             | 0.404          | y=69.346+3.663x      |
| Present Study          | Vijayapur        | 0.823                             | 0.677          | y=55.195+4.469x      |

The mean stature in all the studies was found to be significantly greater in males when compared to females, except in Seema, et al,<sup>33</sup> where female mean height was greater. The mean male stature in present study was similar to Vinay, et al<sup>30</sup> may be because his study group region is nearby, and Rahu, et al<sup>12</sup> but variations are present in different study groups. The mean female stature in the present study was similar to Arti, et al<sup>14</sup> and Patel, et al<sup>7</sup> but is inconsistent with other groups. In the pooled subjects, mean stature in the present study was similar to Sumitha, et al<sup>19</sup> but inconsistent with other studies.

The variation in values can be attributed to various reasons like genetic and

environmental factors, study group regions, methodology etc. The mean right foot length in pooled subjects in present study was similar to Rameswarapu, et al<sup>25</sup> and Jitender, et al.<sup>34</sup> but slight variations were observed in other studies. The mean right foot length of males in present study was similar to Vinay, et al<sup>31</sup> since their study region is close to the present study region, but the female mean right foot length was similar to that of Rakhee, et al,<sup>26</sup> and Chavan et al.<sup>28</sup> The other studies were inconsistent with our study.

The mean left foot length in pooled subjects in the present study was similar to that of Chikhalkar, et al<sup>16</sup> but variations were observed in other studies. The mean left foot

length of males in the present study was similar to that of Dayanand, et al<sup>17</sup> but female mean left foot length was similar to that of Sumitha, et al.<sup>19</sup> The other studies were inconsistent with present study.

The foot length was found to be more in males than in females in most of the study group including the present study group. This may be because the growth of feet stops about two years in female than in males. The Correlation coefficient (r) for correlation between right foot length and stature in males for different study group ranged from 0.37 (Vijaykumar, et al<sup>29</sup>) to 0.979 (Utsav, et al<sup>22</sup>), which indicates moderate to nearly perfect correlation.

The value of r in the present study was similar to that of Vinay et al,<sup>30</sup> which has similar study group and also the r value was similar to Chavan, et al,<sup>28</sup> but it varies considerably with other studies.

In the present study, the correlation between right foot length and stature in males was 0.677 suggesting large correlation. Indicating stature could be predicted with good accuracy using right foot length in males.

The Coefficient of determination ( $r^2$ ) was lowest in 0.137 in Vijaykumar, et al<sup>29</sup> suggesting that 13.7% of the variation in stature can be explained by right foot length. The highest was in Utsav et al,<sup>22</sup> which was 0.958, whereas the right foot length explains 95.8% variation in stature. In present study, the value of  $r^2$  was 0.458 implying that 45.8% of variation in stature can be attributed to right foot length in males.

The regression equation of present study was similar to that of Vijayakumar, et al<sup>29</sup> and Arti, et al<sup>22</sup> but it varies in other studies, indicating requirement of different equation for different regions. The regression equation has a constant and a multiplication factor. The right foot length was multiplied with the multiplication factor and added to the constant to get the stature.

In the present study, in case of the males, the constant was 89.297 and the multiplication factor was 3.158, which indicated that for every 1cm increase in right foot length, the stature increases by 3.158cm.

As seen in all studies, the value of r,  $r^2$ , and regression equation varies in a wide range

owing difference in region, age group, and methodology.

The Correlation coefficient (r) for correlation between right foot length and stature in females for different study group ranged from 0.421 (Niveditha, et al<sup>27</sup>) to 0.988 (Utsav et al<sup>22</sup>), which indicates moderate to nearly perfect correlation.

The r value in the present for right foot length in females was similar to Vinay et al,<sup>30</sup> but varied considerably with other studies.

In the present study, the correlation between right foot length and stature in females was 0.592, suggesting large correlation. Indicating stature could be predicted with good accuracy, using right foot length in females.

The values of coefficient of determination ( $r^2$ ) was lowest, 0.117, in Niveditha et al,<sup>27</sup> suggesting that 11.7% of the variation in stature could be explained by right foot length. The highest was in Utsav et al,<sup>22</sup> which was 0.976 where right foot length explains 97.6% variation in stature. In the present study, the value of  $r^2$  was 0.350 implying that 35.0% of variation in stature can be attributed to right foot length in males.

The regression equation in the present study for females was not similar to any of the above studies indicating essentiality of regression equation for separate sexes.

In the present study, in case of females, the constant was 84.203 and multiplication factor was 3.087, which indicated that for every 1cm increase in right foot length, the stature increased by 3.087cm. This equation can be used to estimate stature in female using right foot length.

The values obtained for pooled subjects in the present study vary considerably with other studies only correlation coefficient was similar to Rameswarapu, et al.<sup>25</sup>

The value of r for between right foot length and stature in pooled sample for different study group ranged from 0.671 (Rahul, et al<sup>12</sup>) to 0.892 (Rakhee, et al<sup>26</sup>) and value of  $r^2$  ranged from 0.450 to 0.796, indicating large to very large correlation.

In the present study, the correlation between right foot length and stature in pooled subjects was 0.811 and  $r^2$  was 0.658, suggesting

large correlation and indicating that stature could be predicted with good accuracy using right foot length in pooled subjects.

The value of  $r$  for correlation between left foot length and stature in males for different study group ranged from 0.34 (Vijayakumar, et al<sup>29</sup>) to 0.9669 (Arti, et al<sup>14</sup>), which indicates moderate to nearly perfect correlation (**Table 9**).

The correlation coefficient in the present study for males in present study was similar to Sumitha, et al<sup>19</sup> and Sonali, et al,<sup>20</sup> but it varied in other studies.

In the present study, the correlation between left foot length and stature in males was 0.707, suggesting very large correlation. Indicating stature could be predicted with very good accuracy using left foot length in males.

The Coefficient of determination ( $r^2$ ) was lowest in 0.116 in Vijaykumar et al<sup>29</sup> suggesting 11.6% of the variation in stature can be explained by right foot length. The highest was in Arti et al<sup>14</sup> which was 0.935 whereas the left foot length explains 93.5% variation in stature. In the present study, the value of  $r^2$  was 0.500 implying that 50.0% of variation in stature can be attributed to left foot length in males.

The regression equation obtained from different studies varied from present study but it was closer to the value obtained by Vijayakumar, et al.<sup>29</sup>

In the present study of males, the constant is 89.163 and multiplication factor is 3.189 which indicated that for every 1cm increase in right foot length the stature increases by 3.189cm. The Correlation coefficient ( $r$ ) for correlation between left foot length and stature in females for different study group ranged from 0.3885 (Sumitha, et al<sup>19</sup>) to 0.9848 (Arti, et al<sup>14</sup>), which indicates moderate to nearly perfect correlation (**Table 10**)

In the present study, the correlation between left foot length and stature in females was 0.582 suggesting large correlation and indicating that stature could be predicted with good accuracy using left foot length in females. The value coefficient of determination ( $r^2$ ) was lowest in 0.151 in Sumitha, et al<sup>19</sup> suggesting that 15.1% of the variation in stature can be explained by left foot length. The highest was in Arti, et al<sup>14</sup> which was 0.970, where left

foot length explains 97.0% variation in stature. In present study the value of  $r^2$  was 0.339 implying that 33.9% of variation in stature can be attributed to left foot length in females.

In the present study of females, the constant was 82.477 and the multiplication factor was 3.203, which indicated that for every 1cm increase in left foot length the stature increases by 3.203cm. This equation can be used to estimate stature in female using left foot length. The correlation coefficient in the present study for female's left foot was similar to that of Jitender, et al.<sup>11</sup> The regression equation of the present study was closer to that of Geetha, et al<sup>15</sup> compared to other studies where variation was more.

The value of  $r$  for left foot length and stature in pooled sample for different study groups ranged from 0.602 (Rameswarapu, et al<sup>25</sup>) to 0.991 (Rakhee et al<sup>26</sup>), and value  $r^2$  ranged from 0.362 to 0.982, indicating large to very large correlation.

In the present study, the correlation between left foot length and stature in pooled subjects was 0.823 and  $r^2$  was 0.677, suggesting large correlation and indicating that stature could be predicted with good accuracy using left foot length in pooled subjects. The  $r$  value in pooled subjects for left was closer Keme, et al<sup>4</sup> and regression equation was closer to Rakhee, et al<sup>26</sup> but variations were considerably more, compared to other studies.

By comparing  $r$ ,  $r^2$  in different study groups, it was seen that the pooled sample had better correlation than individual sex, for estimating stature from foot length in most of the studies, including the present one. It was also observed that left foot length showed better correlation to estimate stature than right foot length in most of the studies, including the present. As regards sex, males showed better correlation as compared to females in most of the studies including present study.

The studies, when repeated to the same study group after many years, will help to detect any micro evolutionary changes. These studies have anthropological importance also.

## Conclusion

Different parts of body show correlation with each other. This fact can be utilized to

estimate size of one part of part using another part. Using similar theory, stature could be estimated from different body parts.

In the present study, the right and left foot length of both males and females were measured to estimate stature.

The mean difference between two age groups (Group A 21-30 years, Group B 31-40 years) was statistically insignificant, hence further study was conducted as a single group (21-40 years).

The mean values of stature, right foot length and left foot length were found to be greater for males than in females with statistically significant differences.

Both right and left foot length showed positive correlation with stature as seen in correlation coefficient (r) in both males and females. Among sexes males showed better correlation than females, but pooled subjects showed better correlation than individual sexes. Comparatively left foot length showed better correlation coefficient than right foot length in all the subjects.

Linear regression equation were obtained to estimate stature from right and left foot length in both the sexes separately.

Since anthropometric measurements differ in different sex, race, region which are determined by genetic and environmental factors these types of studies are needed for different regions.

These studies are helpful in medico legal investigations where stature estimation becomes the primary identification parameter. Anthropologically these studies are helpful in differences among different population groups.

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## Original Research Paper

# Pattern of Injures in Death due to Electrocution: A 3 year Retrospective Study

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### Abstract:

**Background:** Electricity has become an essential, inevitable, and invaluable; but at the same time dangerous part of our lifestyle. Electrocution injuries are one of the common causes of morbidity and mortality in India. **Aims:** To study the pattern of injuries, manner of death and changes in internal organs of fatal electrocution deaths. **Materials & Methodology:** A retrospective 3 year medico-legal autopsy study during the period of January 2014 to December 2016 of deaths due to electrocution. **Results:** Most of the victims were men aged between 20 and 50 years. In 43.6%, only entry marks were seen, 26.9% showed both the entry and exit marks. 15.4 % showed flame burns on the body. Upper limbs were involved in 55.2% due to a contact with electric source and the commonest site of entry wound was the palms and fingers. **Conclusion:** Electrocutions represent only a small segment of unnatural deaths; they often occur accidentally in domestic and occupational places. Such studies help the investigations for the purpose of compensation and to plan future safety measures.

**Key Words:** Electrocution, Flash Burn, Entry & Exit Wound Pattern.

### Introduction:

The human body is a good conductor of electricity because it contains a large amount of water and dissolved salts in the form of blood and other body fluids. This means that an electric current may pass easily through the body, a process known as electrocution, causing various types of tissue damage and even death. The electricity takes the fastest route through the body which is, typically, from one hand to another or from a hand down to the ground. Electricity related death results from an overwhelming transmission of electrical current through the body.

Cases of electric injury or death due to electrocution are quite common in India where the people are electrocuted commonly due to inadvertent touching of current source and rarely by electric 'ash arc' leaping on them from a low-voltage domestic supply or when they come in the magnetic field of a high tension electric supply. Hence the majority of the electrocutions in India are due to accidental contact with low-voltage current (Alternating current (AC) at 50 Hz., 220-240 V) used in houses and small-scale industries, whereas suicides and homicides by electrocution are rare.<sup>1</sup> It is relatively rare to be electrocuted by a voltage lower than 110 V.<sup>2</sup>

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The characteristic injury of electrocution, the electric contact mark over the body, is usually absent in many of the cases, leading to the quest for other diagnostic criteria of electrocution.<sup>3</sup> Death may be due to ventricular fibrillation, respiratory paralysis, or due to secondary effects of electrocution such as blunt trauma to head or chest due to body thrown by electrocution on ground. Among these, ventricular fibrillation is the most common mechanism of death.<sup>4</sup> Electrical injuries are becoming an emerging health problem in the



low-income countries due to extensive usage of electricity by general public and less awareness of safety issues among them.<sup>5</sup> In view of widespread use of electricity for commercial, industrial, public and domestic purposes, this study was undertaken to know the pattern of electrocution over body, cause of death and its effect on internal organs.

### Materials and Methodology:

This was a 3 year retrospective study conducted at the Department of Forensic Medicine and Toxicology, Dr. V. M. Government Medical College & S.C.S.M.G. Hospital, Solapur, Maharashtra, during the period from January 2014 to December 2016. A total of 6057 autopsies were conducted during this period, of which 78 cases (1.3%) of alleged fatal electrocution were selected for the study. For uniformity, findings were entered in a data sheet with respect to age and gender, pattern of electrocution in the form of either entry or exit wound (contact wound of endogenous thermal injury) or flame burn, site of marks over body and effect on internal visceral organs and cause of death. Information regarding the incidence of electrocution was collected from the history of the cases, the police papers, and autopsy reports. The findings were then scrutinised and statically analysed.

**Inclusion Criteria:** Cases of alleged history of electrocution deaths undergoing medico legal autopsy at place of study during said study period.

**Exclusion criteria:** Cases of lightning strikes, flame burn due to other than electrocution, scald burn and blast death and decomposed dead bodies wherein cause of death could not arrived with certainty.

### Results:

A total 78 cases of fatal electrocution were recorded during the study period. Most of the victims (33.3%) were in the third decade of their life, while around three-fourths belonged to younger and adult age groups (i.e. from 21 to 50 years). 2 victims of fatal electrocution were below the age of 10 years. Majority of the victims were men 70 (89.74%), with a male/female ratio of 8.75:1.

Only entry mark was observed in 34 (43.6%) cases while 21 cases (26.9%) showed both the entry and exit marks. (**Table 1**)

**Table No.-1 Cases according to Types of marks present over body**

| Types of Marks    | No.       | Percentage (%) |
|-------------------|-----------|----------------|
| Only entry mark   | 34        | 43.58          |
| Entry & Exit mark | 21        | 26.92          |
| No mark           | 08        | 10.25          |
| Flame Burn        | 12        | 15.38          |
| Other injuries    | 03        | 3.84           |
| <b>Total</b>      | <b>78</b> | <b>100</b>     |

Upper limbs (Palm& fingers) were the most common sites of the entry mark, 43 cases (55.1%). This was followed by lower limbs, 8 (10.3 %) cases. Palm was the most common site of entry while left foot was the most common site for exit mark, 10 cases (12.8 %), followed by right foot, 6 cases (7.7 %). (**Table 2**)

**Table NO.-2 Cases according to pattern of Entry mark (n-55) & Exit mark ( n-21) over the body**

| Entry Marks over body       | N 55      | (%)        | Exit Marks over body | N 21      | (%)        |
|-----------------------------|-----------|------------|----------------------|-----------|------------|
| Upper Limb (palm & Fingers) | 43        | 55.12      | Right Hand           | 00        | 00         |
| Lower Limb (Soles & Toes)   | 08        | 10.25      | Left Hand            | 04        | 5.12       |
| Head & Neck                 | 02        | 2.56       | Left Foot            | 10        | 12.82      |
| Chest                       | 01        | 1.28       | Right Foot           | 06        | 7.69       |
| Abdomen                     | 01        | 1.28       | Left Thigh           | 01        | 1.28       |
| <b>Total</b>                | <b>55</b> | <b>100</b> | <b>21</b>            | <b>21</b> | <b>100</b> |

The main cause of electrocution was human negligence, which was seen in 56.4% cases, followed by the lack of protective measures, 32.1% cases, and faulty equipment & connection, 11.5% cases. (**Table 3**)

**Table No.-3 Distribution of cases indicating cause of electrocution**

| Cause of electrocution           | No. of Cases | Percentage (%) |
|----------------------------------|--------------|----------------|
| Human Negligence                 | 44           | 56.41%         |
| Faulty Equipment's & Connections | 09           | 11.53%         |
| Lack of Protective Measures      | 25           | 32.05%         |
| <b>Total</b>                     | <b>78</b>    | <b>100%</b>    |

The leading cause of death in electrocution injuries was shock, which constituted 69.2% cases, followed by

septicaemia, 15.4%; coma, 11.5% and shock with head injury, 3.8% cases. (Table 4)

**Table No. -4: Distribution of cases indicating cause of death in Electrocution**

| Cause of Death      | No. of Cases | Percentage (%) |
|---------------------|--------------|----------------|
| Shock               | 54           | 69.23          |
| Septicaemia         | 12           | 15.38          |
| Coma                | 9            | 11.53          |
| Shock & Head Injury | 3            | 3.84           |
| <b>Total</b>        | <b>78</b>    | <b>100%</b>    |

Internal examination revealed visceral organ congestion in 56 cases (71.8%), followed by septicaemic changes in 12 cases (15.4%). Petechial haemorrhage over pericardium, pleura and white matter of brain was found in 7 cases (9%); and pulmonary oedema was seen in 3 cases (3.8%). (Table 5)

**Table No. -5 Effect on visceral organs in Electrocution**

| Variables  | No. of Cases | %age        |
|--|--------------|-------------|
| Congestion   | 56           | 71.79       |
| Septicaemic changes (Secondary Effect of Flame burn) | 12           | 15.38       |
| Petechial Haemorrhages                               | 7            | 8.97        |
| Pulmonary Oedema                                     | 3            | 3.84        |
| <b>Total</b>   | <b>78</b>    | <b>100%</b> |

## Discussion:

Even with high utility of electricity in domestic places, electrocution deaths are not very common in this territory and most of these events were accidental in nature.

In this study, most of the victims (33.3%) were in the third decade of their life, which may be due to the fact that this is the most productive age group which often remains engaged in some or other job related to electric power or equipments or take lead in handling electric equipments at home too, as compared to other age groups. The findings of this study are similar to the studies conducted by Chakroborty.<sup>6</sup> Most of the cases belonged to younger and adult age group from 21 to 40 years, 65.4%, which is also consistent with the findings of study of Rautiji.<sup>7</sup> Obviously, many factors like illiteracy amongst the general public, lack of awareness about the hazards of electricity, poor maintenance of equipment and wire linings etc. must have been responsible for this.

Majority of the victims were men, similar to other studies,<sup>6,8-10</sup> with a male/female ratio of

8.75:1 which coincides with study of Chakroborty.<sup>6</sup>

## Table No.1 - Cases according to Types of Marks present over body

The production of electrical injury depends on voltage, amount of current flow, the area of the contact and duration of contact.<sup>11</sup> As quoted by Bardale,<sup>12</sup> "Entry wound of electrocution is seen as a crater, either round or oval, shallow, bordered by a ridge of skin of about 1 to 3 mm high, around part or whole of the circumference of crater. It is tough on palpation. The crater 'oor is lined by pale ' attened skin and the exit wound is noticed as a greyish white circular spots ,rm to touch and free from in' amatory reaction." The wound of exit may show splitting of skin in form of puncture or lacerated wounds instead of formation of craters or blisters as in entry wound. In this study, in 34 cases (43.6%), only entry marks were seen, while 21 cases (26.9%) showed both the entry and exit marks; in contrast to the findings of the other workers from India,<sup>7</sup> who had figures as high as 86.3% for cases with only entry marks and 13.7 % for both entry and exit wounds.

Surprisingly, in their study, there was not a single case of electrocution without any mark. In 8 cases (10.3%), no marks were seen. In our study there were 9 (8.8%) cases lacking any mark. These cases certainly became cases of negative autopsies. In such cases the cause of death was ascertained by inference after full legal and medical investigations.

In 3 cases (3.8 %), there were additional marks (injury) in the form of 3 cases of head injury. These are associated with touching electric wire and causing electric shock and repelled violently over ground. These results are similar to others also.<sup>12</sup> 12 cases (15.4 %) showed flame burns on the body and clothes, as per the sites involved. These results are consistent with studies of other workers.<sup>13,14</sup> This concluded that the pattern of electrical injuries includes and ranges from entry wound alone; entry & exit wound, flash burns and no external typical signs at all.

**Table No. 2 - Cases according to pattern of Marks present over body**

Our study shows that in majority of the cases, upper limbs (palm & Fingers) were the most common body part affected, followed by lower limbs (soles & toes), which is similar to the observations of almost all other Indian authors.<sup>7,9,10,13,14</sup> This study revealed that the commonest site of entry is the palms and fingers, which coincides with study of Shrigiriwar.<sup>15</sup> The commonest site of exit mark was the left foot, which coincides with study of Mellen.<sup>13</sup>

**Table No. 3 - Distribution of cases indicating cause of electrocution**

In this study, the main cause of electrocution was human negligence, which was seen in 56.4% cases, followed by the lack of protective measures, 32.1% cases, which was almost similar with the observations of Chandru<sup>16</sup> and Kumar.<sup>17</sup>

Workers doing some electrical work were negligent because they were not using the protective measures while working, which were provided to them in the form of protective gloves, harness, belts, etc. For domestic deaths, accidental electrocution could be due to carelessness, ignorance, haste, malfunction of appliances or equipment such as ineffective insulation, lack of protective earthing, faulty grounding and short circuits.<sup>13</sup>

**Table No.4 - Distribution of cases indicating cause of death in Electrocution**

The leading cause of death in electrocution injuries was shock, accounting for 69.2% cases, while it was 56% in the study by Chandu<sup>16</sup> and 70% in the study by Kumar.<sup>18</sup> The main cause of death in electrocution is usually believed to be a disturbance in cardiac conduction system leading to ventricular fibrillation which lead to cardiogenic shock.<sup>12</sup>

**Table No.5 - Effect on visceral organs in Electrocution**

Internal examination showed visceral organ congestion in maximum number of cases along with Petechial haemorrhage over pericardium, pleura and brain white matter, which is consistent with the study by

Koumbourlis<sup>19</sup> & Bardale.<sup>12</sup> It depends upon path of electric current flowing in the system.

Again, septicaemic changes like sub-pleural pus patches, liver sub-capsular yellowish colour pus and mushy spleen were seen in 12 cases (15.4%), following effect of flame burn by electrocution causing dermo-epidermal thermal burns. These are consistent with those of Vij k.<sup>2</sup>

**Conclusion :**

The morbidity and mortality can be reduced by educating the people and the use of proactive measures must be made compulsory to the workers. This study data on fatal electrocution cases may be useful for compiling statistical information and for developing preventive measures.

**Conflict of Interest:** None

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## Original Research Paper

# Pattern of Fatal Cranio-Cerebral Injury in Road Traffic Accidents - An Autopsy Based Study

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### Abstract:

Road traffic accidents are the major cause of death, worldwide. Among the various types of fatalities in road traffic accidents, head or cranio-cerebral injury is on the top, the head being the most vulnerable part of the body. The present study was performed on 100 cases of road traffic accidents in which cranio-cerebral injuries were the only fatal injuries present over body of the victims. In this study, males clearly outnumbered females with male to female ratio as 4.26:1. The highest incidents were seen in the age group 21 - 30 years (29%), followed by the age group 31 - 40 (20%). Most of the victims died within 24 hours of hospitalization i.e. 40%, followed by duration between 24 - 72 hours (26%). Commonest scalp injury noticed in the present study was contusion, seen in 48% of cases, followed by lacerated wounds in 46% cases. Skull fractures were noticed in 77% of cases in which linear fracture (41%) was the most common type of fracture observed. Among the intracranial haemorrhages, combination of SDH and SAH (53% cases) was the commonest.

**Key Words:** Road traffic accidents, Cranio-cerebral injury, Skull fractures, Intracranial haemorrhages.

### Introduction:

WHO defines the road traffic injury as, % fatal or non-fatal injury incurred as a result of a collision on a public road involving at least one moving vehicle+<sup>1</sup> Children, pedestrians, cyclists and the elderly are among the most vulnerable of road users. According to the Ministry of Road Transport and Highways, 4,80,652 persons were injured and 1,50,785 persons were killed in road side accidents in India in 2016.<sup>2</sup>

Among the various fatal injuries in road accident, head or cranio-cerebral injury is the principal killer. Head injury usually refers to traumatic brain injury, but is a broader category because it can involve damage to structures other than the brain, such as the scalp and skull.<sup>3</sup> In this paper, patterns of head injury in road traffic accidents with regards to age, sex, type of injuries over the head and survival period are analysed and discussed.

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### Material and methods:

The present study was carried out in the Department of Forensic Medicine, Pt. B. D. Sharma PGIMS, Rohtak on 100 cases of death due to road side accidents, brought to the department for post-mortem examination, wherein, cranio-cerebral injury was opined as the cause of death. Cases of road side accidents in which other associated fatal injuries were present not included in the study. The details of the all 100 cases namely; age, sex, survival period, scalp injury, skull fractures and intracranial haemorrhages were recorded at the time of post-mortem examination.

**Observations & results:**

As per the **Table no. 1**, males accounted for 81 % victims and the overall Male: Female ratio is 4.26:1.

**Table 1: Gender wise distribution of cases**

| Gender       | Percentage |
|--------------|------------|
| Male         | 81         |
| Female       | 19         |
| <b>Total</b> | <b>100</b> |

Age-wise, maximum cases of road side accidents were seen in the 21- 30 years age group (29 %), followed by 31- 40 years age group (20%). The lowest incidence was seen in 61 . 70 age group (2%). (**Table 2**)

**Table 2: Age & Sex wise distribution of cases**

| Age group (in years) | Male      | Female    | Total % of cases |
|----------------------|-----------|-----------|------------------|
| <10 years            | 3         | 1         | 4                |
| 10 – 20              | 11        | 1         | 12               |
| 21 – 30              | 23        | 6         | 29               |
| 31 – 40              | 15        | 5         | 20               |
| 41 – 50              | 15        | 3         | 18               |
| 51 – 60              | 10        | 2         | 12               |
| 61 – 70              | 1         | 1         | 2                |
| 71 – 80              | 3         | 0         | 3                |
| <b>Total</b>         | <b>81</b> | <b>19</b> | <b>100</b>       |

Majority of the victims died within 24 hours of hospitalization (40%), followed by those who died between 24-72 hrs (26%). Twenty five percent victims either died on the spot or on the way to hospital i.e. brought dead. (**Table 3**)

**Table 3: Distribution according to survival period**

| Sr. no. | Survival period | No. of cases (%) |
|---------|-----------------|------------------|
| 1.      | Brought dead    | 25               |
| 2.      | < 24 hours      | 40               |
| 3.      | 24 – 72 hours   | 26               |
| 4.      | 3 – 7 days      | 7                |

The most common injury noticed over the scalp was contusion (48% cases) followed by lacerated wounds (46%).

**Table 4: Distribution according to type of scalp injury**

| Sr. no. | Type of scalp injury | No. of cases (%) |
|---------|----------------------|------------------|
| 1.      | Contusion            | 48               |
| 2.      | Abraded contusion    | 6                |
| 3.      | Laceration           | 46               |
|         | <b>Total</b>         | <b>100</b>       |

Skull fractures were present in 77% of the cases. The commonest type of skull fracture was linear fracture (41%), followed by combination of linear and diastatic fracture (11%). (**Table: 5**)

**Table 5: Distribution according to type of skull fracture**

| Sr. no. | Type of skull fracture | No. of cases (%) |
|---------|------------------------|------------------|
| 1.      | Linear                 | 41               |
| 2.      | Linear + diastatic     | 11               |
| 3.      | Linear + DCF           | 6                |
| 4.      | DCF                    | 7                |
| 5.      | Diastatic fracture     | 4                |
| 6.      | DCF+ Diastatic         | 8                |
|         | <b>Total</b>           | <b>77</b>        |

DCF: Depressed Comminuted Fracture

**Table 6** shows distribution of intracranial haemorrhages which were seen in all cases. The most common type of intracranial haemorrhage was a combination of SDH and SAH (53%), followed by SAH only (26%).

**Table 6: Distribution according to type of intracranial haemorrhage**

| Sr. no. | Type of intracranial haemorrhage | No. of cases (%) |
|---------|----------------------------------|------------------|
| 1.      | SAH                              | 26               |
| 2.      | SDH                              | 5                |
| 3.      | SAH+SDH                          | 53               |
| 4.      | SAH+ICH                          | 6                |
| 5.      | EDH+SDH+SAH                      | 10               |
|         | <b>Total</b>                     | <b>100</b>       |

SAH: Subarachnoid Haemorrhage, SDH: Subdural Haemorrhage, EDH: Extradural Haemorrhage.

**Discussion:**

In this study, males clearly outnumbered the females with male to female ratio of 4.26:1. This result is similar to the other studies i.e. Kumar A, et al,<sup>4</sup> Singh YN, et al,<sup>5</sup> Singh H, et al<sup>6</sup> and Biswas G et al<sup>7</sup>.

In the age group analysis of the victims, maximum incidence was observed in age group of 21-30 years which was also noticed by the other authors in their studies like Tirpude BH, et al,<sup>8</sup> Singh H, et al<sup>6</sup> and Sharma B, et al; whereas least incidence was noticed in the age group 61-70.

The time of survival in cases of head injury depends on the severity of trauma and availability of health care services. In present study, the maximum number of victims died

within 24 hours of hospitalization (40%) followed by death between 24 to 72 hours (26%); which is similar to the study of Chaturvedi RK, et al.<sup>10</sup>

In head injury, severity does not depend on the size of external wound i.e. injury of scalp and there is no direct linear correlation between the fracture and intracranial haemorrhages. In the present study, the most common type of scalp injury noticed was contusion (48%) followed by lacerated wounds (46%) which signifies that victims were hospitalized or attended to by health care providers. Skull fractures were noticed in 77% of the cases among which linear (fissured) fracture was the commonest type of fracture noticed (41%), followed by linear and diastatic fracture (11%). Depressed comminuted fracture individually and in combination with diastatic fracture were observed in 15% of cases. 23% of victims with head injury not shown any kind of fracture. Among the various kinds of intracranial haemorrhages, SDH and SAH was the most common intracranial haemorrhages noticed (53%). SDH and SAH in combination with EDH were noticed in 10% cases which were invariably associated with the skull fractures specially depressed comminuted fracture. Similar findings were observed by the other studies Goyal PK et al<sup>11</sup>, Singh H et al<sup>6</sup> and Nath NC, et al<sup>12</sup>.

### Conclusion:

The substantial increase in the use of two wheelers, particularly in developing countries like India, is being accompanied by an increase in the number of head and traumatic brain injuries. Head is the most vulnerable part of the body as shown in the various studies, raising awareness about traffic rules especially in two wheelers can decrease the morbidity and mortality in road side accidents.

**Conflict of Interest:** None

**Financial Asistance:** None

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## Original Research Paper

# Effect of Soaking on Gel Pen Writings: A Forensic Examination

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### Abstract:

Forensic document examiners daily meet new type of challenges during document examination. Many of documents, sometimes in drastic conditions such as torned, burnt, shredded and soaked in some liquid are faced by experts for examination. Sometimes the criminal tries to hide the documents in water tank, pond etc. Very less research work has been reported on documents in soaked conditions. So, the study has been carried out to analyze the effects of water soaking on gel point pen ink writings on different surface at different time intervals. The samples of writings with different brands of gel pens were prepared on different types of paper in the forensic science laboratories (documents division) to assess the effect of different liquid mediums (acidic, basic, and neutral) on to gel pen writings and the paper surfaces.

**Key Words:** Suicidal Death, Dowry, Autopsy, Crimes Against Women Cells

### Introduction:

Questioned document examination is becoming a tough challenge for the document examiner day by day. Criminals often try to damage, hide or destroy important information. Different kinds of documents, such as daily dairy writings, letters, wills, suicide notes, etc. are submitted to a document examiner in a variety of conditions such as shredded, torn, burned and thrown in water media, etc. to examine. A forensic document examiner is prepared to meet new and unique challenges during an examination of any kind of document. Cases have been reported in which important documents are either flooded in disaster cases or are thrown deliberately in lakes, ponds, canals and other water streams to destroy vital information.

These types of documents come to the document expert to decipher the content of the writing on the papers. The success of restoration of different writings depends on writing medium, type of paper and period of immersion.

Researchers have attempted and successfully restored and deciphered different writings using stereo microscope, vacuum freeze dehydration method, liquid nitrogen and freeze drying method.<sup>1-7</sup> Phenomena such as the feathering of ink, lateral spreading of ink, transference of ink on subsequent or facing paper, change in sheen, etc, have been studied in the soaked ballpoint pen writings<sup>8</sup>. From the literature survey, it has been apparent that less research work has been reported on the soaked document examination.

The aim of the present research was to acquire a conceptual knowledge on the effect of soaking on gel pen writings written on the different nature of substrates in different mediums such as acidic, neutral and basics at different time intervals. An effort was made to decipher the writings of gel pen by using stereo microscope and UV light. The project gives a perfect vent to the understanding made on various aspects of gel pen inks writings made on different types of papers soaked in the different nature of liquid media.

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## Materials and Methodology:

The present study was carried out to analyze the soaked blue color gel pen writings of different brands made on bond paper and A4 size paper in three different natures of liquids at three different time intervals, after approval from the Institutional Ethics Committee. The samples of gel pen writings were prepared with five different brands of blue gel pens commonly available in the market (**Table 1**). The writings of gel pens were prepared on two different types of paper. The type of paper selected for the study was Bilt Royal bond paper of white color of size A4 (21cm X 29.7 cm) with 100 GSM and white normal printing paper of JK Copier brand A4 size (21cm X 29.7 cm) with 70 GSM that makes the sample number ten.

**Table I Brands of gel pens chosen for the study.**

| S.No | Brands of Gel Pen | Color |
|------|-------------------|-------|
| 1.   | Today's           | Blue  |
| 2.   | Flair writometer  | Blue  |
| 3.   | Cello Sprinter    | Blue  |
| 4.   | Octoglide         | Blue  |
| 5.   | Stic gel          | Blue  |

Three different natures of liquid mediums, i.e. acidic (pH 3), neutral (pH 7) and alkaline (pH 13) were prepared for the study for soaking the gel pen writings prepared on the two different natures of paper. The normal tap water with pH 7 was selected as a neutral medium for the study. The tap water was made acidic and alkaline by adding concentrated hydrogen

chloride (HCL) and sodium hydroxide (NaOH) and their pH was maintained to 3 7 13, respectively. The pH level of each solution, i.e. acidic (pH 3), neutral (pH 7) and alkaline (pH 13) were measured using a pH meter before soaking the samples.

As the booklets were to be soaked in three media chosen for the study, it made the sample number thirty. The thirty booklets were to be soaked for three different time intervals, i.e. one week, fifteen days and one month; that made the sample number ninety. Before immersion, these booklets were examined and recorded in daylight and under UV radiations. One booklet from each brand of blue gel pen, prepared on two different papers selected for the study, were prepared and was preserved as control samples. One booklet was taken out from each medium, i.e. acidic (pH 3), neutral (pH 7) and alkaline (pH 13) after one week, fifteen days and one month, respectively, and was examined in day light, under stereomicroscope and UV radiations and the results were compared with the control samples. The results given by each soaked gel pen writings on different papers at different interval in three chosen mediums were recorded (**Table 2-4**). Blind samples were also prepared for the same examination in a similar manner by the other author and key exemplars were preserved.

**Table - 2: Showing phenomenon observed in blue gel pen writings immersed in acidic medium (HCL) on A4 paper and bond paper at different intervals.**

| S. No | Brands of gel pen    | Color | Time Interval of one week   | Time Interval of fifteen days   | Time Interval of one month  |
|-------|----------------------|-------|---|---|---|
| 1     | Flair Writometer Gel | Blue  | 1.No change in ink color.<br>2.No Spreading or feathering of ink.<br>3.No ink transferred on facing or subsequent paper.<br>4.No fading of ink color.<br>5. No change in paper texture.     | 1. No change in ink color.<br>2. No Spreading or feathering of ink.<br>3. No ink transferred on facing or subsequent paper.<br>4. No fading of ink color.<br>5. No change in paper texture. | 1. Change in ink color.<br>2. Spreading or feathering of ink.<br>3. Transfer of ink on facing paper.<br>4. Fading of ink color.<br>5. No change in paper texture. |
| 2     | Cello Sprinter Gel   | Blue  | 1. No change in ink color.<br>2. No Spreading or feathering of ink.<br>3. No ink transferred on facing or subsequent paper.<br>4. No fading of ink color.<br>5. No change in paper texture. | 1. No change in ink color.<br>2. No Spreading or feathering of ink.<br>3. No ink transferred on facing or subsequent paper.<br>4. No fading of ink color.<br>5. No change in paper texture. | 1. Change in ink color.<br>2. Spreading or feathering of ink.<br>3. Transfer of ink on facing paper<br>4. Fading of ink color.<br>5. No change in paper texture.  |
| 3     | Octoglide Gel        | Blue  | 1. No change in ink color.<br>2. No Spreading or feathering of ink.   | 1. No change in ink color.<br>2. No Spreading or feathering of ink.   | 1. Change in ink color.<br>2. Spreading or feathering of ink.   |

|   |             |      |  |   |   |
|---|-------------|------|--|---|---|
|   |             |      | 3. No ink transferred on facing or subsequent paper.<br>4. No fading of ink color.<br>5. No change in paper texture.   | 3. No ink transferred on facing or subsequent paper.<br>4.No fading of ink color.<br>5. No change in paper texture.   | 3. Transfer of ink on facing paper.<br>4. .Fading of ink color.<br>5. No change in paper texture.   |
| 4 | Stic Gel    | Blue | 1. No change in ink color.<br>2. No Spreading or feathering of ink.<br>3. No ink transferred on facing or subsequent paper.<br>4.No fading of ink color.<br>5. No change in paper texture. | 1. No change in ink color.<br>2. No Spreading or feathering of ink.<br>3. No ink transferred on facing or subsequent paper.<br>4. No fading of ink color.<br>5. No change in paper texture. | 1. Change in ink color.<br>2. Spreading or feathering of ink.<br>3. Transfer of ink on facing paper.<br>4. Fading of ink color.<br>5. No change in paper texture. |
| 5 | Today's Gel | Blue | 1. No change in ink color.<br>2. No Spreading or feathering of ink.<br>3. No ink transferred on facing or subsequent paper.<br>4.No fading of ink color.<br>5. No change in paper texture. | 1. No change in ink color.<br>2. No Spreading or feathering of ink.<br>3. No ink transferred on facing or subsequent paper.<br>4. No fading of ink color.<br>5. No change in paper texture. | 1. Change in ink color.<br>2. Spreading or feathering of ink<br>3. Transfer of ink on facing paper<br>4. Fading of ink color.<br>5. No change in paper texture.   |

**Table - 3: Showing phenomenon observed in blue gel pen writings immersed in neutral medium (tap water) on A4 paper and bond paper at different intervals.**

| S.No | Brands of gel pen    | Color | Time Interval of one week  | Time Interval of fifteen days   | Time Interval of one month  |
|------|----------------------|-------|--|---|---|
| 1    | Flair Writometer Gel | Blue  | 1. Spreading or feathering of ink.<br>2. Transferred on facing or subsequent paper.<br>3. Little is fading of ink color.<br>4. No change in paper texture. | 1 Spreading or feathering of ink.<br>2. Transferred on facing or subsequent paper.<br>3. Fading of ink color.<br>4. No change in paper texture. | 1 Spreading or feathering of ink.<br>2. Transferred on facing or subsequent paper.<br>3. Disappearance of ink color.<br>4. Indentation left by gel pen present.<br>5. No change in paper texture. |
| 2    | Cello Sprinter Gel   | Blue  | 1. Spreading or feathering of ink.<br>2. Transferred on facing or subsequent paper.<br>3. Little is fading of ink color.<br>4. No change in paper texture. | 1 Spreading or feathering of ink.<br>2. Transferred on facing or subsequent paper.<br>3. Fading of ink color.<br>4. No change in paper texture. | 1 Spreading or feathering of ink.<br>2. Transferred on facing or subsequent paper.<br>3. Disappearance of ink color.<br>4. Indentation left by gel pen present.<br>5. No change in paper texture. |
| 3    | Octoglide Gel        | Blue  | 1. Spreading or feathering of ink.<br>2. Transferred on facing or subsequent paper.<br>3. Little is fading of ink color.<br>4. No change in paper texture. | 1 Spreading or feathering of ink.<br>2. Transferred on facing or subsequent paper.<br>3. Fading of ink color.<br>4. No change in paper texture. | 1 Spreading or feathering of ink.<br>2. Transferred on facing or subsequent paper.<br>3. Disappearance of ink color.<br>4. Indentation left by gel pen present.<br>5. No change in paper texture. |
| 4    | Stic Gel             | Blue  | 1. Spreading or feathering of ink.<br>2. Transferred on facing or subsequent paper.<br>3. Little is fading of ink color.<br>4. No change in paper texture. | 1 Spreading or feathering of ink.<br>2. Transferred on facing or subsequent paper.<br>3. Fading of ink color.<br>4. No change in paper texture. | 1 Spreading or feathering of ink.<br>2. Transferred on facing or subsequent paper.<br>3. Disappearance of ink color.<br>4. Indentation left by gel pen present.<br>5. No change in paper texture. |
| 5    | Today's Gel          | Blue  | 1. Spreading or feathering of ink.<br>2. Transferred on facing or subsequent paper<br>3. Little is fading of ink color<br>4. No change in paper texture    | 1 Spreading or feathering of ink.<br>2. Transferred on facing or subsequent paper.<br>3. Fading of ink color.<br>4. No change in paper texture. | 1 Spreading or feathering of ink.<br>2. Transferred on facing or subsequent paper.<br>3. Disappearance of ink color.<br>4. Indentation left by gel pen present<br>4. No change in paper texture.  |

Table - 4: Showing phenomenon observed in blue gel pen writings immersed in alkaline medium (NaOH) on A4 paper and bond paper at different intervals.

| S. No | Brands of gel pen    | Color | Time Interval of one week   | Time Interval of fifteen days  | Time Interval of one month  |
|-------|----------------------|-------|---|--|---|
| 1     | Flair Writometer Gel | Blue  | 1. No change in ink color.<br>2. No Spreading or feathering of ink.<br>3. No ink transferred on facing or subsequent paper.<br>4. No fading of ink color.<br>5. No change in paper texture. | 1. No change in ink color. 2. No Spreading or feathering of ink.<br>3. No ink transferred on facing or subsequent paper.<br>4. No fading of ink color.<br>5. No change in paper texture. | 1. Change in ink color.<br>2. Spreading or feathering of ink.<br>3. Transfer of ink on facing paper.<br>4. Fading of ink color.<br>5. No change in paper texture. |
| 2     | Cello Sprinter Gel   | Blue  | 1. No change in ink color.<br>2. No Spreading or feathering of ink.<br>3. No ink transferred on facing or subsequent paper.<br>4. No fading of ink color.<br>5. No change in paper texture. | 1. No change in ink color. 2. No Spreading or feathering of ink.<br>3. No ink transferred on facing or subsequent paper 4.No fading of ink color<br>5. No change in paper texture        | 1. Change in ink color.<br>2. Spreading or feathering of ink.<br>3. Transfer of ink on facing paper<br>4. Fading of ink color.<br>5. No change in paper texture.  |
| 3     | Octoglide Gel        | Blue  | 1. No change in ink color.<br>2. No Spreading or feathering of ink.<br>3. No ink transferred on facing or subsequent paper.<br>4. No fading of ink color.<br>5. No change in paper texture. | 1. No change in ink color. 2. No Spreading or feathering of ink.<br>3. No ink transferred on facing or subsequent paper. 4.No fading of ink color.<br>5.No change in paper texture.      | 1. Change in ink color.<br>2. Spreading or feathering of ink.<br>3. Transfer of ink on facing paper<br>4.Fading of ink color.<br>5.No change in paper texture.    |
| 4     | Stic Gel             | Blue  | 1. No change in ink color.<br>2. No Spreading or feathering of ink.<br>3. No ink transferred on facing or subsequent paper.<br>4. No fading of ink color.<br>5. No change in paper texture. | 1. No change in ink color. 2. No Spreading or feathering of ink.<br>3. No ink transferred on facing or subsequent paper. 4. No fading of ink color.<br>5. No change in paper texture.    | 1. Change in ink color.<br>2. Spreading or feathering of ink.<br>3. Transfer of ink on facing paper<br>4.Fading of ink color<br>5.No change in paper texture.     |
| 5     | Today's Gel          | Blue  | 1. No change in ink color.<br>2. No Spreading or feathering of ink.<br>3. No ink transferred on facing or subsequent paper<br>4.No fading of ink color<br>5. No change in paper texture     | 1. No change in ink color. 2. No Spreading or feathering of ink.<br>3. No ink transferred on facing or subsequent paper. 4.No fading of ink color.<br>5. No change in paper texture.     | 1. Change in ink color.<br>2. Spreading or feathering of ink.<br>3. Transfer of ink on facing paper.<br>4. Fading of ink color.<br>5. No change in paper texture. |

## Results and Discussion

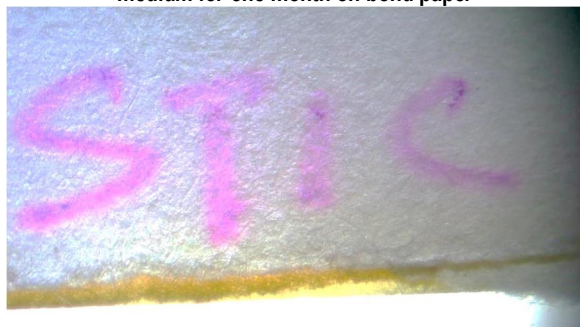
The results of each booklet of gel pen writing prepared on two different papers, i.e. bond paper and normal printing paper immersed in three different liquids such as acidic, neutral and alkaline for three different time intervals have been interpreted (**Table 2-4**). The results have been based on the various phenomenon shown by the immersed booklet which were interpreted on the basis of ink transfer on subsequent paper/ facing paper, seepage of ink, feathering of ink, lateral spreading of ink, wrinkling of paper surfaces, fading of ink color or change in ink color, disappearance of ink color and presence and absence of indentations.

### ***Gel pen writings in acidic medium at different periods of time:***

The results of gel pen writings immersed in acidic medium, i.e. hydrochloride acid in acidic medium after one week were interpreted (**Table-2**). It was observed from the results that no phenomena of lateral spreading or feathering of blue gel inks, fading of ink color, change of gel ink color, transfer of ink on facing paper or subsequent papers was observed on both bond paper & A4 size printing paper in acidic medium in any of brand gel pen after one week and fifteen days. Similarly, no effect was seen on the texture of bond paper and A4 printing paper after soaking them in acidic medium for one week and fifteen days. Whereas, the characteristics of lateral spreading of blue gel inks, fading of gel ink color, change of gel ink color to brown and pink, transfer of ink on facing paper or subsequent papers started gradually

appearing in gel ink writings written on both bond paper & A4 size printing paper after fifteen days to up to one month. No change in the paper texture was observed in both paper types in the same medium and time interval. After almost one month, the phenomena of color change of ink and spreading of ink around the letter are more frequent and prominent **Figure 1**. So, as the immersion time interval increases more were the characteristics shown by the gel inks writings.

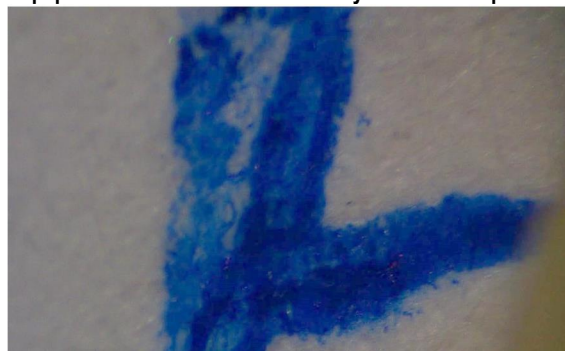
**Figure 1** Change in color of gel ink after immersion in acidic medium for one month on bond paper



#### **Gel pen writings in neutral medium at different periods of time:**

The results of gel pen writings immersed in neutral medium, i.e. tap water were interpreted (**Table 3**). It was observed from the results that the phenomena of lateral spreading of blue gel inks, feathering of ink color, little fading of gel ink color, transfer of ink on facing paper or subsequent papers started appearing on both bond paper & A4 size printing paper writings immersed in neutral medium in all brand gel pens after three days of soaking (**Figure 2-3**). The color fading of gel ink appeared at about one week of immersion. The color of ink then started disappearing and there was a change in ink color in gel writings sample and by about one month, the ink completely disappeared and indentations were left (**Figure 4-6**). The indentations left by gel pens were observed in the paper that helped in restoring the content under stereomicroscope with oblique light. It is worth mentioning here that more heavily the pen pressure, more deeper the indentations and more easily the content deciphered. But no effect was observed in change in texture of bond paper and A4 printing paper after soaking them in neutral medium until a month.

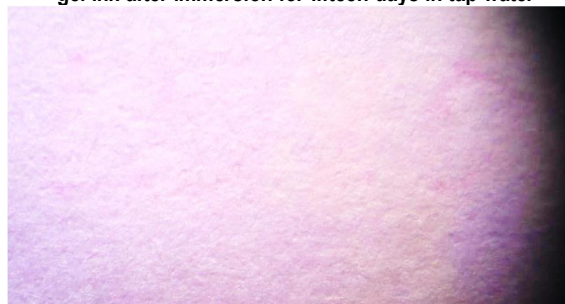
**Figure 2** Appearance of lateral spreading of gel ink on A4 paper after immersion for three days in neutral tap water



**Figure 3** Transfer of gel ink on facing paper immersed in neutral tap water after one week



**Figure 4** Starting of color change and the disappearance of gel ink after immersion for fifteen days in tap water



**Figure 5** Lighter indentations left by gel pen after total disappearance of gel ink immersed for one month in neutral in tap water



Figure 6 Heavier indentations left by gel pen after total disappearance of gel ink immersed for one month in neutral in tap water



**Gel pen writings in alkaline medium at different periods of time:**

The results of gel pen writings immersed in alkaline medium, i.e. sodium hydroxide solution after one week, fifteen days and one month were interpreted (**Table 4**). It was observed from the results that no phenomena of lateral spreading of blue gel inks, fading of ink color, change of gel ink color, transfer of ink on facing paper or subsequent papers was present on both bond paper & A4 size printing paper in alkaline medium in any of brand gel pen after one week and fifteen days. Similarly, no effect was seen on the texture of bond paper and A4 printing paper after soaking them in alkaline medium for one week and fifteen days. Whereas, the characteristics of lateral spreading of blue gel inks, fading of gel ink color, change of gel ink color to purple and pink, transfer of ink on facing paper started appearing in gel ink writings written on both bond paper & A4 size printing paper after fifteen days to until one month. (**Figure 7-8**).

Figure 7 Fading of ink on bond paper after immersion after fifteen days in the alkaline NaOH medium

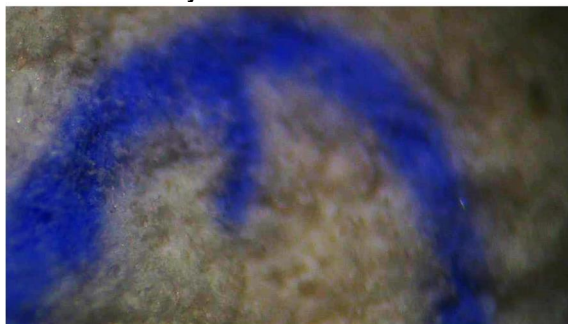


Figure 8 Fading of gel ink on bond paper after immersion for one month in the alkaline NaOH medium



Whereas, after fifteen days to one month, there was the appearance of wrinkles on paper surface that damaged the indentations left by the gel pens on paper surface (**Figure 9**). The wrinkles on the paper surface in alkaline medium did not help in restoring any type of content present on the paper surface, whether written with less pen pressure or heavier pen pressure. So, the different phenomena such as color change of ink, feathering of ink, spreading of ink around the letter, fading of ink color and appearance of wrinkles on paper surface were apparent after long immersing the gel ink writings in alkaline medium.

Figure 9 Appearance of wrinkles on the paper soaked in alkaline NaOH medium after twenty two days



**Deciphering of the disappeared content under UV light and stereo microscope Under UV light:**

The factor that was taken into account to decipher the writings or content is the fluorescence of the ink when they are exposed to UV radiations. It was seen that no gel pen ink produced fluorescence during exposure to UV light where the ink color totally disappeared in neutral medium.



### **Under Stereomicroscope:**

Another feature that was employed for deciphering the disappeared content was the examination of indentations left by pen on the paper where the ink disappeared. It was noted that analysis of indentations with oblique light at the angle of approximately 60-65° under the stereo microscope revealed the content present on the paper surface. The indentations made with heavy pen pressure were more easily deciphered than the lighter indentations.

In the similar way, the blind samples were analyzed for the estimation of soaking time period of gel pen writings in different medium prepared on two different papers from the appearance of different phenomena. 100% accuracy was achieved in the estimation of time periods from the presence of different phenomena in gel pen writings on different papers at different time periods as the results were matched with the keys preserved. The content was restored only in cases where indentations were made with heavy pen pressure than the lighter indentations.

### **Conclusion:**

It is concluded from the study that research project on the gel pen writings soaked in different nature of liquid medium prepared on two different natures of papers generated very encouraging and reliable results. The results observed in the study can be successfully utilized used in forensic evaluations of soaked gel pen writings. The present study is limited to one month only which can be extended to more time period and other writing or printed materials can be explored with a similar study.

**Conflict of interest:** None

**Financial Assistance:** None

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## Original Research Paper

# Poisoning Pattern in the Cases Reported by Chemical Examiner Laboratory - Punjab, India

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### Abstract:

Punjab is one of the leading food grain producing states in India. However, in Punjab, increased productivity has been fuelled by the excessive use of agriculture based chemicals or agro-chemicals like pesticides, insecticides, herbicides etc. Common poisons used or consumed by the people of Punjab are related to agriculture based chemicals like organophosphorus compounds (OP), organochlorine compounds (OC), carbamates, herbicides, fungicides and metallic compounds like Aluminium Phosphide (AIP) and Zinc Phosphide (ZnP). The analysis of available data was conducted from 1st April, 2016 to 31st March, 2017. During this period, 1918 viscera cases were analysed for the various poisons by seven analysts. AIP and OP were found to be the most common poisons in this study. So, there is an urgent need to develop less toxic but equally effective alternatives of these agro-chemicals in Punjab.

**Key Words:** Chemical Examiner Laboratory, Punjab, Poisoning, Viscera, Agro-chemicals

### Introduction:

Poisoning by agriculture based chemicals is a global public health problem particularly because of poor regulatory frameworks. Singh et al,<sup>1</sup> in their study, reported that AIP (marketed in India as tablets of Celphos, Alphos, Quickphos etc. and commonly known as wheat pills in Punjab) poisoning was found to be the major cause of death among all cases of poisoning in northwest India. Since the first available report of AIP poisoning in the early 1980s from India, it is now one of the most common causes of poisoning among agricultural pesticides.<sup>2-4</sup>

The objective of the present study was to assess the poisoning pattern in the cases reported by Chemical Examiner Laboratory (CEL), Punjab, India. Such knowledge can be helpful to control the open sale of these chemicals/poisons by the state government and to develop less toxic and equally effective alternatives of these agro-chemicals by agricultural scientists.

### Materials and Methodology:

The CEL, Govt. of Punjab, is the only government laboratory in the state of Punjab covering all districts where viscera for chemical analysis in poisoning or suspected cases of poisoning are received from Police officials and are analyzed. Analysis of available data from 1st April, 2016 to 31st March, 2017 was conducted. During this period, 1918 viscera cases were analysed for the various poisons by seven analysts.

### Observations and Results:

Various poisons (**Table 1**) were found to be positive in 793 cases (excluding ethyl alcohol and morphine). AIP (50.8%) was found to be the most common poison in this study, followed by

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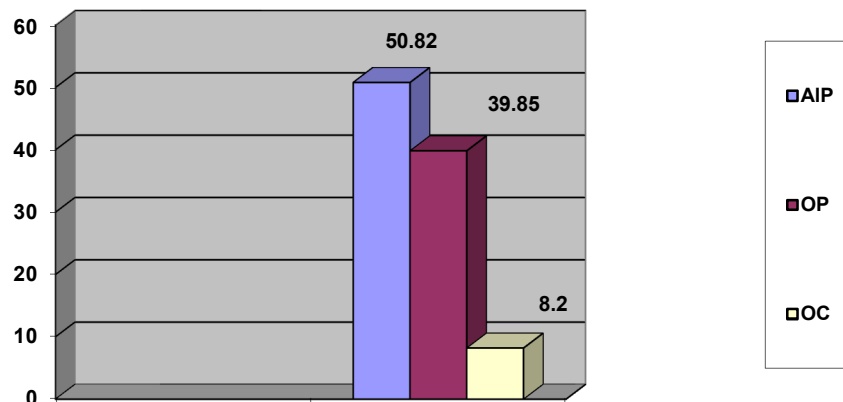
DOR: 28/01/2018 DOA: 05/12/2018

DOI: 10.5958/0974-0848.2018.00080.5

Table 1: Type of poison reported

| Type of Poison | AIP | OP  | OC | CO | ZnP | Carbamate | Phenyl | Total |
|----------------|-----|-----|----|----|-----|-----------|--------|-------|
| Cases          | 403 | 316 | 65 | 05 | 02  | 01        | 01     | 793   |

Fig 1: Percentile of common poisons



OP (39.9%) and OC (8.2%) (**Figure 1**). Blood Ethyl Alcohol Level (BAL) more than 350 mg%, which can be fatal and in which death may occur,<sup>5</sup> was found in one case only.

### Discussion:

It is well known that India has a high incidence of poisoning, being the 4<sup>th</sup> most common cause of mortality in rural India.<sup>6</sup> Poisoning with agro-chemicals has become more common in the modern times because of their low cost and easy availability. AIP is being used as a common outdoor and indoor pesticide in developing countries as it is cheap, effective, free from toxic residue and does not affect seed viability.<sup>7</sup> Each year, around 300,000 deaths occur worldwide due to pesticides.<sup>8</sup>

Malik, et al,<sup>9</sup> in their study in cases of suspected poisoning deaths from Kamrup district coming to the GMCH morgue, Guwahati, Assam, reported OC and OP as the most common poisons. In our study, AIP and OP were found to be the most commonly used poisons in Punjab. As Punjab is an agricultural hub and easy availability with no restriction on the sale of these agro-chemicals, it could be the main reason for high incidence of poisoning by these agro-chemicals.

AIP has currently aroused interest because of increased use in non-agricultural purpose in addition to agricultural purpose. A 3

gm tablet of AIP contains 56% of the active ingredient and only a part of the tablet is usually sufficient for the suicidal purpose.<sup>5</sup> The tablet liberates toxic phosphine gas when it comes in contact with gastric juice. Therefore, it is suggested that legislation related to storage, sale, purchase and utilization of these agriculture based poisons (Especially OP and AIP) should be strictly implemented to reduce deaths due to these poisons in Punjab.

Open sale of most toxic agro-chemicals should be restricted by state government agencies and users of these must be licensed. Government should make attempts to develop less toxic and equally effective alternatives in consultation with agricultural scientists.

**Conflict of interest:** None

**Financial Assistance:** None

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## Original Research Paper

# Status of Ossification at Elbow Joint, Dental Eruption and Secondary Sexual Characteristics in Schoolboys of 14-16 Years Age Group

<sup>1</sup>Prasad L. Jaybhaye, <sup>2</sup>Ashutosh B. Potdar

### Abstract:

A study was conducted to make coordinated observations based on ossification of bones, dental eruption and secondary sexual characteristics. Healthy school going children (100 males) of age group 14 . 16 years were examined for ossification status at elbow joint; status of dental eruption, including space behind the second molar tooth and secondary sexual characteristics.

By the age of 14-16 years, all epiphyseal centers around the elbow joint, except for conjoint epiphyses, were still in the process of fusion. Eruption of second molar tooth, either by way of cutting or being completely erupted, was found by this age in all the cases and space behind 2nd molar tooth developed appreciably in the lower jaw. Majority of the males (66%) of this age group had their pubic hairs at stage 2 or 3.

**Key Words:** Age estimation; Dental status; Ossification status; Secondary sexual characteristics

### Introduction:

Age group of 14 . 16 years is medicolegally important in cases related with sexual offences, juveniles in conflict with law, kidnapping and child labor. In all such cases, medical opinion regarding the age of the victim or the accused, is sought. It is not at all possible on part of a forensic practitioner to give exact age. Higher Courts of law have held that one can only estimate a range of age.<sup>1</sup> Study of indicators like ossification status, secondary sexual characters and dental eruption status, together, gives more reliable estimation of age, as compared to studying them individually.

In the light of these facts, it becomes an obvious necessity to have a local data for each population in the interest of proper dispensation of justice. Hence, in the present study, an attempt was made to know the status of ossification at elbow joint, dental eruption status and secondary sexual characteristics in school going boys between 14 -16 years age group of Bagalkot city in India.

### Materials and Methodology:

Permission from the Institutional Ethics Committee was obtained. Informed consent was taken from the subjects after explaining the purpose and procedure of the study. A proforma was prepared to collect all relevant information from the subjects.

### Inclusion Criteria:

- Healthy, normal boys between age group 14 to 16 years.
- Subjects who had documentary evidence of age.
- Subjects who were born and brought up in Bagalkot district.

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L. M. No: Not a Member  
DOR: 31/01/2018 DOA: 20/12/2018  
DOI: 10.5958/0974-0848.2018.00081.7

**Exclusion Criteria:**

- Subjects with skeletal deformity, disease, malformation or injury, chronic illness

**Method of collection of data:**

All the selected 100 subjects were broadly classified into two different groups:

- 14 years age group: Subjects who had completed 14 years to 14 years +364 days
- 15 years age group: Subjects who had completed 15 years to 15 years +364 days

**Physical Examination:**

For the height measurement, the subject was asked to stand straight without footwear, heels together, shoulder, buttocks and heel touching the scale and the subject looking straight. The weight was calculated in kilograms on the standardized weighing machine. For knowing the appearance and development of secondary sexual characteristics, the subjects were examined in a private room with cubicle curtain.

**Dental examination:**

Dental charting was done according to Palmer's notation. Space behind the second molar was inferred to be present in cases where the hard part of an underlying bone was appreciated and was inferred to be absent in cases where only soft tissue was felt. Staging of second molar tooth eruption was done in the following manner:<sup>2</sup>

**Stage 0** - Non cutting through the gum

**Stage 1** - When the tip of the crown of tooth penetrated the gum margin.

**Stage 2** - When this crown has grown into oral cavity beyond gum margins, but not yet reached the occlusal plane.

**Stage 3** - When the occlusal surface came in contact with its counterpart and the bite was complete.

**The staging of epiphyseal union:**

As the process of ossification starts, earliest appearance of epiphyses can be easily detected when it is no bigger than the size of a pin head. Its position can be recorded and its direction of spread can be watched.<sup>3</sup> Keeping this in mind, and taking into consideration stages of ossification as given by Galstaun<sup>4</sup>, Sidhom and Derry<sup>5</sup>, McKern and Stewart<sup>6</sup> and Kothari;<sup>7</sup> in the present study, stages of ossification of epiphyses are noted as follows:

- **Stage 0:** When epiphyseal cartilage did not begin to decrease in thickness.

- **Stage 1:** Epiphyseal cartilage begins to decrease in thickness.

- **Stage 2:** Thickness of epiphyseal cartilage was found to be reduced appreciably.

- **Stage 3:** When epiphysis begins to fuse with the shaft and complete union was well underway.

- **Stage 4:** When epiphyseal cartilage was bony in architecture and density indistinguishable from the epiphysis and diaphysis in its surroundings, but an epiphyseal line called an epiphyseal scar could still be distinguished.

- **Stage 5:** Complete union with absence of epiphyseal scar.

Modified B. G. Prasad classification was used to determine socioeconomic status.<sup>8</sup>

**Results:**

**Tables 1 to 9** show the physical, dental and the radiological status of boys of age group 14-16 years and factors affecting the same.

Table no. 1: Ossification status around elbow joint

| Ossification Status           | 14 Years Boys |            | 15 Years Boys |            | Total      |            |
|-------------------------------|---------------|------------|---------------|------------|------------|------------|
|                               | N             | %          | N             | %          | n          | %          |
| <b>Conjoint epiphysis</b>     |               |            |               |            |            |            |
| Stage 0                       | 00            | 00         | 02            | 04         | 02         | 02         |
| Stage 1                       | 03            | 06         | 02            | 04         | 05         | 05         |
| Stage 2                       | 00            | 00         | 00            | 00         | 00         | 00         |
| Stage 3                       | 10            | 20         | 01            | 02         | 11         | 11         |
| Stage 4                       | 05            | 10         | 00            | 00         | 05         | 05         |
| Stage 5                       | 32            | 64         | 45            | 90         | 77         | 77         |
| <b>Total</b>                  | <b>50</b>     | <b>100</b> | <b>50</b>     | <b>100</b> | <b>100</b> | <b>100</b> |
| <b>Medial epicondyle</b>      |               |            |               |            |            |            |
| Stage 0                       | 00            | 00         | 00            | 00         | 00         | 00         |
| Stage 1                       | 00            | 00         | 00            | 00         | 00         | 00         |
| Stage 2                       | 06            | 12         | 06            | 12         | 12         | 12         |
| Stage 3                       | 32            | 64         | 24            | 48         | 56         | 56         |
| Stage 4                       | 00            | 00         | 00            | 00         | 00         | 00         |
| Stage 5                       | 12            | 24         | 20            | 40         | 32         | 32         |
| <b>Total</b>                  | <b>50</b>     | <b>100</b> | <b>50</b>     | <b>100</b> | <b>100</b> | <b>100</b> |
| <b>Proximal end of Radius</b> |               |            |               |            |            |            |
| Stage 0                       | 00            | 00         | 00            | 00         | 00         | 00         |
| Stage 1                       | 00            | 00         | 00            | 00         | 00         | 00         |
| Stage 2                       | 00            | 00         | 01            | 02         | 01         | 01         |
| Stage 3                       | 28            | 56         | 20            | 40         | 48         | 48         |
| Stage 4                       | 15            | 30         | 13            | 26         | 28         | 28         |
| Stage 5                       | 07            | 14         | 16            | 32         | 23         | 23         |
| <b>Total</b>                  | <b>50</b>     | <b>100</b> | <b>50</b>     | <b>100</b> | <b>100</b> | <b>100</b> |
| <b>Proximal end of Ulna</b>   |               |            |               |            |            |            |
| Stage 0                       | 00            | 00         | 00            | 00         | 00         | 00         |
| Stage 1                       | 04            | 08         | 01            | 02         | 05         | 05         |
| Stage 2                       | 04            | 08         | 03            | 06         | 07         | 07         |
| Stage 3                       | 24            | 48         | 18            | 36         | 42         | 42         |
| Stage 4                       | 02            | 04         | 6             | 12         | 08         | 08         |
| Stage 5                       | 16            | 32         | 22            | 44         | 38         | 38         |
| <b>Total</b>                  | <b>50</b>     | <b>100</b> | <b>50</b>     | <b>100</b> | <b>100</b> | <b>100</b> |

Table no.2: Factors affecting ossification of conjoint epiphyses

|                                       | Ossification status of conjoint epiphysis |                     |                      |                    |            |
|---------------------------------------|---|---------------------|----------------------|--------------------|------------|
|                                       | Not appeared (Stage 0)                    | Active (Stage 1, 2) | Advanced (Stage 3,4) | Complete (Stage 5) | Total      |
| <b>Age (for age, n×2= %)</b>          |   |                     |                      |                    |            |
| 14 years                              | 0   | 3                   | 15                   | 32                 | 50         |
| 15 years                              | 2   | 2                   | 1                    | 45                 | 50         |
| <b>Total</b>                          | <b>2</b>                                  | <b>5</b>            | <b>16</b>            | <b>77</b>          | <b>100</b> |
| <b>Fisher exact test, p &lt;0.001</b> |   |                     |                      |                    |            |
| <b>Socioeconomic Status</b>           |   |                     |                      |                    |            |
| Upper class (I+II)                    | 2   | 3                   | 10                   | 41                 | 56         |
| Lower class (III+IV+V)                | 0   | 2                   | 6                    | 36                 | 44         |
| <b>Total</b>                          | <b>2</b>                                  | <b>5</b>            | <b>16</b>            | <b>77</b>          | <b>100</b> |
| <b>p =0.6867</b>                      |   |                     |                      |                    |            |
| <b>Exercise</b>                       |   |                     |                      |                    |            |
| Never                                 | 2   | 4                   | 13                   | 64                 | 83         |
| Daily                                 | 0   | 1                   | 3                    | 13                 | 17         |
| <b>Total</b>                          | <b>2</b>                                  | <b>5</b>            | <b>16</b>            | <b>77</b>          | <b>100</b> |
| <b>p =0.99</b>                        |   |                     |                      |                    |            |
| <b>Diet</b>                           |   |                     |                      |                    |            |
| Veg.                                  | 2   | 2                   | 9                    | 28                 | 41         |
| Mixed                                 | 0   | 3                   | 7                    | 49                 | 59         |
| <b>Total</b>                          | <b>2</b>                                  | <b>5</b>            | <b>16</b>            | <b>77</b>          | <b>100</b> |
| <b>p = 0.1567</b>                     |   |                     |                      |                    |            |

Table no. 3: Factors affecting ossification of the epiphysis of the medial epicondyle

|  | Ossification status of medial epicondyle |                      |                      |                    |            |
|--|--|----------------------|----------------------|--------------------|------------|
|  | Not appeared (Stage 0)                   | Active ( Stage 1, 2) | Advanced (Stage 3,4) | Complete (Stage 5) | Total      |
| <b>Age (for age, <math>n \times 2 = \%</math>)</b> |  |                      |                      |                    |            |
| 14 years   | 0  | 6                    | 32                   | 12                 | 50         |
| 15 years   | 0  | 6                    | 24                   | 20                 | 50         |
| <b>Total</b>                                       | <b>0</b>                                 | <b>12</b>            | <b>56</b>            | <b>32</b>          | <b>100</b> |
| <b>Fisher exact test, <math>p = 0.2243</math></b>  |  |                      |                      |                    |            |
| <b>Socioeconomic Status</b>                        |  |                      |                      |                    |            |
| Upper class  | 0  | 6                    | 34                   | 16                 | 56         |
| Lower class  | 0  | 6                    | 22                   | 16                 | 44         |
| <b>Total</b>                                       | <b>0</b>                                 | <b>12</b>            | <b>56</b>            | <b>32</b>          | <b>100</b> |
| <b><math>p = 0.6515</math></b>                     |  |                      |                      |                    |            |
| <b>Exercise</b>                                    |  |                      |                      |                    |            |
| Never  | 0  | 12                   | 45                   | 26                 | 83         |
| Daily  | 0  | 0                    | 11                   | 6                  | 17         |
| <b>Total</b>                                       | <b>0</b>                                 | <b>12</b>            | <b>56</b>            | <b>32</b>          | <b>100</b> |
| <b><math>p = 0.2799</math></b>                     |  |                      |                      |                    |            |
| <b>Diet</b>  |  |                      |                      |                    |            |
| Veg.   | 0  | 8                    | 22                   | 11                 | 41         |
| Mixed  | 0  | 4                    | 34                   | 21                 | 59         |
| <b>Total</b>                                       | <b>0</b>                                 | <b>12</b>            | <b>56</b>            | <b>32</b>          | <b>100</b> |
| <b><math>p = 0.1562</math></b>                     |  |                      |                      |                    |            |

Table no. 4: Factors affecting ossification of the epiphysis of proximal end of the radius

|   | Ossification status of proximal end of radius |                      |                      |                    |            |
|---|---|----------------------|----------------------|--------------------|------------|
|   | Not appeared (Stage 0)                        | Active ( Stage 1, 2) | Advanced (Stage 3,4) | Complete (Stage 5) | Total      |
| 14 years  | 0   | 0                    | 43                   | 7                  | 50         |
| 15 years  | 0   | 1                    | 33                   | 16                 | 50         |
| <b>Total</b>                                      | <b>0</b>                                      | <b>1</b>             | <b>76</b>            | <b>23</b>          | <b>100</b> |
| <b>Fisher exact test, <math>p = 0.0338</math></b> |   |                      |                      |                    |            |
| <b>Socioeconomic Status</b>                       |   |                      |                      |                    |            |
| Upper class                                       | 0   | 1                    | 43                   | 12                 | 56         |
| Lower class                                       | 0   | 0                    | 33                   | 11                 | 44         |
| <b>Total</b>                                      | <b>0</b>                                      | <b>1</b>             | <b>76</b>            | <b>23</b>          | <b>100</b> |
| <b><math>p = 0.8947</math></b>                    |   |                      |                      |                    |            |
| <b>Exercise</b>                                   |   |                      |                      |                    |            |
| Never   | 0   | 1                    | 63                   | 19                 | 83         |
| Daily   | 0   | 0                    | 13                   | 4                  | 17         |
| <b>Total</b>                                      | <b>0</b>                                      | <b>1</b>             | <b>76</b>            | <b>23</b>          | <b>100</b> |
| <b><math>p = 0.99</math></b>                      |   |                      |                      |                    |            |
| <b>Diet</b>                                       |   |                      |                      |                    |            |
| Veg.  | 0   | 1                    | 34                   | 6                  | 41         |
| Mixed   | 0   | 0                    | 42                   | 17                 | 59         |
| <b>Total</b>                                      | <b>0</b>                                      | <b>1</b>             | <b>76</b>            | <b>23</b>          | <b>100</b> |
| <b><math>p = 0.091</math></b>                     |   |                      |                      |                    |            |

Table no .5: Factors affecting ossification of the epiphysis of proximal end of ulna

|                             | Ossification status of proximal end of ulna |                         |                         |                       |            |
|-----------------------------|---|-------------------------|-------------------------|-----------------------|------------|
|                             | Not appeared<br>(Stage 0)                   | Active<br>( Stage 1, 2) | Advanced<br>(Stage 3,4) | Complete (Stage<br>5) | Total      |
| Age (for age, n×2= %)       |   |                         |                         |                       |            |
| 14 years                    | 0   | 8                       | 26                      | 16                    | 50         |
| 15 years                    | 0   | 4                       | 24                      | 22                    | 50         |
| <b>Total</b>                | <b>0</b>                                    | <b>12</b>               | <b>50</b>               | <b>38</b>             | <b>100</b> |
| Fisher exact test p= 0.3249 |   |                         |                         |                       |            |
| Socioeconomic Status        |   |                         |                         |                       |            |
| Upper class                 | 0   | 8                       | 29                      | 19                    | 56         |
| Lower class                 | 0   | 4                       | 21                      | 19                    | 44         |
| <b>Total</b>                | <b>0</b>                                    | <b>12</b>               | <b>50</b>               | <b>38</b>             | <b>100</b> |
| p= 0.5811                   |   |                         |                         |                       |            |
| Exercise                    |   |                         |                         |                       |            |
| Never                       | 0   | 12                      | 39                      | 32                    | 83         |
| Daily                       | 0   | 0                       | 11                      | 6                     | 17         |
| <b>Total</b>                | <b>0</b>                                    | <b>12</b>               | <b>50</b>               | <b>38</b>             | <b>100</b> |
| p= 0.2148                   |   |                         |                         |                       |            |
| Diet                        |   |                         |                         |                       |            |
| Veg.                        | 0   | 7                       | 22                      | 12                    | 41         |
| Mixed                       | 0   | 5                       | 28                      | 26                    | 59         |
| <b>Total</b>                | <b>0</b>                                    | <b>12</b>               | <b>50</b>               | <b>38</b>             | <b>100</b> |
| p= 0.2394                   |   |                         |                         |                       |            |

Table no. 6: Eruption status of the second molar tooth

| Second MolarEruption              | 14 Years Boys |            | 15 Years Boys |            | Total      |            |
|-----------------------------------|---------------|------------|---------------|------------|------------|------------|
|                                   | N             | %          | n             | %          | N          | %          |
| Right Maxillary quadrant p=0.009  |               |            |               |            |            |            |
| Stage 0                           | 0             | 0          | 0             | 0          | 0          | 0          |
| Stage 1                           | 4             | 8          | 0             | 0          | 4          | 4          |
| Stage 2                           | 14            | 28         | 6             | 12         | 20         | 20         |
| Stage 3                           | 32            | 64         | 44            | 88         | 76         | 76         |
| <b>Total</b>                      | <b>50</b>     | <b>100</b> | <b>50</b>     | <b>100</b> | <b>100</b> | <b>100</b> |
| Left Maxillary quadrant p=0.006   |               |            |               |            |            |            |
| Stage 0                           | 0             | 0          | 0             | 0          | 0          | 0          |
| Stage 1                           | 5             | 10         | 0             | 0          | 5          | 5          |
| Stage 2                           | 13            | 26         | 6             | 12         | 19         | 19         |
| Stage 3                           | 32            | 64         | 44            | 88         | 76         | 76         |
| <b>Total</b>                      | <b>50</b>     | <b>100</b> | <b>50</b>     | <b>100</b> | <b>100</b> | <b>100</b> |
| Left Mandibular quadrant p=0.009  |               |            |               |            |            |            |
| Stage 0                           | 0             | 0          | 0             | 0          | 0          | 0          |
| Stage 1                           | 1             | 02         | 0             | 0          | 1          | 1          |
| Stage 2                           | 17            | 34         | 6             | 12         | 23         | 23         |
| Stage 3                           | 32            | 64         | 44            | 88         | 76         | 76         |
| <b>Total</b>                      | <b>50</b>     | <b>100</b> | <b>50</b>     | <b>100</b> | <b>100</b> | <b>100</b> |
| Right Mandibular quadrant p=0.009 |               |            |               |            |            |            |
| Stage 0                           | 0             | 0          | 0             | 0          | 0          | 0          |
| Stage 1                           | 1             | 02         | 0             | 0          | 1          | 1          |
| Stage 2                           | 17            | 34         | 6             | 12         | 23         | 23         |
| Stage 3                           | 32            | 64         | 44            | 88         | 76         | 76         |
| <b>Total</b>                      | <b>50</b>     | <b>100</b> | <b>50</b>     | <b>100</b> | <b>100</b> | <b>100</b> |

Table no. 7: Space behind Second Molar Tooth

|   | 14 years Boys |            | 15 years Boys |            | Total      |            |
|---|---------------|------------|---------------|------------|------------|------------|
|   | n             | %          | N             | %          | N          | %          |
| <b>Right Maxillary quadrant p=0.3175</b>    |               |            |               |            |            |            |
| Absent                                      | 46            | 92         | 42            | 84         | 88         | 88         |
| Present                                     | 4             | 08         | 8             | 16         | 12         | 12         |
| <b>Total</b>                                | <b>50</b>     | <b>100</b> | <b>50</b>     | <b>100</b> | <b>100</b> | <b>100</b> |
| <b>LeftMaxillary quadrant p=0.2336</b>      |               |            |               |            |            |            |
| Absent                                      | 46            | 92         | 41            | 82         | 87         | 87         |
| Present                                     | 4             | 08         | 9             | 18         | 13         | 13         |
| <b>Total</b>                                | <b>50</b>     | <b>100</b> | <b>50</b>     | <b>100</b> | <b>100</b> | <b>100</b> |
| <b>Right Mandibular quadrant p&lt;0.001</b> |               |            |               |            |            |            |
| Absent                                      | 34            | 68         | 13            | 26         | 47         | 47         |
| Present                                     | 16            | 32         | 37            | 74         | 53         | 53         |
| <b>Total</b>                                | <b>50</b>     | <b>100</b> | <b>50</b>     | <b>100</b> | <b>100</b> | <b>100</b> |
| <b>Left Mandibular quadrant p&lt;0.001</b>  |               |            |               |            |            |            |
| Absent                                      | 30            | 60         | 9             | 18         | 39         | 39         |
| Present                                     | 20            | 40         | 41            | 82         | 61         | 61         |
| <b>Total</b>                                | <b>50</b>     | <b>100</b> | <b>50</b>     | <b>100</b> | <b>100</b> | <b>100</b> |

Table no. 8: Factors affecting Pubic hair staging in Boys

|                             | Pubic Hair Staging in Boys |           |           |           |          |            |
|-----------------------------|----------------------------|-----------|-----------|-----------|----------|------------|
|                             | Stage 1                    | Stage 2   | Stage 3   | Stage 4   | Stage 5  | Total      |
| <b>Age</b>                  |                            |           |           |           |          |            |
| 14 years                    | 14                         | 30        | 4         | 2         | 0        | 50         |
| 15 years                    | 3                          | 8         | 24        | 14        | 1        | 50         |
| <b>Total</b>                | <b>17</b>                  | <b>38</b> | <b>28</b> | <b>16</b> | <b>1</b> | <b>100</b> |
| <b>p &lt;0.001</b>          |                            |           |           |           |          |            |
| <b>Exercise</b>             |                            |           |           |           |          |            |
| Never                       | 16                         | 32        | 20        | 14        | 1        | 83         |
| Daily                       | 1                          | 6         | 8         | 2         | 0        | 17         |
| <b>Total</b>                | <b>17</b>                  | <b>38</b> | <b>28</b> | <b>16</b> | <b>1</b> | <b>100</b> |
| <b>p=0.329</b>              |                            |           |           |           |          |            |
| <b>Diet</b>                 |                            |           |           |           |          |            |
| Vegetarian                  | 6                          | 19        | 11        | 5         | 0        | 41         |
| Mixed                       | 11                         | 19        | 17        | 11        | 1        | 59         |
| <b>Total</b>                | <b>17</b>                  | <b>38</b> | <b>28</b> | <b>16</b> | <b>1</b> | <b>100</b> |
| <b>p= 0.582</b>             |                            |           |           |           |          |            |
| <b>Socioeconomic Status</b> |                            |           |           |           |          |            |
| Class I                     | 3                          | 8         | 3         | 5         | 0        | 19         |
| Class II                    | 4                          | 16        | 10        | 6         | 1        | 37         |
| Class III                   | 9                          | 9         | 10        | 1         | 0        | 29         |
| Class IV                    | 1                          | 5         | 5         | 4         | 0        | 15         |
| Class V                     | 0                          | 0         | 0         | 00        | 0        | 0          |
| <b>Total</b>                | <b>17</b>                  | <b>38</b> | <b>28</b> | <b>16</b> | <b>1</b> | <b>100</b> |
| <b>p= 0.271</b>             |                            |           |           |           |          |            |

Table no. 9: Factors affecting other secondary sexual characteristics in boys

|                      | Axillary Hair |          |       | Mustache     |          |       | Beard        |          |       |
|----------------------|---------------|----------|-------|--------------|----------|-------|--------------|----------|-------|
|                      | Not appeared  | Appeared | Total | Not appeared | Appeared | Total | Not appeared | Appeared | Total |
| Age                  |               |          |       |              |          |       |              |          |       |
| 14 years             | 20            | 30       | 50    | 23           | 27       | 50    | 47           | 3        | 50    |
| 15 years             | 6             | 44       | 50    | 12           | 38       | 50    | 30           | 20       | 50    |
| Total                | 26            | 74       | 100   | 35           | 65       | 100   | 77           | 23       | 100   |
|                      | p=0.002       |          |       | p=0.035      |          |       | p <0.001     |          |       |
| Diet                 |               |          |       |              |          |       |              |          |       |
| Veg.                 | 10            | 31       | 41    | 15           | 26       | 41    | 35           | 6        | 41    |
| Mixed                | 16            | 43       | 59    | 20           | 39       | 59    | 42           | 17       | 59    |
| Total                | 26            | 74       | 100   | 35           | 65       | 100   | 77           | 23       | 100   |
|                      | p=0.819       |          |       | p=0.833      |          |       | p=0.1465     |          |       |
| Exercise             |               |          |       |              |          |       |              |          |       |
| Never                | 24            | 59       | 83    | 32           | 51       | 83    | 64           | 19       | 83    |
| Daily                | 2             | 15       | 17    | 3            | 14       | 17    | 13           | 4        | 17    |
| Total                | 26            | 74       | 100   | 35           | 65       | 100   | 77           | 23       | 100   |
|                      | p= 0.135      |          |       | p= 0.101     |          |       | p=0.99       |          |       |
| Socioeconomic Status |               |          |       |              |          |       |              |          |       |
| Class I              | 3             | 16       | 19    | 6            | 13       | 19    | 14           | 5        | 19    |
| Class II             | 8             | 29       | 37    | 11           | 26       | 37    | 28           | 9        | 37    |
| Class III            | 13            | 16       | 29    | 14           | 15       | 29    | 28           | 1        | 29    |
| Class IV             | 2             | 13       | 15    | 4            | 11       | 15    | 7            | 8        | 15    |
| Class V              | 0             | 0        | 0     | 0            | 0        | 0     | 0            | 0        | 0     |
| Total                | 26            | 74       | 100   | 35           | 65       | 100   | 77           | 23       | 100   |
|                      | p =0.114      |          |       | p = 0.297    |          |       | p = 0.639    |          |       |

Table 10: Comparison of age of ossification of the epiphyses around elbow joint given by various workers in India/abroad with the results of the present study.

| Authors                                 | Age of ossification of epiphyses in years |                   |                        |                      |
|---|---|-------------------|------------------------|----------------------|
|   | Indian studies                            |                   |                        |                      |
|   | Conjoint epiphyses                        | Medial epicondyle | Proximal end of radius | Proximal end of ulna |
| Lal and Nat – Lucknow <sup>9</sup>      | 15-16                                     | 17                | 17                     | 16                   |
| Pillai –Madras <sup>10</sup>            | 14  | 17                | 17                     | 16                   |
| Galstaun – Bengal <sup>11</sup>         | 16  | 16                | 16                     | 17                   |
| Kothari – Marwar <sup>7</sup>           | 15-16                                     | 17-18             | 16-17                  | 16-17                |
| Jain S – Jaipur <sup>12</sup>           | 15-16                                     | 16-17             | 15-16                  | -                    |
| Patel D.S. – Gujrat <sup>13</sup>       | 16-17                                     | 17-18             | 16-17                  | 16-17                |
| Bhise – Mumbai <sup>14</sup>            | 14-16                                     | 16-17             | 15-17                  | 16-17                |
| Jnanesh – Davanagere <sup>15</sup>      | 16-17                                     | 18-19             | -                      | -                    |
| Foreign studies                         |   |                   |                        |                      |
| Davies and Parson-England <sup>16</sup> | -   | 20                | 15-16                  | 17                   |
| Paterson –Manchester <sup>17</sup>      | 19  | 18-21             | 19                     | 19                   |
| Sidhom and Derry –Egypt <sup>5</sup>    | 15-16                                     | -                 | 16                     | -                    |
| Flecker –Australia <sup>18</sup>        | 16  | 16                | 16                     | 16                   |
| Patel B. – Canada <sup>19</sup>         | 15.9                                      | 16.8              | 17.1                   | 16.5                 |
| <b>Present study – Bagalkot, India</b>  | <b>15-16</b>                              | <b>Above 16</b>   | <b>Above 16</b>        | <b>Above 16</b>      |

## Discussion:

Many workers around the world have done a lot of research regarding age estimation based on ossification of bones, eruption of teeth

and pubertal changes. Most of the studies in the past have taken into consideration one of these three criteria. However, in this study all three criteria were taken together to observe the same



between the age group of 14-16 years. Our study shows that the age of union of conjoint epiphyses in Indians is about 2-3 years earlier than the Europeans (**Table No.10**).

#### **Eruption of second molar tooth**

The word eruption refers to the cutting of teeth through the gums. There is a significant time lag between the cutting of the tooth into the oral cavity and completion of eruption (i.e. Completion of bite). In the present study, as shown in **Table No. 6**, we can conclude that complete second molar eruption is more likely to occur in 15 years of age group. A similar study done by Ingle D<sup>20</sup> in Bijapur region mentions the average age of eruption of second molar as 14 years in 95% of males.

#### **Space behind Second Molar Tooth**

Modi<sup>21</sup> mentions that a note should always be made as to whether there is a space behind second molar teeth if third molars are absent. In the present study, as shown in **Table No. 7**, the two age groups were found to be significantly different with respect to the space behind the second molar in the lower jaw with p value <0.001. Critical comparison of this finding was not possible as similar studies for space behind second molar are not available.

#### **Secondary sexual characteristics in boys**

As shown in **Table No. 8**, the findings in our study are consistent with the study done by Singh Z<sup>22</sup> in Punjab, where the boys of age around 14-16 years had Stage 3 of pubic hair. In the United States of America, a study carried out by Sun,<sup>23</sup> observed that white boys of 14-16 years had Stage 4, which seem ahead in maturity as compared to the present study.

As shown in **Table No.9**, it was observed that in the age group of 15 years, the appearance of axillary hair, mustache and beard was seen more, as compared to the age group of 14 years and all were found to be statistically very significant. This finding is consistent with the study done by Singh Z,<sup>22</sup> in Punjab.

#### **Conclusion:**

The following conclusions were derived from the present study about the status of ossification of the epiphyses around the elbow joint, dental eruption and secondary sexual

characteristics in schoolboys of Bagalkot city. (**Tables 4 to 9**)

#### **Age group 14 years**

- Conjoint epiphyses was found to be completely united (Stage 5) in 64% of boys.
- Medial epicondyle was found in either advanced union (Stage 3 and 4) or completely united in 88% of subjects.
- Proximal end of the radius was seen in advanced union (Stage 3 and 4) in 86% of boys
- Proximal end of the ulna was found in either in advanced union (Stage 3 and 4) or completely united in 84% of the subjects.
- The second molar tooth was in Stage 3 of eruption in all quadrants in 64% of boys.
- The space behind the second molar was more evident in the lower jaw as compared to the upper jaw.
- Pubic hair found in stage 2 of development in 60% of boys.
- Axillary hair found in 60% of boys.
- Mustache appeared in 54% of boys.
- Beard not appeared in 94% of boys.
- Deep voice developed in 86% of boys.

#### **Age group 15 years**

- Conjoint epiphyses was found to be completely united in 90% of boys.
- Medial epicondyle was found in either advanced union (Stage 3 and 4) or completely united in 88% of subjects.
- Proximal end of the radius was seen either in advanced union (stage 3 and 4) or completely united in 98% of boys
- Proximal end of the ulna was found in either in advanced union (Stage 3 and 4) or completely united in 92% of the subjects.
- Second molar tooth found in Stage 3 of eruption in all quadrants in 88% of boys.
- The space behind the second molar was more evident in the lower jaw as compared to the upper jaw.
- Pubic hair found in stage 3 of development in 48% of boys.
- Axillary hair found in 88% of boys.
- Mustache appeared in 76% of boys.
- Beard appeared in 40% of boys.
- Deep voice developed in 94% of boys.

From our study experience, we feel that instead of merely mentioning the status of ossification as

fused or not fused and dental eruption as erupted or not erupted, a better co-relation of age can be made by dividing the ossification status and dental eruption into different stages. Further studies are required on these lines.

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## Original Research Paper

## Retrospective Study of Analysis of Cardiac Injuries in Autopsied Hearts at a Centre in South India

<sup>1</sup>Srishti Mukhi, <sup>2</sup>Shankar M Bakkannavar, <sup>3</sup>Vinod C Nayak**Abstract:**

**Background:** Morbidity and mortality related to cardiac injuries are serious health concerns worldwide. The cardiac injuries could be due to traumatic blunt-force injuries or due to natural events such as injuries secondary to ischemia and infarction. The most prevalent type of lethal injuries is due to physical trauma. Cardiovascular injuries due to natural events constitute 31% of total cardiac injuries. **Aim:** The aim of this retrospective study was to give an overview of the trends in cardiac injury epidemiology in Manipal during 2011 to 2015. **Materials and Methodology:** The research was conducted in the Department of Forensic Medicine, Kasturba Medical College, Manipal. All cases due to cardiac injuries between 2011 and 2015 were included in this study. The data collected included age, sex, and type of cardiac injury, which was tabulated and analyzed for descriptive statistics using Statistical Package for Social Sciences (SPSS) version 20. **Results:** Cardiac injuries constituted 35.8% of the total number of autopsies that were conducted during the study period. 80.5% of the victims were male. Maximum number of victims were from the 3<sup>rd</sup> decade of life. Most of the cardiac injuries (38.4%) were caused by road traffic accidents. The most frequent cardiac abnormality seen in our study was subendocardial hemorrhage, 38.6 % of the total cardiac injuries. Due to traumatic events, the most frequent cardiac injury seen was contusion, 5.4% and lacerations, 4.1% of injuries. Hyperemic area was seen in 13% and white patch in 12.4% of cases. The most commonly occluded artery was the left anterior descending artery, 53.4%. The time interval between the occurrence of the incident and death of the victim ranged from few minutes to 2 months. **Discussion:** The findings of this study give us an insight to the pattern and magnitude of deaths due to cardiac injuries in a South Indian region, given that only a very low percentage of the patients who sustain cardiac injury reach hospital alive. The injury pattern helps the clinician and other researchers to concentrate on these injured parts while treating and conducting research, respectively. **Conclusion:** More autopsy studies should be conducted to define the characteristics of population based cardiac injuries.

**Key Words:** Cardiac Injuries; Traumatic Blunt-Force Injuries; Road Traffic Accidents; Subendocardial Hemorrhage; Hyperemic Area

**Introduction:**

Cardiac injury can be defined as the disruption

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of the normal cardiac myocyte membrane integrity resulting in the loss into the extracellular space (including blood) of intracellular constituents.<sup>1</sup> These injuries could either be due to a disease or due to any trauma.

Due to traumatic events, blunt-force injuries like lacerations, avulsions and contusions of the heart and great vessels sustained during motor vehicle crashes, constitute the most prevalent type of lethal physical trauma to the cardiovascular system. The second most prevalent type of trauma is from penetrating and perforating wounds

inflicted by firearms in the US and stab injuries in other parts of the world.<sup>2</sup>

According to Getz BS, et al.,<sup>3</sup> the mechanism of cardiac injury in blunt trauma may be summarized as:

- (1) Direct blow to the anterior chest (most common cause of ventricular rupture);
- (2) Indirect injury that causes a sudden increase in preload, resulting in atrial rupture;
- (3) Compression of the heart between the sternum and vertebral bodies;
- (4) Acceleration/ deceleration of the heart and great vessels;
- (5) Blast injury and
- (6) Penetrating injury of a cardiac chamber by a fractured rib or the sternum.

The heart may be ruptured by compression or from a blow or a fall, usually on its right side and towards its base.<sup>4</sup> Contusions or lacerations of the heart may also be produced by blows from a blunt weapon or by compression of the chest even without fracturing any bone of the thorax or showing marks of external injury.<sup>5</sup> Therefore, there is always a possibility of fatal cardiac injuries to be unnoticed, leading to a fatal outcome.

Risk factors for blunt heart injury:<sup>6</sup> (1) Age > 50 years, (2) History of existing cardiac disease, (3) Vehicular accident with chest impact at speed > 15 miles per hour, (4) Deformation of steering wheel, (5) Marked precordial tenderness, ecchymosis or contusion, (6) Fractured sternum, (7) Multiple injuries, (8) Fractures of thoracic spine or ribs, (9) Hemodynamically unstable condition.

The true incidence of Blunt cardiac injury (BCI) is unknown, as reported rates vary greatly in the literature, ranging between 8 and 71%. It is present in up to 20% of all motor vehicle collision deaths. Although it occurs in only 20% of all blunt thoracic trauma patients, in patients with severe thoracic injury or multiple injuries, the incidence of BCI may be as high as 76%.<sup>7</sup>

The incidence of BCI due to natural causes increase with the age. The risk factors for such injuries are; hypertension, cigarette smoking, diabetes mellitus, genetic (hypercholesterolemia), and obesity. Women, who are protected during reproductive years, are

prone to BCI due to increased coronary artery disease, secondary to decreased estrogen level after post menopause.

An estimated 17.7 million people died from cardiovascular diseases (CVDs) in 2015, representing 31% of all global deaths. Of these deaths, an estimated 7.4 million were due to coronary heart disease i.e 13% of the world population.<sup>8</sup> CVDs have now become the leading cause of mortality in India.<sup>9</sup> The Global Burden of Disease study estimate of age-standardized CVD death rate of 272 per 100 000 population in India is higher than the global average of 235 per 100 000 population.<sup>10</sup>

In order to assess the frequency and pattern, and to identify predictive factors of cardiac injuries, we reviewed the autopsy reports of 591 such fatalities between 2011 and 2015. We found that in our study the incidence of cardiac injuries was 35.8%.

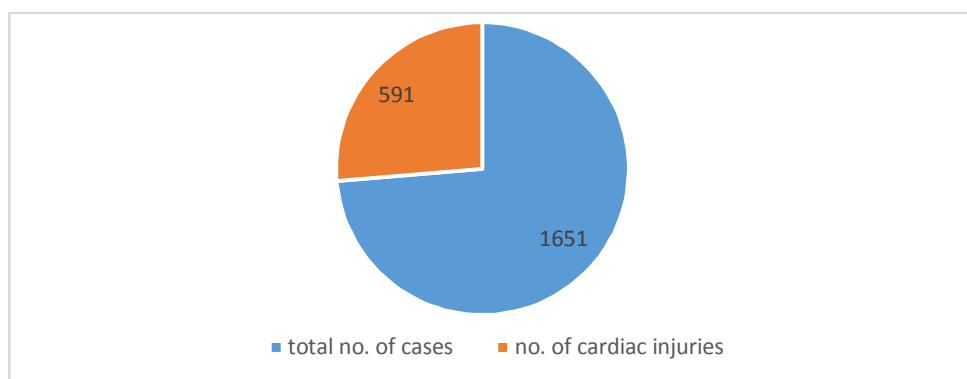
#### **Material and Methodology:**

The material for the present retrospective study were the cases of cardiac injuries brought to the mortuary of Kasturba Medical College, Manipal for post-mortem examination. Approval for the study was granted by the Institutional Ethics Committee. We reviewed 1651 cases of autopsies between the years 2011-2015. The study included cardiac injuries such as hemorrhages, white patches, and injuries (blunt force or sharp force trauma) like contusion, laceration and stab injuries. The data so collected included mainly age, sex, and type of cardiac injury. The cases were studied to be analyzed for the type of cardiac injury, the kind of impact it had and its association with the pericardial effusion and condition of the arterial walls and the cause of death. The data was tabulated and analyzed descriptive statistics using Statistical Package for Social Sciences (SPSS) version 20.

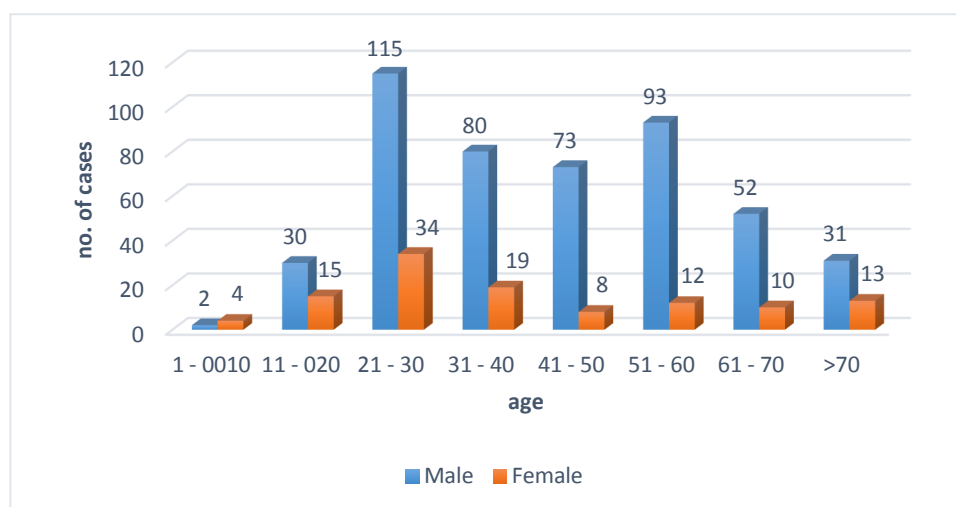
#### **Results:**

For the period 2011. 2015 we identified cardiac injuries in 591 (35.8%) of 1651 autopsied cases as shown in **Graph no. 1**. Of these, 476 (80.5%) were males, thus indicating a clear predominance of male over female.

Graph 1: The number of cardiac injuries



Graph 2: Age – sex wise distribution



Age-wise, the maximum number (25.2%) of the victims were in the age group of 21-30 years, followed by 51-60 years and 31-40 years of age group i.e., 17.8% & 16.8% cases respectively (**Graph 2**).

Table 1: Type of the Case

| Type of the Case        | Male | Female |
|-------------------------|------|--------|
| Accident                | 207  | 20     |
| Blast                   | 0    | 1      |
| Burns                   | 16   | 21     |
| Pregnancy complications | 0    | 8      |
| Drowning                | 5    | 1      |
| Fall                    | 45   | 1      |
| Electrocution           | 4    | 1      |
| Hanging                 | 16   | 8      |
| Heavy object fall       | 5    | 1      |
| Poisoning               | 88   | 34     |
| Homicide                | 3    | 2      |
| Natural                 | 82   | 17     |
| Animal attack           | 1    | 0      |
| Drug overdose           | 1    | 0      |
| Firearm                 | 3    | 0      |

Cases below 10 years were very few (6 cases) accounting for 1% of the total and all of them had hemorrhages in the heart.

Most of the cardiac injuries (38.4%) were caused by road traffic accidents (**Table 1**), followed by poisoning (20.64%), natural causes (16.8%) and by fall from height (7.8%). The most frequent cardiac abnormality seen in our study was subendocardial haemorrhage, 13.8% of the total cases and 38.6% of the cardiac injuries, followed by epicardial hemorrhage in 14.9% of cardiac injuries.

Due to natural events, hyperemic area was seen in 77 cases (13%), of which 76.6% were males. Most of the hyperemic areas were seen on left ventricle (71.4%) and least in the left atrium (1.3%). White patch was seen in 12.4% of the cases, of which most were seen on the right ventricle (49.3%), closely followed by left ventricle (47.9%) and 1.4% each on right

and left atrium. Pale area was seen in 16 cases, of which 15 were males (93.7%). Most of the pale areas were seen on the left ventricle, 81.3% (**Table 2 & 3**).

Table 2: Cardiac Injuries

| Injury                      | Male | Female |
|-----------------------------|------|--------|
| Clot on pulmonary trunk     | 0    | 2      |
| Congestion                  | 6    | 2      |
| Contusion                   | 29   | 3      |
| Hyperemic area              | 59   | 16     |
| Laceration                  | 18   | 6      |
| Membrane defect             | 5    | 1      |
| Thromboembolus              | 0    | 2      |
| Vegetation                  | 2    | 1      |
| White patch                 | 63   | 10     |
| Pale area                   | 15   | 1      |
| Saccular projection         | 1    | 0      |
| Calcification               | 4    | 0      |
| Fibrotic patch              | 2    | 0      |
| Hypopigmented area          | 5    | 0      |
| Rupture of chordae tendinae | 1    | 0      |
| Sharp clean cut wound       | 1    | 0      |
| Penetrating wound           | 1    | 0      |
| Sub endocardial hemorrhage  | 180  | 48     |
| Epicardial hemorrhage       | 109  | 40     |

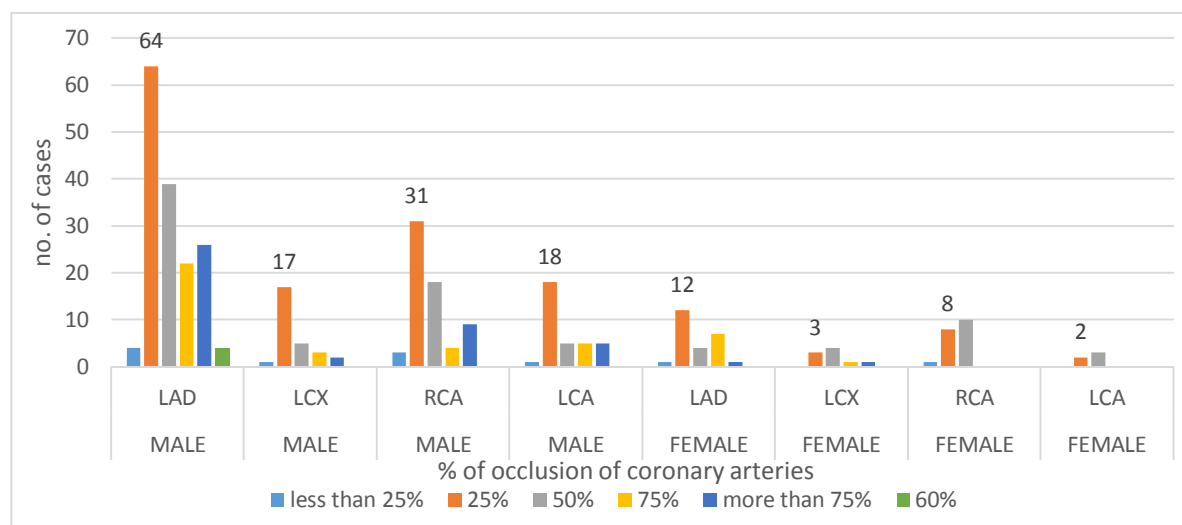
Coronary artery occlusion was found in 344 (58.2%) of 591 cardiac injury cases studied. Of these, 83.1% of occlusions were found in males. The most commonly occluded artery was the left anterior descending, 53.4% cases, followed by the right coronary artery, 24.4%. The left anterior descending artery was found to be 25% occluded in most of the cases (22.1%), followed by right coronary artery, 11.3%. as shown in **Graph 3**.

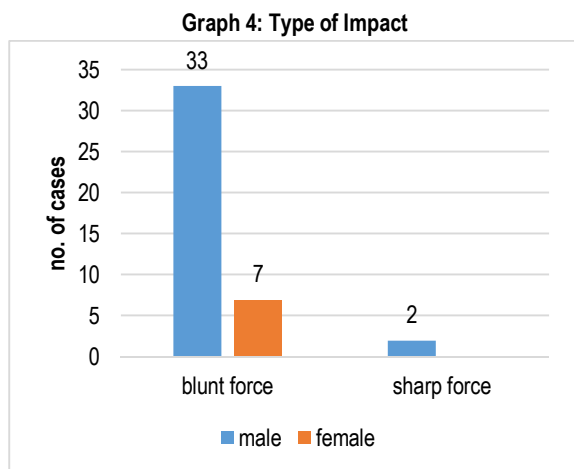
Table 3: Location of Cardiac Injuries

| Cardiac Injuries      | Right Ventricle | Right Atrium | Left Ventricle | Left Atrium |
|-----------------------|-----------------|--------------|----------------|-------------|
| Hyperemic area        | 19              | 2            | 55             | 1           |
| Contusion             | 10              | 8            | 10             | 4           |
| Laceration            | 11              | 3            | 9              | 1           |
| Congestion            | 3               | 0            | 5              | 0           |
| White patch           | 36              | 1            | 35             | 1           |
| Pale area             | 3               | 0            | 13             | 0           |
| Saccular projection   | 0               | 0            | 1              | 0           |
| Calcification         | 0               | 0            | 2              | 2           |
| Fibrotic patch        | 0               | 0            | 2              | 0           |
| Hypopigmented area    | 1               | 0            | 4              | 0           |
| Thromboembolus        | 1               | 1            | 0              | 0           |
| Penetrating wound     | 1               | 0            | 0              | 0           |
| Sharp clean cut wound | 0               | 0            | 1              | 0           |

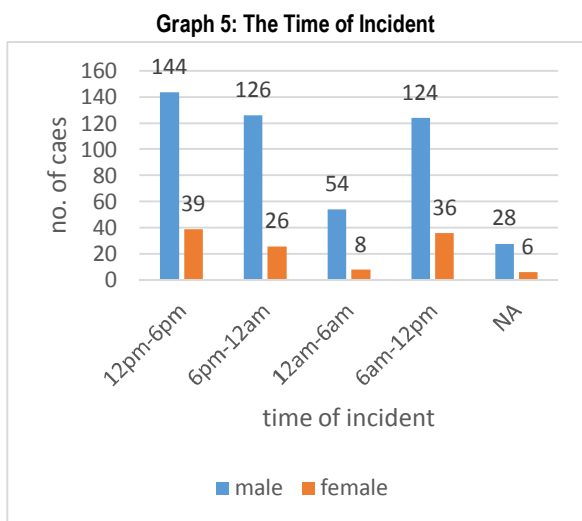
Due to traumatic events, the most frequent cardiac injury seen was contusion, 32 cases (5.4%), of which 29 were males (90.6%). Of these, 31.2% of the injuries were seen both in right and left ventricle and 25% (8 cases) on the right atrium. Lacerations were seen in 24 cases (4%), of which 11 were on the right ventricle (45.8%) and 9 on the left ventricle (37.5%). Injuries due to sharp weapon were also noted. Among these, one was a clean cut wound on the left ventricle and the other was a penetrating wound on right ventricle. Heart wounds were caused by blunt weapon/ surface in 40 cases (6.7%) and sharp weapon in 2 cases (0.3%). The type of injuries and their distribution among sexes are presented in **Graph 4**.

Graph 3: Occlusion of Coronary Arteries



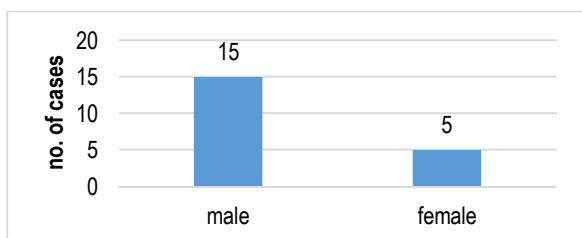


Only 20 cases (3.38%) of the cardiac injuries were associated with pericardial effusion, of which 60% of the cases were deaths due to road traffic accidents, 35% were of natural deaths and 1% of cases were due to poisoning (**Graph 5**).



The incidence of cardiac injuries was maximum during the incidences occurring between 12pm to 6pm, 183 cases (30.96%), followed by 6am-12pm (27.1%) and 6pm-12am (25.8%), as shown in **Graph 6**.

**Graph 6: Association with Pericardial Effusion**



The time interval between the incident and death was less than or equal to one week in 149 (25.2%) cases and less than one day in 125 (21.1%) cases and only 2 cases were found in the time interval of more than a month (**Table 4**).

**Table 4: The Time Interval between Incident and Death**

| Time Interval           | Male | Female |
|-------------------------|------|--------|
| Less than 1 day         | 111  | 14     |
| 1 day                   | 59   | 18     |
| Less than equal to week | 116  | 33     |
| More than a week        | 50   | 18     |
| 1 month                 | 3    | 2      |
| More than a month       | 2    | 0      |
| NA                      | 135  | 30     |

## Discussion

The results of the present study showed that 35.8% of the autopsied cases had cardiac injuries. Kaiser and Birnbaum<sup>11</sup> reported that injuries of the heart were present in 7.12% of all thoracic trauma cases in their study. Kulshrestha, et al.<sup>12</sup> reported that cardiac injuries accounted for 41% of the deaths resulting primarily from chest trauma. Although the results of the present study reveal higher percentages of cardiac injuries in autopsied cases compared to previous studies, this may be due to the fact that the definition of the cardiac injuries in the study includes injuries not only caused by road traffic accidents but also by other causes like poisoning or natural cause.

Consistent with other studies on cardiac injury,<sup>2,13,14</sup> our results demonstrate male dominance (80.5%) and average age range being 21.30 years, suggesting that females are less prone to cardiac injury than males, presumably due to their roles in the professional and social environment.

Reviews of thoracic trauma in children demonstrate an extremely low incidence of cardiac injury. Smyth<sup>15</sup> found a number of cases of cardiac injury amongst 94 children with chest trauma, while Meller et al<sup>16</sup> reported only 2 cases of cardiac injury resulting from blunt trauma in 68 patients. In the present study, we found six children (1.01%) with cardiac injuries.

Traffic accidents are the most frequent cause of blunt cardiac injury, followed by violent fall impacts, interpersonal aggression, and various kinds of high-risk sports,<sup>17,18</sup> which is consistent with the present study, which showed

that 38.4% of the deaths due to cardiac injuries caused by road traffic accidents. This can be explained by the fact that a direct blow to the chest, in combination with the direct transfer of energy during impact, can cause a sudden, forceful deceleration and compression of the heart between the sternum and the spine causing injury.

Due to traumatic events, the most common injury that is seen is contusion (5.4%). In autopsy studies following major blunt trauma, an incidence of cardiac contusion ranging from 14% -16% has been reported. Laceration was seen in 4.1% of the cases, of which 45.8% were seen on the right ventricle, followed by the left ventricle - 37.5%, right atrium and left atrium, in descending frequency, which is consistent with other studies.<sup>19,20,21</sup> The preponderance of right ventricular injury over the left in blunt trauma can be explained by the fact that the sternocostal surface of the heart is mainly formed by the right ventricle, so the major brunt of the trauma is borne by the right ventricle.<sup>2</sup>

While some studies identified penetrating trauma as the major cause of cardiac injury,<sup>19,21-25</sup> other authors<sup>17,26</sup> reported a higher rate of cardiac injury due to blunt trauma which is similar to our study.

Subendocardial haemorrhage was seen in 13.8% of the total number of the cases, which is consistent with the other studies.<sup>27</sup> It was seen more common than the epicardial haemorrhages, as subendocardium is the least perfused region of the heart.<sup>28</sup>

Hyperemic area was seen in 13.9% of the cardiac injuries, both in traumatic and natural causes of death, which is basically an active process in which arteriolar dilation leads to increased blood flow.<sup>28</sup> Most of the hyperemic area was seen on the left ventricle, 71.4%, because left ventricular epicardial region gets perfusion in both systole and diastole, while the subendocardial region gets solely during diastole.

White patches constitute about 12.5% of the cardiac injuries signifying scarring process after an attack of myocardial ischemia.<sup>28</sup> However, studies have not been done regarding the incidence of white patches therefore statistics cannot be matched.

When the incidence of coronary involvement was considered, Left Anterior Descending was seen in 53.4% cases, Right Coronary Artery in 24.4% and Left Circumflex Artery in 10.8% cases, respectively. This was in concordance with the data given by Sudha, et al,<sup>29</sup> who showed Left Anterior Descending as the most common site for plaque (47%), and Yazdi, et al,<sup>30</sup> who showed Left Anterior Descending as the most commonly involved artery (60%), followed by Right Coronary Artery (50%) and Left Circumflex Artery (42.5%).

Most of the individuals showed left anterior descending artery having 25% narrowing (22.1%) in our study. However, study done by Andrew et al<sup>31</sup> showed ~75% cross-sectional luminal narrowing of left anterior descending artery in 52% of cases of sudden coronary death. This can be due to the fact that their study includes cases only from MI or CAD.

Pericardial effusion was found in 3.4% of subjects in general autopsy studies which is in concordance with our study which showed 3.4% of the cases having pericardial effusion.<sup>32</sup>

A group from Harvard, estimated that on an average, the extra risk of having a myocardial infarction, or heart attack, between 6 a.m. and noon is about 40% which is not in accordance with our study, which showed maximum cases between 12 pm-6pm, because our study included injuries caused by both natural and traumatic causes.

### **Conclusion:**

Cardiac injuries are the injuries which must be addressed immediately so as to prevent possible mortality and morbidity. Proper knowledge about these injuries, arising due to traumatic or non-traumatic events, can help the clinician or health care provider to manage the case effectively. In this regard, the present study throws some light on the cardiac injuries. Though there are less studies in this regard, further studies considering few more parameters can be taken up so that compressive knowledge about these injuries can be obtained and shared among the researchers of the globe.

**Conflict of interest:** None

**Financial Assistance:** None



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## Original Research Paper

# A Profile of Workplace Accidents and Injuries at Bengaluru

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### Abstract:

Workplace related injuries are the most important cause of work absence, disability retirement, mutilation, and even mortality.<sup>1,2</sup> A detailed study of workplace accidents and fatal injuries at workplace provides valuable data for implementing effective preventive measures to reduce the burden of injuries related mortality and morbidity and to strengthen legal measures. Vydehi hospital, a tertiary care hospital, receives most of the medico-legal cases from eastern part of Bengaluru, both for treatment and autopsy services. This part of the city is considered as one of the major hubs of IT sector, concentrated by many migrated laborers from various parts of the country, who get employed at the construction sites as laborers. An autopsy study of deaths due to fatal injuries at workplace was conducted with an aim to know the incidents, age, sex, details of education, occupation wise distribution, availability of preventive measures, events leading to patterns of injuries and cause of death. Data in the current study was collected from all the cases of fatal injuries at workplace autopsied for a period of 5 years from September 2007 to August 2012. Male and young workers constituted the bulk. Majority of the victims were construction laborers. Majority of cases lacked pre-recruitment checkups, regular medical checkup and first aid facility at workplace. Falls from height was common type of event, followed by fall of objects. Protective measures were not available in most of the cases.

**Key Words:** Workplace Injuries, Construction Laborers, Fall from Height, Protective Measures

### Introduction:

The World Health Organization (WHO) defines work-related injury as an epidemic problem in the field of public health in developing countries.<sup>2,3</sup> According to the International Labor Organization (ILO), 1 out of 10 workers is involved in these injuries annually, and 5% of national labor days are lost.<sup>4,5</sup> Accidents in any form or degree inflict many economic damages for the worker, employer, and the society.

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This damage can directly or indirectly affect the individual and society<sup>6,8</sup> although many attempts are made to reduce the occupational morbidities and mortalities.<sup>9,10</sup> It also compromises the safety and health of the laborers, due to economic factors and leads to an increase in the number of workplace accidents and disease.<sup>11</sup> Today's intense urbanization, which has affected all the major cities in the recent past, has its own role to play in causing fatal injuries at work place. There is an alarming increase in fatal work place injury deaths in Bengaluru city, which is the hub of all developmental activities due to changing patterns of social, cultural, economic development. In this altered scenario there is very much a need for studying various patterns of deaths through skillful analysis and to incorporate preventive strategies to avert further tragedies. A prompt attempt has been made to study the same.

### Materials & Methodology:

The data was collected from cases of fatal injuries at work place from 2007 to 2012,

autopsied at the mortuary of the department of Forensic Medicine and Toxicology, Vydehi Institute of Medical Sciences and Research Centre, Bengaluru. The approval for the study was obtained from the college Ethics Committee. The particulars of deceased in the form of age, sex, occupation, education, work experience, events leading to fatal injuries, protective measures, along with the cause of death are studied, based on the autopsy reports, police records and information from relatives. It was an observational study, to collect data regarding magnitude and type of problems involved. A descriptive and inferential statistical analysis was carried out and Fisher Exact test was used to find the significance of study parameters.

### Observations and Results:

A total number of 848 autopsies were carried out over a period of 5 years from September 2007 to August 2012 in the mortuary of the department. There were 78 cases of deaths due to fatal injuries at workplace constituting 9.2 % of unnatural deaths at our centre. (Figure 1) Of these, 73 [93.6%] were males & 5 [6.4%] were females. (Figure 2)

Figure 1: Represents burden of deaths due to fatal workplace injuries.

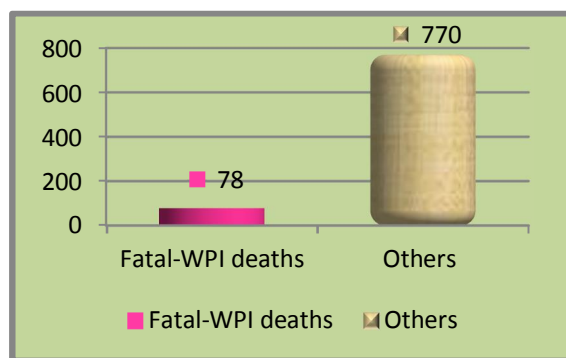
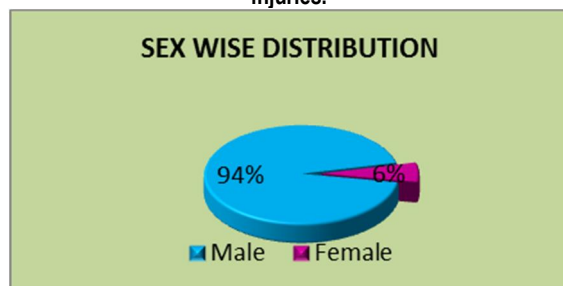
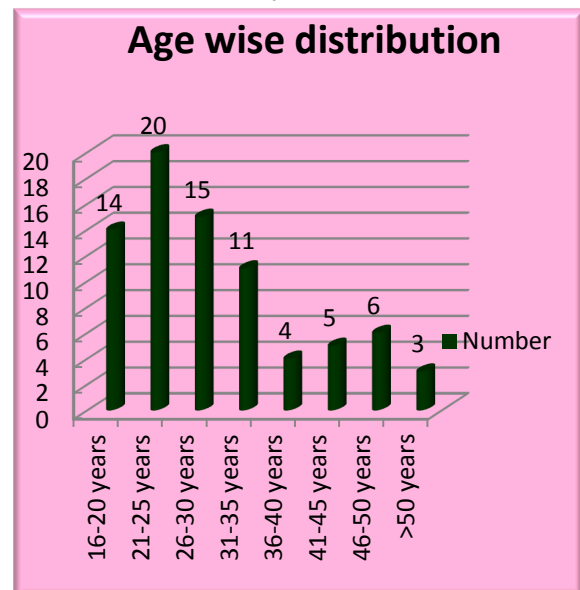


Figure 1: Shows the sex wise distribution of fatal Workplace injuries.



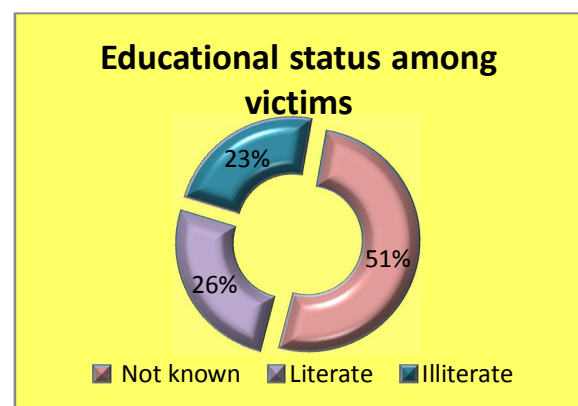
Individuals were grouped in a range of 5 years to get the accurate age of incidence. Highest incidence of 20 cases [25.6%] was noted in the age group of 21 to 25 yrs, followed by 15 cases [19.2%] in the age group of 26. 30 yrs and 14 cases [17.9%] in the age group of 16 to 20 yrs. (Figure 3)

Figure 3: Shows age wise distribution of fatal Workplace injuries.



Details of education were known only in 38 cases, of these, 20 [52.6%] were literate. & 18 [47.4%] were illiterate. (Figure 4)

Figure 4: Shows educational status among victims of fatal Workplace injuries



Majority of the fatalities [69.2%] took place at the construction site involving the laborers. (Figure 5) 26 individuals had a work experience of 6 months to 1 year, followed by 24 with 1 to 2 yrs experience. (Figure 6)

Figure 5: Shows occupation of the victims

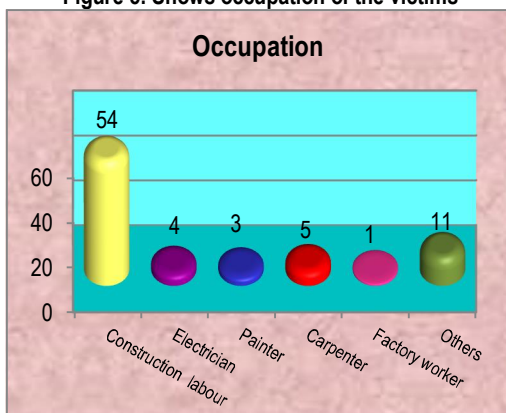
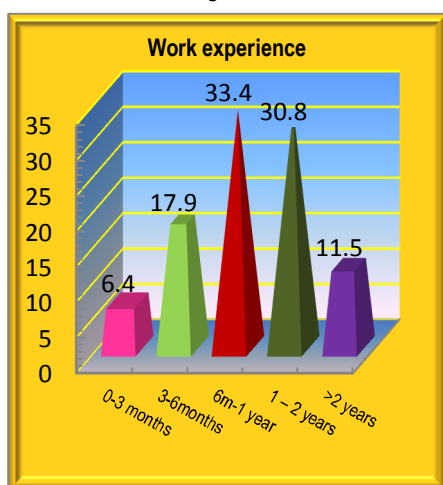


Figure 6: Shows distribution according to work experience among victims.



22 deaths [28.2%] occurred between 12 noon to 4 pm, followed by 21 deaths from 4 pm to 8 pm & 20 deaths between 8 am to 12 noon. (Figure 7)

According to the history, majority of deaths were due to fall from height [59%], followed by fall of objects [15.4%], and electrocution [15.4%], respectively. 2.6% were due to burns, 3.8% due to combination of fall and electrocution/electrocution and burns. 1.2% due to drowning. (Figure 8)

Majority of deaths were due to shock and hemorrhage [46.1%], followed by shock [10.3%]. Coma and head injury constituted 10 and 8 cases, respectively (Figure 9). Protective measures at workplace were available in 5 [6.2%] cases. Of these, 3 cases [3.8 %] had utilized the facility and 2 [2.6%] had not. For 44 cases [56.4%], details were not known (Figure 10).

Figure 7: Shows time of incidence

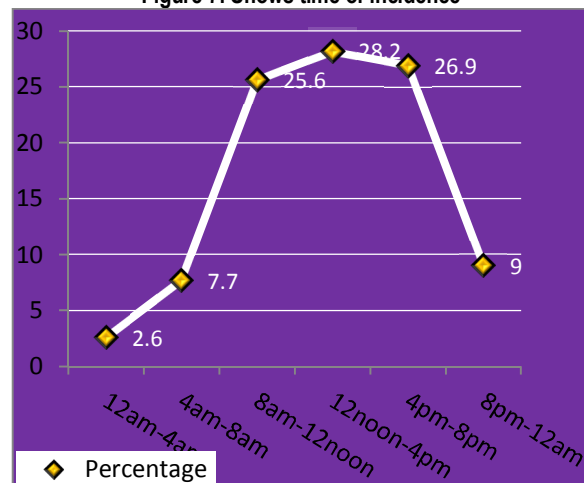


Figure 8: Shows history of incident

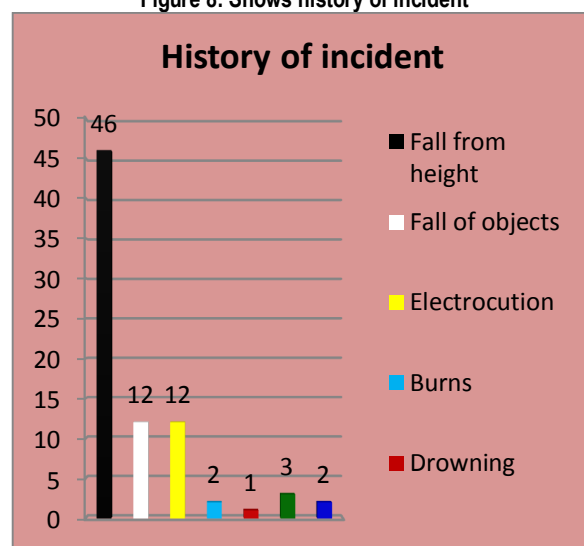


Figure 9: Shows causes of death.

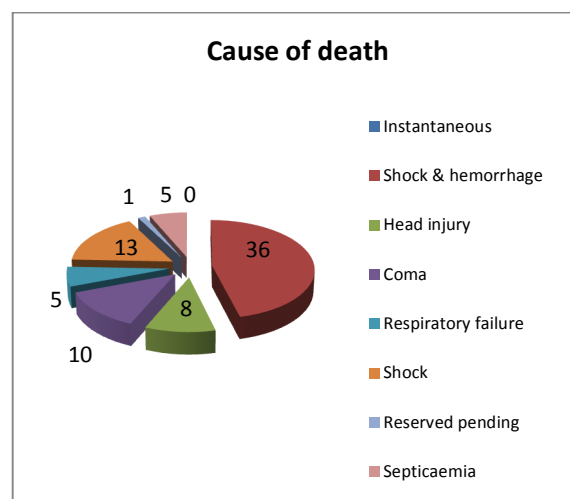
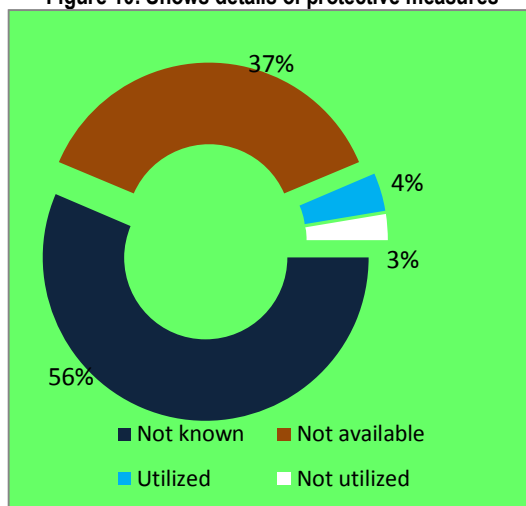


Figure 10: Shows details of protective measures



### Discussion:

In the present study, few salient and interesting observations were recorded and these have been analyzed, discussed and compared with findings of other workers in similar studies.

Of a total of 848 autopsies conducted at Vydehi hospital, 78 cases of fatal workplace injuries were noted, which constituted 9.2% of unnatural deaths. A study conducted at Aurangabad city observed that fatal occupational injuries accounted for 6.85% and in a study in Qatar, the rate was 8.6%.<sup>12,13</sup>

Male predominance [93.6%] was noted in our study which is consistent with studies done at Qatar, Aurangabad and Uttaranchal.<sup>12-14</sup>

The age group of the victims in our study ranged from 18 years to more than 50 years. Maximum number of deaths occurred in the age group of 21 to 25 years [25.6%], followed by 26 years to 30 years [19.2%]. The rate is in accordance with the study done at Victoria Hospital, Bangalore,<sup>15</sup> where maximum number of deaths occurred in the age group of 18 years to 27 years [53.1%], followed by 28 to 37 years [27.3%]. Similar findings were also observed in another study done at Aurangabad which showed the age range as 21 . 30 years [31.5%] and in Uttaranchal, 18 . 36 yrs [64.28%].<sup>13,14,16.</sup>

Construction sector accounted for more fatal work injuries than any other industry, according to the Bureau of Labor Statistics and this correlates with our study, where in 69.2% fatalities were among construction laborers. In

another study, majority of the accidents occurred in construction sectors (48.4%) and demolition sites (16.4%). Accidental falls and being struck by falling objects accounted for 1 in 10 cases. Males and those working at construction were at the greatest risk.<sup>17-19</sup>

In our study maximum number of deaths occurred during the day, with time period between 12 noon to 4 pm [28.2%], followed by 4 pm to 8 pm [26.9%] and it correlates with a study at Bangalore where maximum number of industrial accidents occurred during 12.00 pm to 4.00 pm (43.8%). These findings are also similar to the findings observed by them where time of incidence was 12 noon - 6 pm in 34.57%.<sup>15 19</sup>

Majority of the victims had a work experience of 6 months to 1 yr [33.4%], followed by 1 yr to 2 yr [30.8%] and this is similar to their study where majority of the accidents at workplace involved workers having 6 months to 2 years of work experience [44.5%]. According to that study, approximately 50% of the employees had accident in first six months of employment, followed by 23% in the next months and 3% subsequently.<sup>15, 20</sup>

In our study, details of protective measures were not known for 56.4 %. Protective measures at workplace were available in 6.2 % cases. Of this, 3.8 % had utilized the facility and 2.6 % had not utilized the facility. According to their study, equipment insufficiency has doubled as a cause of work place accident. In another study, similar findings were observed where in 88.3% of the cases safety equipments were not available and in 10.2% of cases safety equipments were utilized, however they could not prevent the accidents which can be attributed to equipment failure.<sup>21.</sup>

The findings in our study are in accordance with the report which states that an effective training and proper recruitment procedures can reduce number of injuries and death and illness. Lack of these facilities had a clear impact on the outcome of fatalities in our study.<sup>22.</sup> First aid facility was not available in 20 cases, 1 case had not undergone and 2 cases had undergone first aid facility. In the remaining cases, details were not available. In a similar study, it was observed that 99.2% of the cases, first aid facility as well as first aid training were

not available. According to their study it was observed that the first aid facilities and first aid training had positive effect on occupational safety and health behaviors of the workers.<sup>23</sup> the severity of the injury, lack of first aid at worksite, longer distance to travel for medical facilities probably contributed for death within 1 hour after accident.<sup>24</sup>

In our study, majority of deaths were due to fall from height (59%); 15.4% each due to fall of objects and electrocution. 2.6 % were due to burns, 3.8 % due to combination of fall and electrocution/electrocution and burns and 1.2 % due to drowning. In their study, falls, being struck by falling objects and machinery were implicated as leading causes of work related injury and death. Similar findings were observed in another study where, 52.4% of the cases were due to injuries, followed by electrocution, burns, traumatic asphyxia and the least were due to drowning.<sup>25</sup>

A rare case of death due to suffocation as a result of fall of mud at construction site was reported by them which correlate with our study where one similar case was found among 78 cases.<sup>26</sup> Causes of death in 46.1% were shock and hemorrhage, followed by coma due to head injury. 23.1%. This is consistent with the other two similar studies.<sup>15,16</sup>

External injuries frequently noted were abrasions and combinations of other injuries. Head and other parts of the body were commonly injured. Fissure fracture of base of skull is common among head injuries.

### **Conclusion:**

Fatal injuries at workplace constituted 9.2% of unnatural deaths. Majority of the victims were male, and the incidence was common among the 21 to 30yrs. Majority of the victims were construction laborers, having work experience of 6 months to 2 yrs. Falls from height was the common type of event leading to fatal injuries, which adds to the few reports on work related injuries in India, a developing country with high immigration from rural to urban areas, where immigrants have little training and experiences and therefore enter job opportunities. That is why the incidence of work-related injuries among developing countries in

construction workers is on rise. Majority of the cases lacked pre-recruitment medical checkup, regular medical checkup and first aid facility at workplace. Protective measures were not available in most of the cases. People working in the industries prove to be inadequate in using proper protective measures. Thus enforcement and use of proper personnel protective equipment will decrease the incidence of deaths to a considerable amount. The results confirm that the gender, age and accident types, medical checkup, protective measures in the workers were significantly different in incidence rates and mortality rates.

### **Acknowledgement:**

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**Conflict of Interest:** None.

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## Original Research Paper

# A Retrospective Based Study on Profile & Pattern of Cervical Injury

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### Abstract:

An ailment not to be treated+to 21<sup>st</sup> century intervention, we have come a long way as far as management of cervical injury is concerned. Cervical spine has been the least explored area of research due its inaccessibility & positioning with vital structures. This autopsy based study on cervical injury mainly underlines its demographic study, type of injury, causes, treatment & survival rate which can help us understand cervical injury & its medical, social, economic & legal implications. It was observed that 40% of the cervical injury cases were menial workers belonging to the reproductive age group, 64% of which was caused due to road traffic accidents, which could be prevented by implementation of strategies at the primordial level in order to decrease the socio-economic burden of the country and society.

**Key Words:** Cervical spine, Autopsy, Implications, Strategies

### Introduction:

Cervical spinal injuries are the most devastating injuries.<sup>1</sup> The anatomical arrangement of the head & neck is such that a heavy immovable object (the head) is supported by a narrow stalk (the neck) providing a vast range of movements. The upper two cervical vertebrae provide rotational movements, while the flexion and extension are provided by last five vertebrae.<sup>2</sup> This functional aspect of cervical spine explains why, as a general rule, rotational forces applied to head are likely to injure the upper two vertebrae, and those causing extreme flexion & extension, the lower five.<sup>2</sup>

Approximately 5-10 % cases in the emergency department presenting with unconsciousness as a result of motor vehicle accidents or fall have a major injury to the cervical spine.<sup>2</sup> Range of spinal injuries can vary from temporary & merely functional impairment due to ligament & muscle strain to vertebral fracture & dislocation, the latter often accompanied by spinal cord lesion. Half of cervical spine fractures occur at the level of C6 or C7 and one-third occur at the level of C2. Most fatal cervical spine injuries occur in upper cervical levels, either at craniocervical junction C1 or C2.<sup>3</sup> Cervical spinal injury may occurs due to flexion rotation, extension rotation and axial compression resulting in fracture, subluxation and dislocation. Frequent mechanisms of cervical spine injury are transverse shear, longitudinal shear and tension created by ventroflexive and retroflexive forces.

By far, only one population-based study of spinal cord has been performed in a complete population. Hu, et al reported on patients in the Manitoba Health Insurance Plan from 1981-1984. The annual incidence rate was 61/1,00,000 with two peaks, one in elderly females and another in 2<sup>nd</sup> and 3<sup>rd</sup> decade of the male population. The most common mechanism of injury was noted to be accidental falls, while

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motor vehicle/ transport injuries were the 2<sup>nd</sup> most common. The cervical spine was the most common level for spinal cord injury, representing 55% of all spinal cord injury.<sup>4</sup>

The cervical spine injury in United States, alone, causes an estimated 6000 deaths and 5000 new cases of quadriplegia each year. Males are affected four times more as compared to females. Approximately 80% of patients are aged between 18-25yrs, leading an active lifestyle prior to injury.<sup>3</sup>

So far, no such population-based study has been conducted in India because of poor socio-economic condition, lack of documentation, deficit funds for study and so on. However, studies with limited sample population have been conducted in different regions, medical colleges and hospitals. One of such study revealed that cervical spinal injury (36.2%) was most common among all the spinal injuries. Males were affected 3.6 times more as compared to females. Most patients were in the age range of 20-39 years, closely followed by that of 40-59years.<sup>5</sup> Another similar study suggested that cervical injury was most commonly seen in menial workers. Most cervical injuries were caused due to road traffic accidents (46.8%), followed by fall from height (39.7%). Only 49.8% could arrange an ambulance for transport.<sup>6</sup>

### Material and Methodology:

This study was conducted at S.C.B. Medical College, Cuttack, Odisha and included 110 autopsy cases brought to the Central Morgue, Department of Forensic Medicine & Toxicology, between the time period of November 2013 to October 2015 after approval of the study protocol by the Institutional Ethics Committee. The retrospective method of survey was used as study design since it was less time consuming and a single retrospective survey can provide necessary information for studying the various parameters. The spinal cord can be removed either by posterior approach or anterior approach based on the dissection method adopted. Each approach has its own advantages and disadvantages. In the present

study, posterior approach was adopted for removal of spinal cord.

### Inclusion Criteria

- All cases suggestive of cervical spinal injuries based on history, investigation report and treatment records.
- Additional injuries concomitant with cervical injuries particularly, hind brain injury is taken into account.

### Exclusion Criteria

- Penetrating neck injuries with intact cervical spine.
- Cervical spinal injury in foetus.
- Skeletal remnants with cervical spinal injuries.
- Decomposed bodies.
- Decapitation injury.

### Observations:

In our study, of the 110 cases of cervical spinal injury, 52% fell in the age group of 21-40 years and 74% in the age group of 21-50 years. (**Figure 1**). The percentage of male victims (89%) was more, forming a sex ratio of 8.2:1; of which 82% were married. (**Figure 2**). This study also revealed that 28% were illiterate, while 72% were literate (57% of literate were school drop-outs). (**Figure 3**). Based on %Revised Income for All India, 2014,+<sup>7</sup> 28% belonged to lower class and 25% belonged to upper middle class. (**Figure 4**).

A significant number, 40%, were menial workers like farmers, laborers, etc. with an average monthly income of Rs.5000, closely followed by 27% who were of working class - self-employed, government or private employee, etc., while 19% was dependent population like students or housewives. Only 13% were drivers or helpers in trucks. (**Figure 5**). Majority, 64%, had sustained cervical spine injury as a consequence of road traffic accidents (RTA), while only 20% injuries resulted due to fall from height. (**Figure 6**).

Fig 1: Distribution of Victims Based on Age (in years)

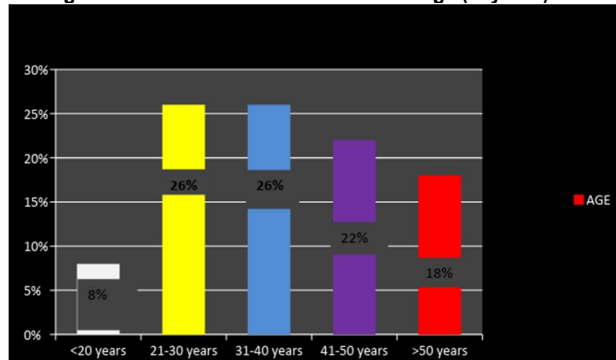


Fig 2: Distribution of Victims Based on Sex

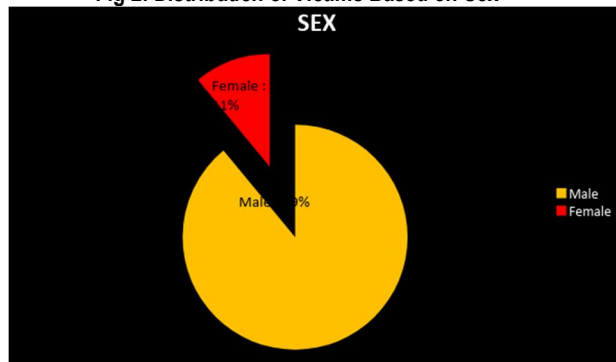


Fig 3: Distribution of Victims Based on Education

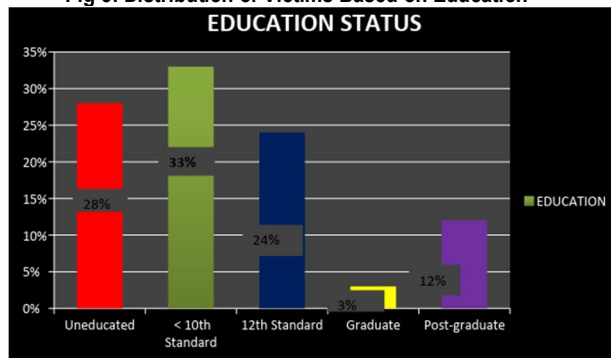


Fig 4: Distribution of Victims Based on Socio-economic status (Revised Income for All India 2014)

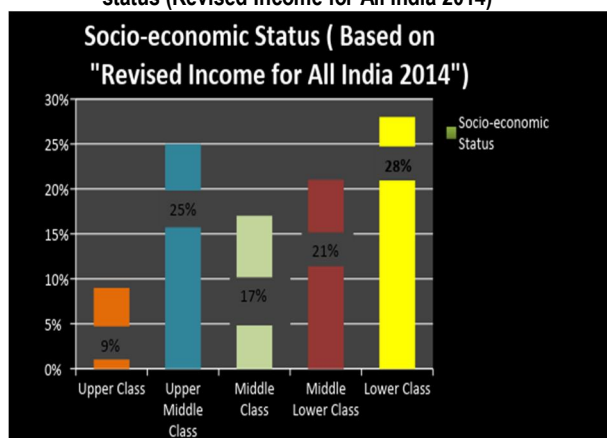


Fig 5: Distribution of Victims Based on Occupation

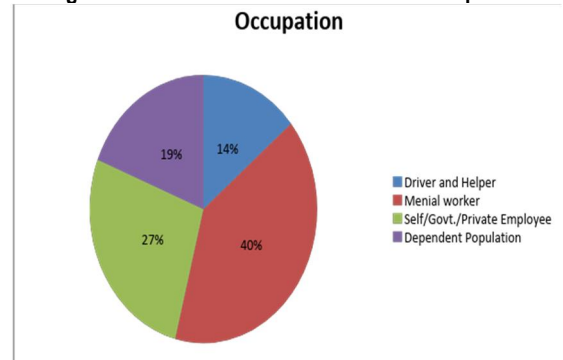
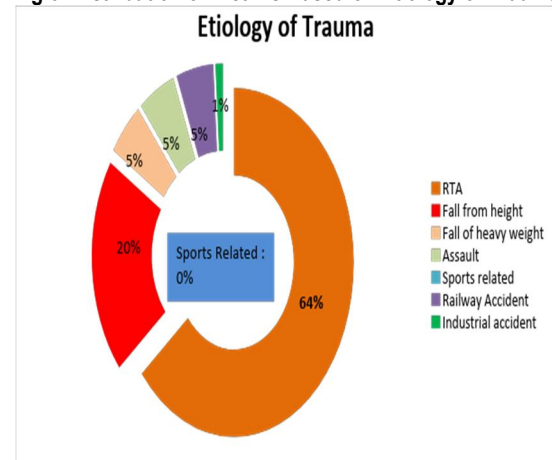


Fig 6: Distribution of Victims Based on Etiology of Trauma



Of the 64% cases of RTA, 49% were pedestrians and 34% were two-wheeler riders; (Figure 7) whereas of the 20% cases of fall from height, 48% fell from roof, tree or vehicle; 17% fell into well; 13% comprised of fall of heavy weight; another 13% was contributed by fall on ground or hit by an animal and 9% fell from height following electrocution. (Figure 8)

Fig 7: Distribution of Victims Based only on Road Traffic accident (RTA) as Causative Factor

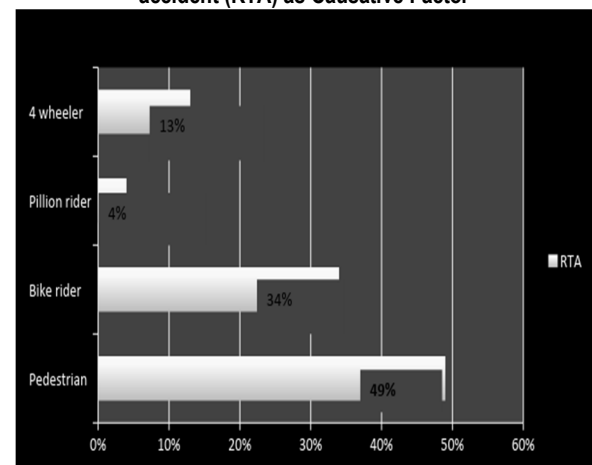
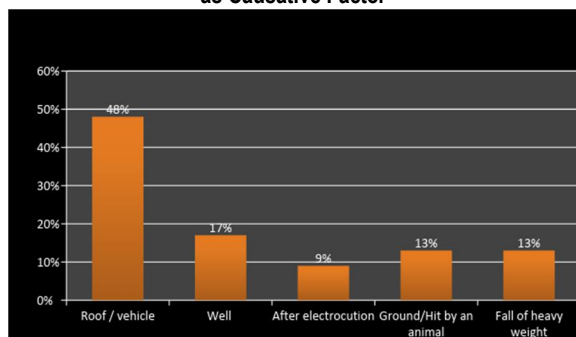
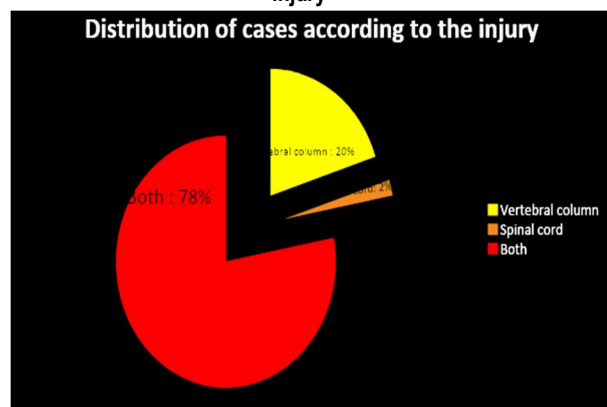


Fig 8: Distribution of Victims Based only on Fall from Height as Causative Factor



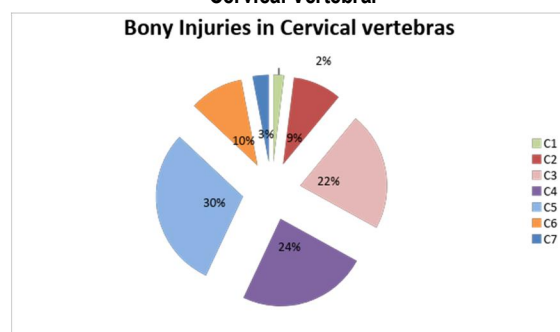
Seventy seven percent of the population had direct impact on the cervical region at the time of incident, while only 23% suffered from cervical injury due to indirect impact or transmitted force. Again, only 2% cases were exclusively of spinal cord injury, while 20% of the cases had only vertebral column involvement and the remaining 78% had both cord and column injury. (Figure 9)

Fig 9: Distribution of Victims Based on Cervical Column Injury



The most commonly involved area of the cervical column was the C5 -C6 (24%) with 30% involvement of C5 vertebrae among 110 cases. On redistributing the cases based on the involvement of anatomical landmarks of cervical vertebra, it was observed that the body of cervical vertebra was most commonly involved (41%) followed by articular facet with 28%. (Figure 10)

Fig 10: Distribution of Victims Based on Bony Injuries of Cervical Vertebral



Biomechanically, most of the cases had hyperextension (55%) pattern of injury involving anterior longitudinal ligament (ALL) along with interspinous ligament (ISL). (Figure 11) We observed that in 83.5% of cases, the spinal cord was injured while in the rest, it was intact. Of the 83.5%, 67% revealed hemorrhagic spinal cord and 16.5% showed non-hemorrhagic (edematous) spinal cord injury. (Figure 12)

Again, 20% of the cases died at the spot, while the remaining were hospitalized and treated. (Figure 13) About 63% of cases were hospitalized within 1 to 6 hours and less than 1% of cases were hospitalized after 24 hours of the incident.

Fig 11: Distribution of Victims Based on Mechanism of Injury

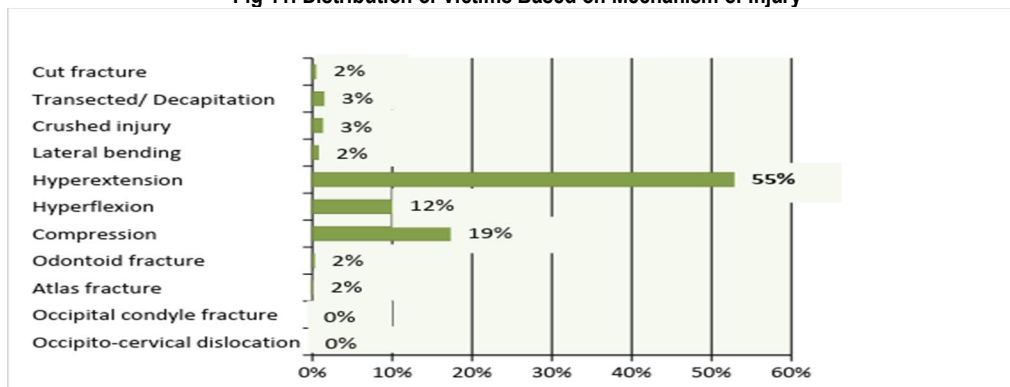
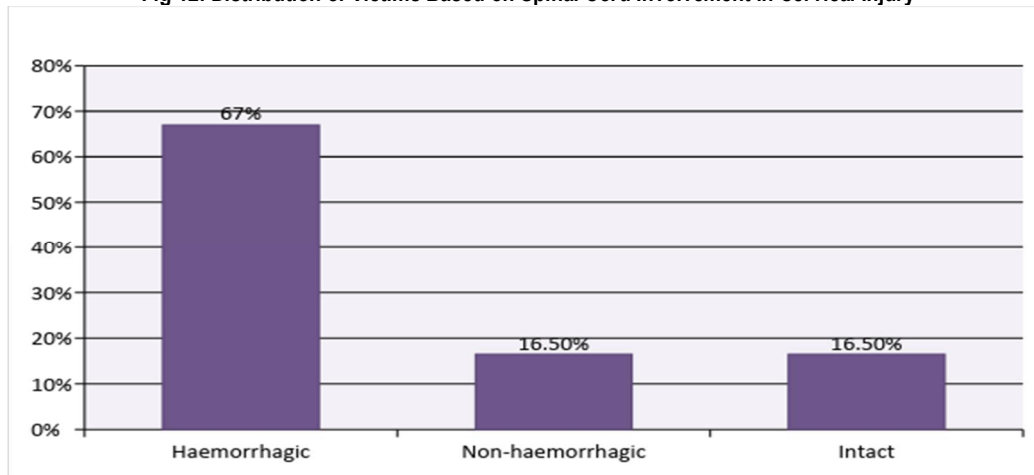


Fig 12: Distribution of Victims Based on Spinal Cord Involvement in Cervical Injury



(Figure 14) It was also observed that 80% of the cases were hospitalized while 20% succumbed to his/her injuries instantaneously. Of those 80% cases, 89% were treated conservatively, 8% had traction and only 3% had been operated. As mentioned earlier, 20% of the

cases with cervical injury died instantaneously while the same number of cases survived for 2 to 7 days. The period of survival decreased drastically after 1 to 2 weeks of hospitalization

Fig 13: Distribution of Victims Based on Period of Survival

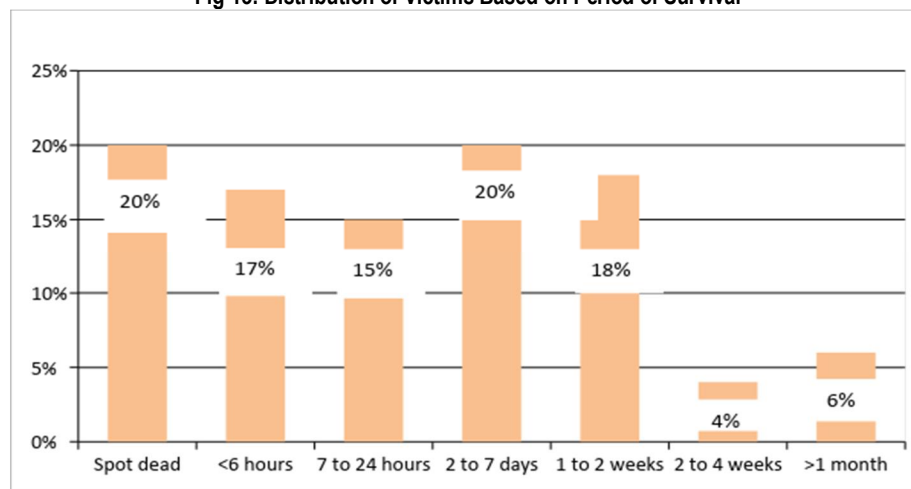


Fig 14: Distribution of Victims Based on Delay in Hospitalization

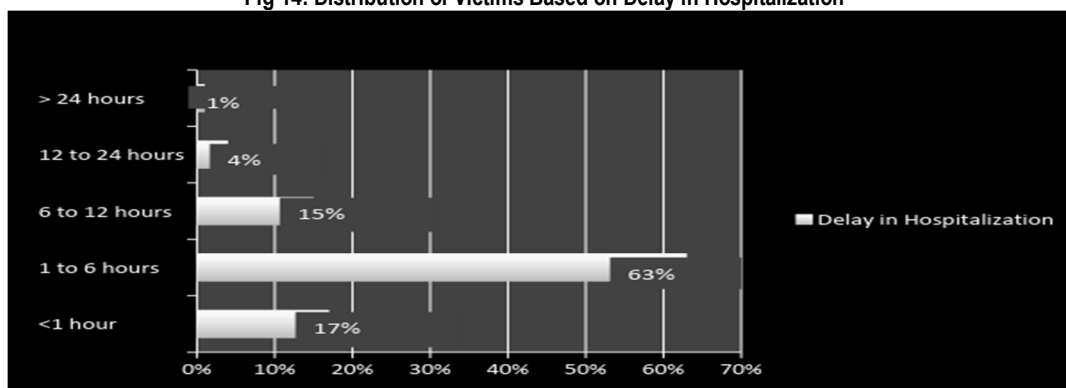
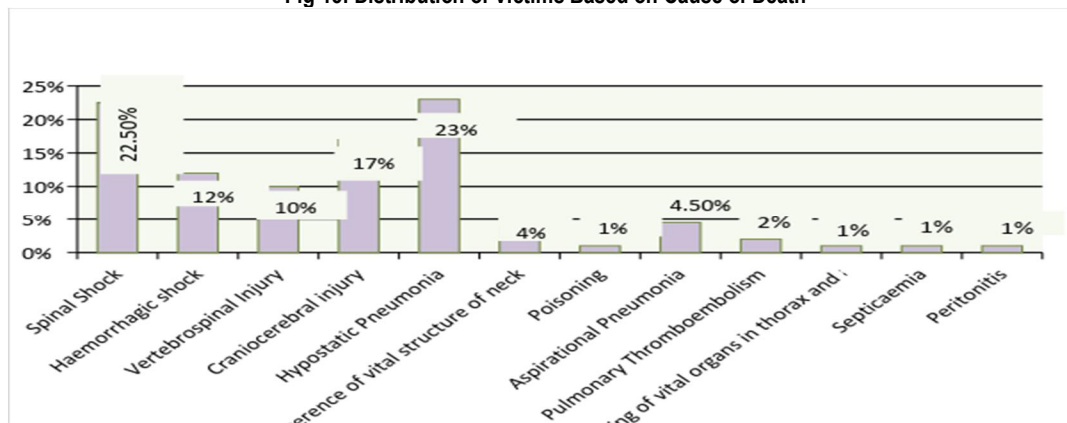


Fig 15: Distribution of Victims Based on Cause of Death



Over the following days, weeks and months, it was observed that 23% died of hypostatic pneumonia, 22.5% died of spinal shock, 17% of craniocerebral injury, 12% of hemorrhagic shock, 10% of vertebrospinal injury, 4.5% died of aspirational pneumonia, 4% of destruction of vital structure of neck, 2% of pulmonary thromboembolism, while 1% each was contributed by poisoning, septicemia, peritonitis and crushing of vital organs in thorax and abdomen. (Figure 15)

### Discussion:

Gururaj in 2011 stated that road crashes and deaths had increased from 68,351 in 1995 to 1,26,896 by 2009, with a national average of 110/million population, though the real incidence of Spinal Cord Injury (SCI) is not yet known because of lack of national registry.<sup>8</sup> Sekhon and Fehlings reported that the incidence of SCI varies between 15 and 40 per million each year in developed countries.<sup>4</sup> According to the National Spinal Cord Injury Databases, Birmingham, Alabama (February 2012),<sup>9</sup> an overall 80.6% of spinal cord injuries reported to the national database had occurred among males in concurrence with our study. Over the history of the database, there has been a slight trend toward a decreasing percentage of males. Prior to 1980, 81.8% of new spinal cord injuries occurred among males in Alabama while no such record is available for comparison.<sup>9</sup> Our findings are comparable to the age range observed in a study carried out by Agarwal, et al in which 41.5% of spinal injury fell in the age group of 20-39 years and 76.8% in 20-59 years.<sup>5</sup> According to the World Bank report,<sup>10</sup> nearly

39.7% of India's population in 2005 (456 million) lived just above line of deprivation (<1.25\$ a day). The upper lower group is the most vulnerable to fall into the category of below poverty line as it cannot sustain health, economical, pathological or social pressure. World Bank estimates show that 2.2% of India's population (around 24 million people) goes into poverty every year because of catastrophic health expenditure that they have to make despite being treated in government hospital where most of the treatment is free of cost or largely subsidized.

Injury to the brain and spinal cord was responsible for the vast majority of severe injuries. Lack of strict implementation of rules at construction site in various non-metropolitan cities of India, along with lack of awareness among the general population regarding adherence to safety precautions at work, still prevails as an important cause of spinal trauma. Lack of fencing on the terrace and guarding of the staircase make fall from the height a realistic possibility. During summer, most people tend to sleep out in an unprotected terrace leading to falls. Use of substandard material in the construction of rural houses endangers the life of people living in them.

Data from developed countries clearly establishes RTA as the main cause of SCI. Holly, et al found 8.2% cervical injury patients involved in MVAs and 1.6% cervical injury patients in Non-MVA-Associated Trauma.<sup>11</sup>

The study conducted by Masahito, et al suggested that most of the cervical injury was caused by traffic accident (41.3%) and slips

(24.8%), closely followed by assaults (17.4%) and fall from height (9.2%).<sup>12</sup> Biomechanically, most of the cases had hyperextension pattern of injury, in concordance with study of Ohshima, et al.<sup>13</sup> In India, with not so strong health infrastructure of our country, a poor per capita health spending (1.4% of GDP), and insufficient healthcare financing mechanisms, 66% healthcare expenditure being out of pocket, is probably increasing the burden of SCI.<sup>5</sup> Also, looking at the startling statistics of only 6% survival in patient with SCI for a period of more than one month, it is high time to realize that prevention of occurrence of SCI is better than cure.

Despite the fact that 108+ ambulance facilities have been started by our government in Odisha, but the lack of awareness, trained paramedical staff, SCI primary management equipment in the form of spinal board, collar, straps etc., this has failed to be effective for patient with SCI on a long run. None of the injured in our study received the primary management as per SCI protocols, well in concordance with studies of Nguyen, et al<sup>14</sup> and Solagberu, et al.<sup>15</sup>

SCI management does not end with spinal instrumentation or a decision to pursue a conservative management regime, SCI rehabilitation is the only way that ensures a successful community reintegration of a SCI patient as an active member. There is complete non-existence of hospital and community rehabilitation in India as a whole, even in Odisha; there is only one department for Regional Spinal Trauma Centre with comprehensive care of inpatients and outpatients. This reflects that health planners are focusing all their resources on acute care and least substantial effort on prevention of ever increasing injuries and rehabilitation of chronically injured are being made.

The home visit program conducted at Ahmadabad by Prabhaka and Thakkar<sup>16</sup> for spinal cord injured patients decreased the number of readmissions by improving the status of rehabilitation, which raised the quality of care for patients with SCI. Such programs comprising of rehabilitation of community dwelling SCI

patients in their homes can be carried out on a broader basis like national programs, by forming the home visit team consisting of an orthopedic surgeon, physiotherapist, occupational therapist, prosthetist and orthotist engineer, medical social worker and a nurse to maximize the number of patients who can be benefited.

In a study conducted by Chang,<sup>17</sup> it was observed that subacute spinal cord contusion revealed few lymphocytes and plenty of macrophages/ activated microglia at the injury sites in consistent with previous report. Recent studies have shown that injection of blood-derived macrophages activated exogenously may be beneficial in rodent models of spinal cord injury. Similar results were obtained in our study.

However, much remains to be learned about the mechanisms involved in this apparent beneficial effect. Although this experimental therapy of injecting blood-derived macrophages for human spinal cord injury is now currently undergoing Phase II clinical trial, reproducible results using this protocol in larger animal models of spinal cord injury, including primates, are disturbingly lacking. Moreover no information is available regarding the possible interactions between the exogenously activated macrophages and the macrophage/ microglia intrinsically activated by spinal cord injury. There is no doubt that caution must be exercised in the planning, initiation and conduct of human clinical trials in spinal cord injury.

## **Conclusion:**

Injury prevention strategies should focus towards the need for better transport facilities, provision of safer roads, stringent traffic rules, as wearing seat belts, helmets, advocating speed limit, proper traffic signals, mandatory traffic classes before awarding the license and alcohol awareness in India. Interpretation and implementation of better laws with severe penalties can reduce the risk factors. World over, there is a recognition that more effective preventive health programs are the only way to reduce spiraling health cost.

**Conflict of interest:** None

**Financial Assistance:** None

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## Original Research Paper

## Profile of Medicolegal Autopsies at a Tertiary Centre in Bhavnagar Region

<sup>1</sup>Ritesh Bhabhor, <sup>2</sup>Amit Parmar**Abstract:**

**Background:** The profiling of medico-legal cases is necessary in order to prevent the preventable casualties in future and to study the genuine crime rate in the area. Nowadays, road traffic accidents cause most of the casualties, which lead to many deaths. **Materials and Methodology:** This was a retrospective, record-based study of postmortems performed at the Medico-legal Centre of a tertiary health care centre in Bhavnagar region, Gujarat, in the year of 2017. During this period, a total of 1057 autopsy cases were conducted. **Results:** A total of 1057 cases were brought for medicolegal postmortem examination of which, maximum number of autopsies, 101(9.6%), were conducted in May, followed by 100 (9.5%) in October. Males predominated the females, 729 (69%) cases. Maximum number of cases, 257 (24.3%), were in the age group of 21. 30 years. Accidental injury related deaths were more in number, 280 (26.5%). Natural deaths accounted for 245 (23.2%) cases, violent asphyxial deaths, 113 (100%) cases, and thermal injury accounted for 190 (17.7%) cases, followed by the poisoning 170(16.08%) cases. **Conclusion:** It was observed that the most common cause of death is road traffic accident, probably owing to higher frequency of transportation..

**Key Words:** Hanging, Burns, Poison, RTA, Mechanical Injuries

**Introduction:**

The term Autopsy originates from ancient Autopsia which is derived from Autos i.e. Oneself and Opsis i.e. to see for oneself<sup>1</sup> An autopsy is frequently done in cases of sudden death where a doctor is not able to give a death certificate or when death is believed due to an unnatural cause.<sup>1</sup> Profiling of medico-legal cases is necessary in order to prevent the preventable casualties in future and to study the genuine crime rate in the area. Nowadays, injuries cause most of the casualties, which leads to many deaths. A medico-legal autopsy should be carried out to determine a cause of death and manner of death, to establish the identity of the deceased, to determine time since death, and

to collect trace evidence and reconstruction of the crime scene.

The autopsy is the scientific examination of bodies after death, where the whole surface of the body, as well as all body cavities and organs, are explored and findings recorded. While doing so, all the possible findings are collected to help in establishing the circumstances leading to the death and also may help the law enforcing agencies. The objective of this study was to describe the profile of medico-legal autopsy as well as the distribution of autopsies by basic data such as age, sex, cause of death and manner of death<sup>2</sup> In case of newborn infants, the question of live birth and viability assume importance and should be determined.

**Materials and Methodology:**

The present study is a record-based retrospective study of medico-legal autopsies performed at the mortuary of a tertiary health care center in Bhavnagar in the year of 2017. During this period, the total number of medico-legal autopsies performed were 1057. Data was collected using a pre-designed format from Postmortem registers/ records, Inquest papers and Postmortem reports, maintaining confidentiality.

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## Results:

A total of 1057 autopsies were done during the period of 1 year. During this period, in the month of May and October, maximum numbers of cases were found, whereas, April, June, and July showed the lowest number. (Table 1)

Table 1: Month-wise distribution of cases

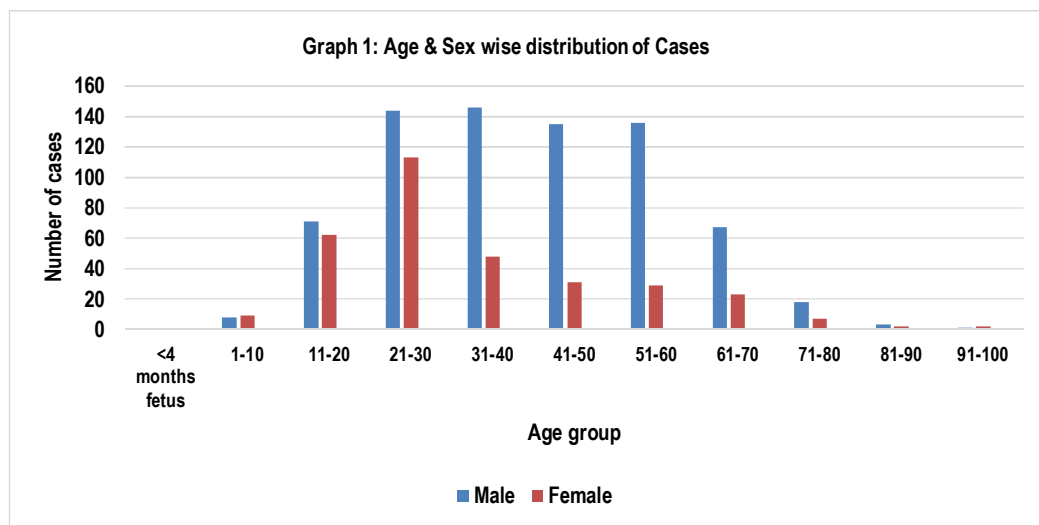
| Month     | Sex            | Total | Total case (%) |
|-----------|----------------|-------|----------------|
| January   | Male           | 56    | 86 (8.13)      |
|           | Female         | 30    |                |
| February  | Male           | 65    | 95 (8.98)      |
|           | Female         | 30    |                |
| March     | Male           | 66    | 97 (9.17)      |
|           | Female         | 31    |                |
| April     | Male           | 47    | 75 (7.09)      |
|           | Female         | 27    |                |
|           | <4 month fetus | 01    |                |
| May       | Male           | 60    | 101 (9.55)     |
|           | Female         | 41    |                |
| June      | Male           | 51    | 73 (6.90)      |
|           | Female         | 21    |                |
|           | <4 month fetus | 01    |                |
| July      | Male           | 56    | 74 (7.0)       |
|           | Female         | 18    |                |
| August    | Male           | 61    | 82 (7.75)      |
|           | Female         | 21    |                |
| September | Male           | 72    | 97 (9.17)      |
|           | Female         | 25    |                |
| October   | Male           | 69    | 100 (9.46)     |
|           | Female         | 31    |                |
| November  | Male           | 59    | 81 (7.66)      |
|           | Female         | 22    |                |
| December  | Male           | 67    | 96 (9.08)      |
|           | Female         | 29    |                |
| Total     |                | 1055  | 1057           |

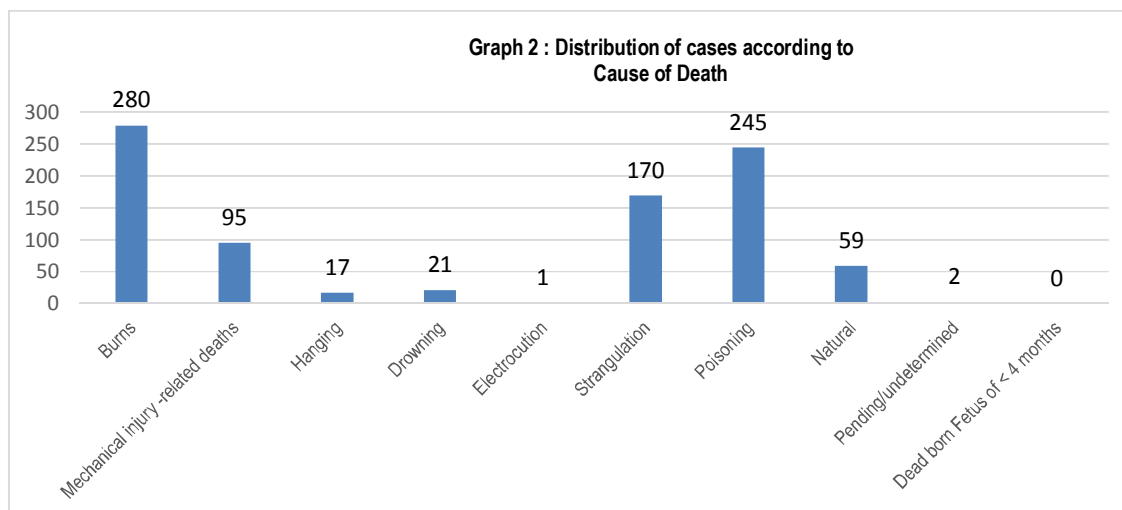
Males constituted 69%, with a male to female ratio of 2.43:1. The maximum number of autopsy cases in both sexes were of the age group of 21. 30 years, 257 (24.71%), followed by the age group of 31. 40 years, and the least number of cases, 3(0.3%) was in the age group of 91. 100 years, and less than 4-month fetus 2 (0.2) cases. (Graph 1, Table 2).

Table 2: Sex wise distribution of Cause of Death

| Sr. No | Cause of death                   | Male (%)   | Female (%) |
|--------|----------------------------------|------------|------------|
| 1      | Burns                            | 47(4.44)   | 122(11.54) |
| 2      | Mechanical injury-related deaths | 223(21.09) | 57(5.39)   |
| 3      | Hanging                          | 69(6.52)   | 26(2.45)   |
| 4      | Drowning                         | 12(1.13)   | 05(0.47)   |
| 5      | Electrocution                    | 14(1.32)   | 07(0.66)   |
| 6      | Strangulation                    | 00(0)      | 01(0.09)   |
| 7      | Poison                           | 111(10.50) | 59(5.58)   |
| 8      | Natural                          | 237(22.42) | 08(0.57)   |
| 9      | Pending/undetermined             | 36(3.40)   | 21(1.98)   |
|        |                                  | 749(70.86) | 308(29.13) |
| 10     | Dead born Fetus of < 4 months    | 02(0.18)   |            |
| Total  |                                  | 1057       |            |

Distribution of cases according to cause of death shows that the maximum number of cases were of injury-related deaths, followed by natural disease, poisoning, burns, violent asphyxial death. Maximum number was contributed by blunt trauma like RTA, fall from height, railway accidents, etc (Graph:2).





The total number of violent asphyxial deaths was 113 (10.7%) of the total 1057 autopsies done during the whole year. Distribution of cases according to violent asphyxial deaths shows that, among the violent asphyxial deaths, the maximum number of a case was of hanging 95 (9%), followed by drowning 17 (1.6%) and strangulation 1 (0.1%). Of the total 1057 autopsy cases, in 59 (5.39%) cases, cause of death was pending (as chemical analysis report yet to be awaited) or undetermined as in some decomposed bodies, even after thorough post mortem examination & proper investigation, cause of death could not be ascertained.

### Discussion:

Of the total 1057 autopsy cases, males were 749 (70.9%), the male: female ratio being 2.43:1, in the total number of cases. In the studies by Radhakrishna et al,<sup>1</sup> and Afandi,<sup>2</sup> this result matched concurrently. The male case predominance may be explained by the fact that male subjects experience more exposure to the outside environment, as the socioeconomic structure of our community is where the man is usually the only partner who earns and has freedom out-of-doors, while women usually stay indoors. The most common age group involved in all types of cases was 21. 30 years and of both sex group. This finding is also consistent with the studies by Radhakrishna et al,<sup>1</sup> and Afandi.<sup>2</sup> The maximum numbers of victims were young adults. Majority of the cases, 101 (9.6%) were

recorded in the month of May and 100 (9.5%) cases during October. Maximum numbers of cases were of accidental injury-related, (26.5%), followed by natural cause (23.2%), violent asphyxia (10.7%), burns (16%), poisoning (16.1%), electrocution (2%), and undetermined - (5.6%). The reason is that owing to the availability of faster mode of transportation leading to traffic accidents, more traveling, and the chances of being more exposed to industrial and occupational hazards. Among the violent asphyxial deaths, 9% cases were of hanging, 1.6% were of drowning, 1% of strangulation.

Of the poisoning cases, majority were of organophosphate (OP) poisoning, followed by acid ingestion, aluminum phosphide (ALP), snakebite, and so on. This is because a major part of the district consisted of rural population with agriculture as the main employment; hence, agrochemical poisoning was more prevalent.

### Conclusion:

The above study radically evaluates data pertaining to medico-legal cases brought for the autopsy at a Medico-legal Centre at a tertiary health care center. This study helps to interpret the types of medico-legal autopsy cases presenting at the mortuary of the Government Hospital. This will provide an insight to the policymakers, law custodians, and the community to look into the specific aspects of the cases and, then, take measures, accordingly, for the benefit of the community and people at large of this place. Health awareness about stress regulation and

control and education creating awareness of the traffic rules and motor vehicle driving legislation must have to be strengthened and reinforced on time and again to bring down the numbers at the casualty. Improvement of road surface infrastructure, strict compliance with road safety rules by drivers and pedestrians, rapid emergency services, and the establishment of trauma care centers are the major factors that can reduce this hazard. Population explosion is a catalyzing factor for the increased number of accidents.

RTA is a preventable feature, and it is, in fact, sad to see that maximum number of deaths occur owing to this reason. The traffic rules and traffic sense needs to be taught right from the junior level, and laws should be strictly implemented. Natural deaths are the next cause of death, in which coronary insufficiency has been found out to be the main reason. Poisoning deaths were the third commonest cause of deaths, and burn cases occupied the fourth place in this study; then, poisoning cases were found with,

predominantly, OP poisoning. The majority of the state population is dependent on agriculture as the main source of income, and, therefore, there is a possibility of easy availability and individual accessibility of agricultural poisons. Such cases can be prevented by counseling them personally. Online counseling should be started along with online help for poison treatment provided for, at least, the commonly used poisons.

**Conflict of Interest:** None

**Financial Assistance:** None

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## Original Research Paper

### Trends of Suicide in Ahmedabad City

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#### Abstract:

The present prospective study was carried out at the mortuary of GMERS Medical College and Associated Civil Hospital, Sola, Ahmedabad. During the 5 calendar years from 2011 to 2015, we received a total of 1561 bodies for postmortem examination. Of them, 1183 (75.8 %) were males. The manner of death was ascertained as suicidal in nature for 195 (16.5 %) males and 148 females (39.2 %). The month associated with the maximum number of suicidal deaths was May. Majority were from the age group of 21-30 years (40.2%). Hanging (56.9%) was the most common cause of death, followed by poisoning (20.7%). The most common reason was unknown (51.6 %), followed by family disputes (20.4%).

**Key Words:** Autopsy cases, Suicide, Cause of death, Reason for death

#### Introduction:

Rapidly growing population in the cities of India and unchecked urbanization of their periphery exposes more and more population to the hazards of urban lifestyle. Adaptation to stressful life has become mandatory to live our dreams. Majority of the population of Ahmedabad city belongs to middle and lower middle socioeconomic class. Several factors such as age, occupation, lack of emotional and financial support, inability to bear a child, sexual jealousy and marital infidelity, failure in love and scolding by parents of unmarried girls are the reasons which influence the suicidal death.

More and more people in this part of the country are now coming out of the safe territory of their homes for education and employment, and thus exposing themselves to related causes of death, like road traffic accidents and occupational deaths. Hence, we have undertaken the study to evaluate the causative factors. Present study was designed to determined pattern of suicidal deaths in Ahmedabad city as the suicidal cases reveal the social and mental status of the residents of the society.<sup>1</sup>

The motto behind this study was to illustrate the continued value of autopsy in the practice of medicine, in health care and health statistics. Efforts were done to identify the magnitude & trends of suicidal death cases in a developing city like Ahmedabad.

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#### Materials and Methodology:

The present prospective study was carried out at GMERS Medical College and Associated Civil Hospital, Sola, Ahmedabad, Gujarat. The study material comprised of 1561 autopsies carried out at the mortuary over a period of 5 calendar years from 1<sup>st</sup> January 2011 to 31<sup>st</sup> December, 2015. The bodies were received for the postmortem examination, accompanied by a requisition letter, 'maranottar' form and copy of inquest report.

In all cases, a detailed history of the case was elicited from the police and near relatives. Preliminaries of the deceased including sex, age, etc. with a short history of the incident and circumstances noted on a specially designed performa. Positive findings of post-mortem examination, with laboratory reports and final cause of death were also recorded. Of the total cases, those of suicidal death were identified. These cases were studied by applying different criteria like age groups of the victims, sex, cause of death, reason of suicide, month and year wise distribution, history of hospitalization. The data so received was tabulated on a sheet and analyzed.

#### Observations and Discussion:

As can be seen from the **Table No.1**, during 2011 to 2015, a total of 1561 postmortem examinations were performed. Of these 1183 (75.8 %) were males. In comparison, there were 65.2% male victims in the study by Bhagora, et al.<sup>2</sup> This is because

males are more exposed to outdoor activities as well as disputes in family matters. They are the main bread-earners of the family. While looking at the proportionate allocation of cases, we found that of the 378 females, 148 (39.2 %) had committed suicide, whereas, it was 195 for males (16.5 %). On looking at the percentage, it appears that females have more suicidal tendency as compared to males. But while looking at numbers, it is clear that males form around 50-51 % of the total population of the society and committed suicide in higher numbers as compared to females.

Total suicidal death cases observed during the study period was 343 (22%). Year and month wise break-up of cases is described in **Table No. 2**. It is clear that the percentage of suicides varied between 17 to 26 % with an average of 21.97 %. Maximum suicidal death cases were observed in the month of May, 45(13.1%). In contrast, other researchers observed that maximum suicides occur in October, followed by June.<sup>2,3</sup>

**Table No.1: Classification of Suicidal Cases**

| Year         | Male                   |                        | Female                |                        | Total                 |                      |
|--------------|------------------------|------------------------|-----------------------|------------------------|-----------------------|----------------------|
|              | Total Autopsies        | Suicides               | Total Autopsies       | Suicides               | Total Autopsies       | Suicides             |
| 2011         | 196                    | 34                     | 38                    | 20                     | 234                   | 54 (23.1 %)          |
| 2012         | 221                    | 22                     | 70                    | 28                     | 291                   | 50 (17.2 %)          |
| 2013         | 221                    | 43                     | 82                    | 35                     | 303                   | 78 (25.7 %)          |
| 2014         | 263                    | 48                     | 80                    | 24                     | 343                   | 72 (21 %)            |
| 2015         | 282                    | 48                     | 108                   | 41                     | 390                   | 89 (22.8 %)          |
| <b>Total</b> | <b>1183</b><br>(100 %) | <b>195</b><br>(16.5 %) | <b>378</b><br>(100 %) | <b>148</b><br>(39.2 %) | <b>1561</b><br>(100%) | <b>343</b><br>(22 %) |

**Table No. 2: Year and Month wise Distribution of Suicide Cases**

| Year<br>Month | 2011      | 2012      | 2013      | 2014      | 2015      | Total              |
|---------------|-----------|-----------|-----------|-----------|-----------|--------------------|
| January       | 1         | 8         | 6         | 5         | 4         | 24 (7.00 %)        |
| February      | 3         | 8         | 1         | 2         | 8         | 22 (6.41 %)        |
| March         | 7         | 3         | 7         | 3         | 9         | 29 (8.45 %)        |
| April         | 5         | 3         | 6         | 8         | 6         | 28 (8.16 %)        |
| May           | 6         | 7         | 11        | 10        | 11        | 45 (13.12 %)       |
| June          | 7         | 0         | 8         | 9         | 8         | 32 (9.33 %)        |
| July          | 6         | 7         | 7         | 4         | 5         | 29 (8.46 %)        |
| August        | 5         | 7         | 4         | 3         | 10        | 29 (8.46 %)        |
| September     | 5         | 2         | 8         | 4         | 6         | 25 (7.29 %)        |
| October       | 4         | 3         | 10        | 7         | 8         | 32 (9.33 %)        |
| November      | 2         | 1         | 5         | 10        | 9         | 27 (7.87 %)        |
| December      | 3         | 1         | 5         | 7         | 5         | 21 (6.12 %)        |
| <b>Total</b>  | <b>54</b> | <b>50</b> | <b>78</b> | <b>72</b> | <b>89</b> | <b>343 (100 %)</b> |

Maximum suicides (40.2%) were from the age group of 21.30 years, which is the

young work force group. This finding was consistent with the findings of Sharma, et al.,<sup>4</sup>

Pankaj, et al,<sup>5</sup> and Kulkshetra, et al.<sup>6</sup> This was followed by 80 victims (23.3 %) of 31-40 years

of age, and 54 victims (15.7%) of 11-20 years.(

**Table No. 3)**

**Table No. 3: Age and Sex-wise Distribution of Suicides**

| Age Groups (years) | 2011      |           | 2012      |           | 2013      |           | 2014      |           | 2015      |           | Total      |            | Grand Total  |
|--------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|------------|--------------|
|                    | M         | F         | M         | F         | M         | F         | M         | F         | M         | F         | Male       | Female     |              |
| 11-20              | 4         | 2         | 4         | 8         | 6         | 6         | 4         | 7         | 4         | 9         | 22         | 32         | 54 (15.7 %)  |
| 21-30              | 14        | 10        | 7         | 12        | 15        | 16        | 21        | 6         | 20        | 17        | 77         | 61         | 138 (40.2 %) |
| 31-40              | 12        | 6         | 2         | 7         | 13        | 8         | 13        | 6         | 8         | 5         | 48         | 32         | 80 (23.3 %)  |
| 41-50              | 3         | 0         | 4         | 0         | 5         | 2         | 2         | 2         | 6         | 7         | 20         | 11         | 31 (9.4 %)   |
| 51-60              | 0         | 2         | 3         | 0         | 2         | 0         | 5         | 2         | 3         | 1         | 13         | 5          | 18 (5.3 %)   |
| 61-70              | 0         | 0         | 0         | 0         | 1         | 1         | 1         | 0         | 4         | 1         | 6          | 2          | 8 (2.3 %)    |
| 71-80              | 1         | 0         | 2         | 1         | 1         | 2         | 2         | 1         | 3         | 1         | 9          | 5          | 14 (4.1 %)   |
| <b>Total</b>       | <b>34</b> | <b>20</b> | <b>22</b> | <b>28</b> | <b>43</b> | <b>35</b> | <b>48</b> | <b>24</b> | <b>48</b> | <b>41</b> | <b>195</b> | <b>148</b> | <b>343</b>   |
| <b>Grand Total</b> | 54        |           | 50        |           | 78        |           | 72        |           | 89        |           | (56.9 %)   | (43.2 %)   | (100 %)      |

Hanging was the most common method employed to commit suicide, constituting 195 (56.9%) suicidal deaths. Poisoning was the second most common cause of death, constituting 71 (20.7%) suicidal deaths. Organo-phosphorus compounds, aluminium phosphide and acids were the most commonly consumed poisons. This findings consistent with others.<sup>6-8</sup> But the observations of Pankaj, et al<sup>5</sup> showed that burns was the most common cause of suicidal deaths among females. In our study, railway injury constituted the third most common cause, with 32 (9.3 %) cases, followed by self-inflicted burns 24 cases (7 %), while 14 victims (4.1 %) jumped from height. 6 cases (1.8 %) of drowning and a single case of cut throat are also on record. (**Table No. 4**)

In more than half of the cases, (177 victims, 51.6 %), the reason for suicide could not be elicited by questioning the relatives, as they themselves did not know. (**Table No. 5**) There might be some matter of defamation, which they did not want to make public. Whatever the case may be, the actuality was lost with the deceased, and the curtain will never be pulled up in the future. Family disputes (70 cases, 20.4 %) was the second most commonest reason. This findings are consistent with those of others.<sup>5,9-10</sup> Love affairs also accounted a fair number of cases (34 cases, 9.9 %), followed by failure in examinations (23 cases, 6.7 %). Long term illness, psychological illness and borrowings were the basis to commit suicide in less than 5 % each

**Table No. 4: Distribution of Cases According to the Cause of Death**

| Cause of Death      | 2011      | 2012      | 2013      | 2014      | 2015      | Total              |
|---------------------|-----------|-----------|-----------|-----------|-----------|--------------------|
| Hanging             | 30        | 30        | 41        | 46        | 48        | 195 (56.9 %)       |
| Poisoning           | 10        | 8         | 17        | 13        | 23        | 71 (20.7 %)        |
| Hit by railway      | 7         | 5         | 9         | 6         | 5         | 32 (9.3 %)         |
| Burns               | 4         | 4         | 7         | 3         | 6         | 24 (7 %)           |
| Jumping from height | 2         | 2         | 3         | 3         | 4         | 14 (4.1 %)         |
| Drowning            | 1         | 0         | 1         | 1         | 3         | 6 (1.8 %)          |
| Cut throat          | 0         | 1         | 0         | 0         | 0         | 1 (0.34 %)         |
| <b>Total</b>        | <b>54</b> | <b>50</b> | <b>78</b> | <b>72</b> | <b>89</b> | <b>343 (100 %)</b> |

**Table No. 5: Distribution of Cases According to Reason for Suicide**

| Reason of Death          | 2011      | 2012      | 2013      | 2014      | 2015      | Total             |
|--------------------------|-----------|-----------|-----------|-----------|-----------|-------------------|
| Family disputes          | 12        | 12        | 13        | 15        | 18        | 70 (20.4 %)       |
| Love affairs             | 8         | 7         | 8         | 5         | 6         | 34 (9.9 %)        |
| Failures in examinations | 5         | 5         | 6         | 3         | 4         | 23 (6.7 %)        |
| Long term illness        | 2         | 2         | 4         | 2         | 6         | 16 (4.7 %)        |
| Psychological problems   | 2         | 1         | 3         | 2         | 4         | 12 (3.5 %)        |
| Borrowings               | 2         | 2         | 2         | 3         | 2         | 11 (3.2 %)        |
| Unknown                  | 23        | 21        | 42        | 42        | 49        | 177 (51.6 %)      |
| <b>Total</b>             | <b>54</b> | <b>50</b> | <b>78</b> | <b>72</b> | <b>89</b> | <b>343 (22 %)</b> |

**Conclusion and Suggestions:**

1. Suicidal deaths were more common in males. But as a proportion of autopsy cases, suicidal death were more commonly observed in females.
2. Highest number of suicidal deaths (52%) was seen in the age group of 21 . 30 years.
3. Hanging (56.85%) was the most common cause of suicides, followed by poisoning (20.7%).
4. In more than half of the cases, the reason for suicide was not known (51.6 %), followed by family disputes (20.4%).

A multipronged approach is needed to bring down this social evil, which should include measures at society level, strong legislation, counseling of concerned person and preventive measures against further malady.

**a) Social measures**

1. Educating people, particularly from poor families, so that they can become self-sufficient.
2. Females should be encouraged to marry at an appropriate age.
3. The society, through various agencies, like media coverage and NGO's should be mobilized.

**b) Counseling**

Centers should be established to provide free counseling to the families and newlywed couple about their expected problems and their solutions in initial years of their interaction and formative years of new social and familial relationship so that the story of their rest of the life in their new role is nicely scripted.

**c) Strong legislation and its co-ordinate implementation:**

1. Registration of marriages should be made popular and compulsory, with proper disclosure of list of items gifted to newlyweds from either side and declaring that the women have all rights over these.
2. Anti-dowry cell and women protection cell be popularized and their number increased. Besides police personnel, these cells should also have social

workers, psychiatrist, counselors and other trained staff with proper training in effective dealing with the crisis and also preventing and controlling such crimes.

3. An effective coordination should be sought between the non-government voluntary and law enforcing agencies.
4. Investigations into the death in such cases should be carried out by experts, essentially beginning from scene of crime.

**d) Preventive measures**

1. Risk factors of suicide should be identified and addressed.
2. A change in attitude and mindset of society, judiciary, legislature, and the most importantly of a male person (husband/father) who is supposed to be guardian of person should be sensitized to make home/workplace a safer and happier place for a woman.

**Conflict of Interest:** None

**Financial Assistance:** None

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## Original Research Paper

### Pattern of Injuries in Homicidal Victims in South Bangalore

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#### Abstract:

Homicide is a heinous crime against the civilized society. It is defined as killing of one person by another. The incidence of homicide is on the rise, worldwide. A prospective study on homicidal deaths were conducted in the department of Forensic Medicine, Kempegowda Institute of Medical Sciences, Bangalore, from November 2012 to May 2014, for a period of 18 months, to assess the pattern of injuries in victims of homicide in south Bangalore area. A total of 36 cases of homicidal deaths were reported during the study period and most of the victims had sharp weapon injuries (36.1%), mostly present over the head (47.2%). Abrasion (52.8%) was the most common injury present. Stone (29.1%) was the most common weapon used. Defense wounds were absent in most (63.9%). Most victims (80.6%) died on the spot, while the most common cause of death was shock and haemorrhage (61.1%).

**Key Words:** Homicidal Death, Injuries, Victim, Abrasion, Weapon, Defense Wounds, Haemorrhage

#### Introduction:

Homicide is a heinous crime against the civilized society. It is defined as the killing of one person by another.<sup>1</sup> Since very long, laws were framed by different judicial authorities in a bid to prevent its further occurrence.

In spite of this, there has been a phenomenal rise in the incidence of homicides in India, and also, all over the world. The pattern is also changing because of population explosion, changing life style, modern needs of the man and easy availability of various types of weapons.

With increasing awareness of the various means of crime detection among the criminals, and also the knowledge in them as to the means of concealment of the crimes committed so as to avoid detection, it has become a lot more difficult to solve these crimes. Thus, the role of the forensic pathologist is enormous in solving homicidal deaths.

In view of the magnitude and frequency of such homicidal deaths in south Bangalore, and its impact on the society, we undertook the present study so as to find out the types of injury, types of assault weapon and any particular pattern of injuries to denote them as homicidal injuries.

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#### Material And Methodology:

A prospective study on homicidal deaths was conducted at the mortuary of the department, Kempegowda Institute of Medical Sciences (KIMS) Hospital, Bangalore over a period of 18 months from November 2012 to

May 2014. All the cases brought to the department for medicolegal autopsy with alleged history of homicide and also the cases which were later registered as homicide during and after the autopsy, were included in the study. All the cases subjected for autopsy with alleged history of homicide, but which were later recorded as accidental deaths, after medicolegal autopsy, were excluded in the study. Using pre-tested structured proforma, information was collected from the police, victims relatives and friends, visits to the scene of crime and by perusal of hospital records in cases of hospitalization.

### Results:

During the study period a total of 36 cases of Homicidal deaths were studied that were subjected to autopsy at the mortuary of our institute and the results are tabulated under various parameters.

Deaths due to sharp weapon injuries (36.1%) out-numbered those due to blunt weapon injuries (27.8%). Ligature strangulation (15% cases) was a less common mode of killing, as observed in our study. (Table No. 1 & 2) Head (47.2 %) was the most often targeted area in the victims of homicide. This was followed by injury on multiple sites (27.8%) and neck (11.1%). (Table No. 3) Abrasion (52.8%) was the most common injury observed in our study, followed by fracture or dislocation (47.2%), laceration (44.5%) and contusion (44.5%). The least frequent injury was chop wound (13.9%). (Table No. 4) Of the 36 cases, only 14 had defence wounds.

Table No. 1: Distribution based on Pattern of Homicide

| Sl.No. | Pattern of Homicide   | No        | %age       |
|--------|---|-----------|------------|
| 1      | Sharp Weapon Injuries   | 13        | 36.12      |
| 2      | Blunt Weapon Injuries   | 10        | 27.78      |
| 3      | Sharp & Blunt Weapon Injuries   | 06        | 16.66      |
| 4      | Asphyxial Deaths<br>a) Strangulation (05 cases)<br>b) Throttling (01 Case)<br>c) Smothering (01 Case) | 07        | 19.44      |
| 5      | Firearms  | 00        | 00.00      |
|        | <b>Total</b>  | <b>36</b> | <b>100</b> |

Table No 2: Distribution based on Type of Weapon used:

| Sl.No. | Weapon Type   | Number    | Percentage |
|--------|---------------|-----------|------------|
| 1      | Sharp Weapon  | 13        | 36.11      |
| 2      | Blunt         | 17        | 47.22      |
| 3      | Sharp + Blunt | 06        | 16.67      |
|        | <b>Total</b>  | <b>36</b> | <b>100</b> |

Table No. 3: Distribution based on Site involved over the body:

| Sl.No. | Site Involved     | Number    | Percentage |
|--------|-------------------|-----------|------------|
| 1      | Head              | 17        | 47.22      |
| 2      | Neck              | 04        | 11.11      |
| 3      | Head and Neck     | 03        | 08.33      |
| 4      | Chest             | 01        | 02.78      |
| 6      | Chest and Abdomen | 01        | 02.78      |
| 7      | Multiple          | 10        | 27.78      |
|        | <b>Total</b>      | <b>36</b> | <b>100</b> |

Table No 4: Distribution based on Type of Injuries:

| Sl.No | Type of Injury          | Present In | Percentage |
|-------|-------------------------|------------|------------|
| 1     | Abrasion                | 19         | 52.78      |
| 2     | Contusion               | 16         | 44.45      |
| 3     | Laceration              | 16         | 44.45      |
| 4     | Fracture or Dislocation | 17         | 47.22      |
| 5     | Incised Wound           | 12         | 33.33      |
| 6     | Stab Wound              | 13         | 36.11      |
| 7     | Chop Wound              | 05         | 13.89      |

Among the sharp weapons that were used for homicide, sharp pointed weapons like knife was mostly used (76.9%). Sharp heavy cutting weapons like sword, were used in 3 cases (23.1%). These weapons are carried by the assailants in premeditated murders. Among the blunt weapons that were used for homicides, stone was mostly used (29.41%). (Table No. 5 & 6)

Table No 5: Distribution based on Weapon used – Sharp weapon

| Sl.No. | Weapon              | Number    | Percentage |
|--------|---------------------|-----------|------------|
| 1      | Sharp Pointed       | 10        | 76.92      |
| 2      | Sharp Heavy Cutting | 03        | 23.08      |
|        | <b>Total</b>        | <b>13</b> | <b>100</b> |

Table No 6: Distribution based on Weapon used – Blunt weapon

| Sl.No. | Blunt Weapon    | Number    | Percentage |
|--------|-----------------|-----------|------------|
| 1      | Stone           | 05        | 29.41      |
| 2      | Metallic Hammer | 03        | 17.65      |
| 3      | Iron Rod        | 02        | 11.77      |
| 4      | Cloth           | 04        | 23.52      |
| 5      | Others          | 01        | 05.88      |
| 6      | Not known       | 02        | 11.77      |
|        | <b>Total</b>    | <b>17</b> | <b>100</b> |

Most of the victims died on the spot (80.6%) while 16.7% of victims died between ½ hr to 1 day. Only one victim (2.8%) died after 2 days. (Table No. 7) In 61.1 % of cases, cause of death was shock and

haemorrhage. Cranio-cerebral damage constituted 16.7% cases. Asphyxia (19.4%) in fatal pressure over the neck. Others, being 2.8 % included septicaemia. (Table No. 8)

Table No.7: Distribution Based on Survival Period:

| Sl.No. | Survival Period      | Number    | Percentage |
|--------|----------------------|-----------|------------|
| 1      | Spot Death(< ½ Hour) | 29        | 80.55      |
| 2      | ½ Hour to 1 Day      | 06        | 16.67      |
| 3      | 1 Day to 7 Days      | 1         | 02.78      |
| 4      | >7 Days              | 0         | 00.00      |
|        | <b>Total</b>         | <b>36</b> | <b>100</b> |

Table No. 8: Distribution based on Cause of Death:

| Sl.No. | Cause of Death          | Number    | Percentage |
|--------|-------------------------|-----------|------------|
| 1      | Cranio- cerebral Damage | 06        | 16.67      |
| 2      | Shock and Haemorrhage   | 22        | 61.11      |
| 3      | Asphyxia                | 07        | 19.44      |
| 4      | Others                  | 01        | 02.78      |
|        | <b>Total</b>            | <b>36</b> | <b>100</b> |

### Discussion:

Death due to sharp weapon injuries outnumbered those due to blunt. Our findings are consistent with those of Vij, et al<sup>2</sup> who observed sharp weapon injuries in 49.4% of the cases, while in 34.8% cases, blunt weapon injuries were present. Similar findings were also observed by Shivakumar, et al,<sup>3</sup> Mohanty, et al<sup>4</sup> and Hugar, et al,<sup>5</sup> where Sharp weapons were mostly used to commit homicide. In contrast, Prajapati, et al<sup>6</sup> and Kominato, et al<sup>7</sup> observed the hard and blunt weapon occupying the top most position as the favorite weapon for causing injuries. Ligature strangulation is a less common mode of killing, as observed in our study.

Interestingly, we did not find any firearm injury case. In contrast, Sinha et al<sup>8</sup> observed firearms as the most commonly used weapons in homicide, with an explanation of easy availability of license and non-licensed fire arms, in their study area. This contrasting geographical variation is an important feature.

It was observed that head was the most often targeted area in the victims of homicide. This was followed by injury on multiple sites and neck. Sharp weapons like sword, chopper etc., are most often used on the head. Blunt injuries to the head are mostly due to stones which are readily available, the

motive, usually after a heated argument. Head is targeted often because it contains the vital organ i.e. Brain and its nearness to the hand of the assailant. Neck injuries are most often cut throat injuries, in case of sharp weapons. Blunt injuries on the neck are usually due to strangulation, either by materials like saree or veil. These findings are similar to studies done by Dhiraj, et al,<sup>9</sup> Gambhir, et al,<sup>10</sup> Mohanty, et al,<sup>11</sup> Hugar, et al<sup>5</sup> and Vij, et al,<sup>2</sup> the head and neck were most targeted parts of the body for both sharp and blunt weapons. It was seen that abrasion was the most common injury observed in a case of homicide. This may be due to the fact that abrasion can be caused by both blunt weapons as well as blunt part of sharp weapons.

Among the sharp weapons that were used for homicides, sharp pointed weapons like knife was mostly used. Sharp heavy cutting weapons like sword, etc were used in 3 cases. These weapons are carried by the assailants in premeditated murders. Among the blunt weapons that were used for homicides, stone was mostly used. Usually blood stained stones were recovered at the scene.

Most of the victims died on the spot and rest of the victims died within one day. Only one victim died after 2 days. The fact that most of the victims dying on the spot could be attributed to the lethality of weapon used and determination on the part of assailant to kill the victim, since most of these cases were premeditated. Similar observations were made by Gupta, et al<sup>11</sup> and Hugar, et al,<sup>5</sup> where majority of the victims died on the spot; whereas in the study by Mohanty, et al,<sup>4</sup> majority of the victims died within 24 hours.

In most of cases, cause of death was shock and haemorrhage. Heart and Lungs are involved in homicide by sharp light cutting weapons by stabbing and great vessels of the neck are involved in cut throat injuries leading to severe bleeding. In case of heavy cutting weapons, the target being head, face and neck fatal injury to brain and vascular structures is more common. The other causes were neurogenic shock, 16.7%, followed by asphyxia, septicaemic shock, embolism, etc. Similar observation were made by Mittal, et al,<sup>12</sup> Dhiraj, et al<sup>9</sup> and Hugar, et al<sup>5</sup> where most

of the victims died due to shock and haemorrhage.

### **Conclusion:**

Cracking down the causes of homicides, which are due to desperation from unemployment, fear of gang violence or dependency on drugs is the need of the hour.

**Conflict of Interest:** None

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## Original Research Paper

## Study of Early Postmortem Changes in Skin for Estimation of Postmortem Interval at PIMS, Loni

<sup>1</sup>Gonnade U, <sup>2</sup>Chavan K.D**Abstract:**

The primary task of medico-legal death examination is the reliable estimation of the time since death, on the basis of postmortem changes, under influence of different factors. Elasticity, transparency, softness, luster, moistness were the features of skin tested in study. In all the 66 cases, skin did not show luster, elasticity, transparency, moistness or softness after death, between 3 to 24 hours of postmortem interval, in relation to age, sex, body mass index, built, season, minimum to maximum temperature, humidity, cause, mode and manner of death factor. The dead body showed loss of elasticity and transparency, dullness, lusterless, hardness and dryness of skin between 3 to 24 hours postmortem interval in relation to various external and internal factors.

**Key Words:** Postmortem Examination, Postmortem Interval, Early postmortem changes

**Introduction:**

The primary task of medico-legal death examination is the reliable estimation of the time since death.<sup>1</sup> There is a broad gap in the literature of postmortem changes of skin and other changes for the determination of postmortem interval. Broadly, postmortem interval is defined as the time elapsed between death and autopsy<sup>2</sup> and determined by examining early postmortem changes like gross and histologic postmortem changes of the skin.<sup>3</sup> Computerized image analysis technique by Image 1 software, which is used for morphometric examination of epidermal and dermal layers of the skin and histological examination of skin in adult male albino rats,<sup>4</sup>

decrease of dna in postmortem samples of human parenchym cells,<sup>5</sup> sweat gland response to adrenergic and cholinergic installation in the skin,<sup>6</sup> human head hair proximal end postmortem changes,<sup>7</sup> corneal cloudiness,<sup>8</sup> postmortem decline in intra ocular pressure,<sup>9</sup> postmortem intraocular ophthalmoscopic examination of eye,<sup>10</sup> pupillary reaction to injection of homatropine and pilocarpine in the anterior chamber of the eye,<sup>11</sup> postmortem cooling,<sup>12</sup> rigor mortis,<sup>13,14</sup> bombay famine hospital report(1901),<sup>14</sup> postmortem staining,<sup>15</sup> study of percentage of postmortem vital spermatozoa,<sup>16-17</sup> forensic entomology,<sup>18</sup> gastro-intestinal content,<sup>19</sup> postmortem vitreous chemistry,<sup>1</sup> red blood cell,<sup>20</sup> white blood cell and in vitro blood,<sup>21</sup> cerebro- spinal fluid,<sup>22</sup> and own experience are the various studies conducted in this area.

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But there is still scarcity on the literature on study of early postmortem changes in skin. Skin that was translucent in life<sup>23</sup> becomes pale<sup>24,25</sup> due to drainage of blood from small vessels.<sup>26</sup> It becomes ashy white after death.<sup>24,25</sup> Usually in fair bodies,<sup>14</sup> skin becomes dull, waxy and opaque because of stoppage of peripheral circulation.<sup>23</sup> It loses elasticity within a few minutes of death.<sup>25,27</sup> In the living body, if any part of the surface is compressed, the skin will gradually return to its original form on removing the pressure.<sup>28</sup> After death, due to ironing of the facial creases, the

face looks younger.<sup>29</sup> Thickness of skin is different in tip of nose, sole, palm, scalp than other part of body and with progress of duration its behavior is different in close and open environment.

In this study, an attempt was made to study early changes of skin of dead body in the close environment of mortuary with progress of time interval.

### Aims and Objectives

The aim of this study was (1) to determine the postmortem interval on basis of early postmortem changes of skin. (2) to study the influence of different factors on the development of it.

### Materials and Methodology:

A observational cross sectional study was conducted on a total 66 bodies brought for postmortem examination to the mortuary of Rural Medical College, Loni, Rahata, Ahmednagar. (Maharashtra) between 2011 to 2013, after taking due permission from the Institutional Ethics Committee.

Elasticity was tested by giving incision to skin and assessing the capacity of wound for gaping, transparency was tested by light of torch passing through the webs of fingers and hardness of skin was tested by pressing the skin by tip of finger and assessing its capability to regain its original shape after release of pressure from skin. This hardness is not the hardness like a wood, metal, stone, bone, nail, cartilage, eraser, mummified skin, parchamentised ligature mark and the softness is not like that of sponge, cotton, putrified or adipocere skin, but is something in between.

Those dead bodies which are subjected for the postmortem after unnatural, sudden, unexpected, unexplained death or brought dead cases where time of death was known, were included in the study and unknown, unclaimed bodies where exact time of death was not known, all fetal deaths, all dead bodies which were kept in mortuary refrigerator, mutilated, amputated, all bodies preserved with preservatives, heavy racial pigmentation, Jaundice, phosphorus poisoning, CO poisoning and Postmortem staining,<sup>26</sup> drowning, where the skin retains

its normal appearances for some time,<sup>14</sup> anemic, old person, burn, scald, electrocution, and lightning were excluded from the study.

### Results:

Skin was dull, lusterless, dry, hard with loss of elasticity and transparency between 03-24 hours in 13 cases of Thin built; 03-21 hours in 33 cases of Average built and 03-17 hours in 20 cases of Well built bodies. Again, it was dull, lusterless, dry, hard with loss of elasticity and transparency between 03-24 hours in 7 cases of age group 00-10 years, 04-19 hours in 04 cases of 10-20 years age gp, 03-20 hours in 18 cases of age group 20-30 years, 03-10 hours in 10 cases of 30-40 years age group, 03-17 hours in 10 cases of 40-50 years, 05-16 hours in 06 cases of 50-60 years age group, 04-05 hours in 05 cases of age group 60-70 years, 03-15 hours in 03 cases of 70-80 years age group, 05-15 hours in 03 cases of age group 80-90 years. Similarly, in 03-21 hours in 44 cases of male sex, 03-16 hours in 22 cases of female sex, 03-24 hours; in 28 cases of winter, with temperature range of 11 °C- 41°C and humidity range of 30-85%, 03-19 hours in 19 cases (28.79%) of summer, with temperature range of 20.7 °C to 37 °C and humidity below 30% range, 03-20 hours in 19 cases (28.8%) of rainy season with temperature range of 8.72 °C - 39.9 °C and humidity below 70-95% range; 03-19 hours in 15 cases of death due to syncope, 03-24 hours in 17 cases of death due to coma, 03-20 hours in 33 cases of death due to asphyxia, 04-05 hours in 01 cases of death where manner of death could not be determined, 03-24 hours in 25 cases of death due to injury, 03-16 hours in 08 cases of death due to pathology, 03-19 hours in 25 cases of death due to poisoning, 03-04 hours in 01 cases of death due to natural cause, 05-13 hours in 07 cases of death where cause of death not determined, 03-11 hours in 05 cases of suicidal death, 03-05 hours in 02 cases of homicidal death, 03-21 hours in 26 cases of accidental death, 03-24 hours in 24 cases of death where manner of death could not be determined, 03-16 hours in 09 cases of where manner of death was natural.

Table 1:- Showing the early postmortem changes in skin with different postmortem interval, factor affecting it and total number of cases.

| S. No. | Postmortem Interval In Hours | Factor Present   | Number of Cases | Skin Changes  |
|--------|------------------------------|--|-----------------|---|
| 1      | 3-24                         | Thin   | 13              | Hard, Dry, Lusterless, Dull, Non-Elastic. Non-Transparent |
| 2      | 3-21                         | Average  | 33              |   |
| 3      | 3-17                         | Well Built   | 20              |   |
| 4      | 3-24                         | 00-10 Year   | 07              |   |
| 5      | 04-19                        | 10-20 Year   | 04              |   |
| 6      | 03-20                        | 20-30 Year   | 18              |   |
| 7      | 03-10                        | 30-40 Year   | 10              |   |
| 8      | 03-17                        | 40-50 Year   | 10              |   |
| 9      | 5-16                         | 50-60 Year   | 06              |   |
| 10     | 4-5                          | 60-70 Year   | 05              |   |
| 11     | 3-15                         | 70-80 Year   | 03              |   |
| 12     | 5-15                         | 80-90 Year   | 03              |   |
| 13     | 3-21                         | Male   | 44              |   |
| 14     | 3-16                         | Female   | 22              |   |
| 15     | 3-24                         | Winter, Temperature 11-41degree Centigrade, Humidity 30-85%  | 28              |   |
| 16     | 3-19                         | Summer, Temperature Range From 20.7 To 37 °c, Humidity < 30% | 19              |   |
| 17     | 3-20                         | Rainy, Temperature Range From 8.72c-39.9c, Humidity < 70-95% | 19              |   |
| 18     | 3-19                         | Syncope  | 15              |   |
| 19     | 3-24                         | Coma   | 17              |   |
| 20     | 3-20                         | Asphyxia   | 33              |   |
| 21     | 4-5                          | Undetermined   | 1               |   |
| 22     | 3-24                         | Injury   | 25              |   |
| 23     | 3-16                         | Pathology  | 08              |   |
| 24     | 3-19                         | Poisoning  | 25              |   |
| 25     | 3-4                          | Natural  | 1               |   |
| 26     | 5-13                         | Undetermined   | 07              |   |
| 27     | 3-11                         | Suicidal   | 05              |   |
| 28     | 3-5                          | Homicidal  | 2               |   |
| 29     | 3-21                         | Accidental   | 26              |   |
| 30     | 3-24                         | Undetermined   | 24              |   |
| 31     | 3-16                         | Natural  | 09              |   |

## Discussion:

Postmortem interval is an important interpretation during the postmortem examination, on the basis of postmortem changes present in the body. Both external and internal factors were taken into consideration in relation to the presence of the findings in skin after death. Internal factors like age, gender, built, Manner, Mode and Cause of death, were the factors which were analysed to create a baseline difference in the characteristics of skin for the purpose of postmortem changes in presence of external factor like postmortem interval, environmental temperature, humidity, season, etc.

Our result showed that there were characteristic differences in the various parameters studied, i.e. the skin was dull, lusterless, dry and hard as compared to the shiny, luster, moist and soft appearance of

skin during life time. It also loses its transparency and elasticity after death.

Our results are in consonance with the observations of others.<sup>1-4</sup> It may yield significant results if conducted with postmortem interval of more than 24 hours when temperature of open environment is high. Hardness and dryness was appreciated, but grading of it required in future study.

In the absence of pertinent literature, it is not possible to compare the results of present study with other studies. Due to inclusion of postmortem changes of one week study period, geographical variation, multiple site selection, this study was not comparable with the study of Kovarik C et al.<sup>12</sup>

## Conclusion:

Skin shows early postmortem changes from shiny, luster, elastic, transparent, soft,



and moist character to dull, dry, hard, lusterless, loss of elasticity and transparency between 03 to 24 hours postmortem interval in presence of internal and external factor.

### Limitation

Data of temperature and humidity collected from the agriculture science center, which is located 15 km away from the mortuary. Hardness and Dryness require grading for perfect description of early postmortem changes.

### Acknowledgement:

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## Original Research Paper

# Estimation of Age From the Fusion of Body of Sternum in Central India Indore Region (M.P.)

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### Abstract:

Age determination from unknown human skeletal remains or decomposed bodies is an important initial step in forensic investigation. Accurate determination of skeletal age has been a critical issue in medicolegal cases and the accuracy depends on the nature of material available and the methods applied. Sternum is a bone which is easily retrievable even from the advanced decomposed body and also from the bundle of bones, so it becomes a very important bone for age and sex determination in the advanced stage of decomposition and from mutilated, fragmented bodies.

In our study we have taken a total of 770 subjects of which 432 were male and 338 female, in the age group of 10 to 70 years and the data analysis was done by using SPSS software and p-value and standard deviation was calculated. At the end, conclusions were drawn which were inconsistent with available literatures. In our study, age estimation in relation to fusion of sternal body segment was found inconclusive.

**Key Words:** Anthropometry, Age estimation, Sternum, Body Segment Fusion.

### Introduction:

Creation of an individual's biological profile is of extreme importance and depends on factors age, sex and stature, among others. The cranial and pelvic bones, in addition to the long bones, are important in estimating the age and sex of an individual. Forensic experts are left with no choice but to depend on less sexually dimorphic elements of the human skeleton such as the sternum. Thus, studies focusing on sternum have provided important information to forensic experts.<sup>1</sup>

Identity means the determination of individuality of a person based on certain physical characteristics i.e. exact fixation of personality. Article 6 of the Universal Declaration of Human Rights states that everyone has the right to recognition everywhere as a person before the law.<sup>2</sup> Accurate identification is necessary for the establishment of corpus delicti in homicidal cases. The term corpus delicti means the body of offence.<sup>3</sup> Identification of dead body and proof of %corpus delicti+ is essential and an integral part of any criminal and civil justice delivery system throughout the world. Identification of an individual is very important in criminal cases like assault, murder, rape, disputed paternity, impersonation etc. and in civil cases like marriage inheritance, disputed sex etc.

The osseous skeleton of the sternum is the structure which is observed to resist the effects of putrefaction and decomposition for a long period of time. Determination of age from human skeletal remains for forensic and medico-legal purpose is an integral part. Still, perfect identification of age from human skeleton remains relatively a difficult task.

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About 90% accuracy can be achieved if the specimen includes skull or pelvis. But without them, it becomes difficult to judge the age with accuracy. In present study, all existing parameters were used for determination of age by study of sternum, and data base was developed for sternums of known age. In this, parameters like a pattern of fusion was examined and recorded in relation to age. This data base of measurement and indices were statistically analyzed and conclusions were drawn.

This study was done previously in various region of India but not in the central India (M.P.) region. It is an established fact that as regards the anthropometric measurements, standards differs according to different races, and different regions, and it is advised that one should not used the data of one place to the other, that is why this study was undertaken and sternum was selected for anthropometric measurements to develop the standards which would be helpful in determination of age in central Indian population. Another purpose of the study was to derive a formula for this population in medicolegal cases.

Sternum is a bone which is easily retrievable even from the advance decomposed body and also from the bundle of bone so it become very important bone for age determination in the advance stage of decomposition and from mutilated, fragmented bodies.

### Materials and Methodology:

This was an observational, Cross sectional, analytical study conducted at the mortuary of the Department of Forensic Medicine and Toxicology, M.G.M. Medical College, Indore (M.P.), after getting clearance from the Institutional Ethics Committee. The study was carried out over a period of 12 months from July 2016 to June 2017. A total of 770 subjects, 432 males and 338 females of age >10 years were taken. Sterna showing any pathology, fracture, gross deformity or with any missing part; and bodies with unknown age, were excluded from the study As a routine protocol, for opening the thoracic cavity during autopsy, the sternum was removed from the body by sectioning the costal cartilages just beside the costo-chondral

junction. The age of the deceased was obtained from the nearest relatives/ police and was verified by necessary documents. The age of the deceased was rounded off to full figures. For estimation of age, the elements of each sternum i.e. body of sternum was examined for their degree of fusion:- ( complete / partial /absent. )

### Observations & Results :

Table No. 1: Association of age with fusion of 4<sup>th</sup> to 3<sup>rd</sup> segment:

| Age          | Fusion of 4 <sup>th</sup> to 3 <sup>rd</sup> segment |                   |                     |                       |
|--------------|--|-------------------|---------------------|-----------------------|
|              | Complete   | Partial           | Non-fusion          | Total                 |
| <15 year     | 14<br>1.82%  | 0<br>0.0%         | 0<br>0.0%           | 14<br>1.82%           |
| 16-20 year   | 82<br>10.68%   | 0<br>0.0%         | 0<br>0.0%           | 82<br>10.65%          |
| 21-25 year   | 82<br>10.68%   | 0<br>0.0%         | 0<br>0.0%           | 82<br>10.65%          |
| 26-30 year   | 92<br>11.98%   | 0<br>0.0%         | 2<br>100.0%         | 94<br>12.2%           |
| 31-35 year   | 99<br>12.89%   | 0<br>0.0%         | 0<br>0.0%           | 99<br>12.86%          |
| 36-40 year   | 76<br>9.90%  | 0<br>0.0%         | 0<br>0.0%           | 76<br>9.87%           |
| 41-45 year   | 79<br>10.29%   | 0<br>0.0%         | 0<br>0.0%           | 79<br>10.26%          |
| 46-50 year   | 61<br>7.94%  | 0<br>0.0%         | 0<br>0.0%           | 61<br>7.92%           |
| 51-55 year   | 65<br>8.46%  | 0<br>0.0%         | 0<br>0.0%           | 65<br>8.44%           |
| 56-60 year   | 66<br>8.59%  | 0<br>0.0%         | 0<br>0.0%           | 66<br>8.57%           |
| >60 year     | 52<br>6.77%  | 0<br>0.0%         | 0<br>0.0%           | 52<br>6.75%           |
| <b>Total</b> | <b>768<br/>100.0%</b>                                | <b>0<br/>0.0%</b> | <b>2<br/>100.0%</b> | <b>770<br/>100.0%</b> |

Pearson Chi-Square = 14.420, DF = 10

p value = 0.1547, Not significant

The above **Table 1** shows the association of age with fusion of 4<sup>th</sup> to 3<sup>rd</sup> segment of sternum. There was no statistically significant association seen between the age and the fusion of 4<sup>th</sup> to 3<sup>rd</sup> segment of sternum ( $P>0.05$ ), showing that the distribution was comparable in relation to the fusion.

**Table 2** shows the association of age with fusion of 3<sup>rd</sup> to 2<sup>nd</sup> segment of sternum. There was no statistically significant association seen between the age and the fusion of 3<sup>rd</sup> to 2<sup>nd</sup> segment of sternum ( $P>0.05$ ), showing that the distribution was comparable in relation to the fusion.

**Table 3** shows the association of age with fusion of 2<sup>nd</sup> to 1<sup>st</sup> segment of sternum. There was statistically significant association

seen between the age and the fusion of 2<sup>nd</sup> to 1<sup>st</sup> segment of sternum ( $P < 0.05$ ), showing that the distribution in relation to fusion is dependent on the age.

Table No. 2: Association of age with fusion of 3<sup>rd</sup> to 2<sup>nd</sup> segment

| Age          | Fusion of 3 <sup>rd</sup> to 2 <sup>nd</sup> segment |                     |                     |                       |
|--------------|--|---------------------|---------------------|-----------------------|
|              | Complete   | Partial             | Non-fusion          | Total                 |
| <15 year     | 14<br>1.83%  | 0<br>0.0%           | 0<br>0.0%           | 14<br>1.82%           |
| 16-20 year   | 78<br>10.21%   | 2<br>100.0%         | 2<br>50.0%          | 82<br>10.65%          |
| 21-25 year   | 82<br>10.73%   | 0<br>0.0%           | 0<br>0.0%           | 82<br>10.65%          |
| 26-30 year   | 94<br>12.30%   | 0<br>0.0%           | 0<br>0.0%           | 94<br>12.2%           |
| 31-35 year   | 97<br>12.70%   | 0<br>0.0%           | 2<br>50.0%          | 99<br>12.86%          |
| 36-40 year   | 76<br>9.95%  | 0<br>0.0%           | 0<br>0.0%           | 76<br>9.87%           |
| 41-45 year   | 79<br>10.34%   | 0<br>0.0%           | 0<br>0.0%           | 79<br>10.26%          |
| 46-50 year   | 61<br>7.98%  | 0<br>0.0%           | 0<br>0.0%           | 61<br>7.92%           |
| 51-55 year   | 65<br>8.51%  | 0<br>0.0%           | 0<br>0.0%           | 65<br>8.44%           |
| 56-60 year   | 66<br>8.64%  | 0<br>0.0%           | 0<br>0.0%           | 66<br>8.57%           |
| >60 year     | 52<br>6.81%  | 0<br>0.0%           | 0<br>0.0%           | 52<br>6.75%           |
| <b>Total</b> | <b>764<br/>100.0%</b>                                | <b>2<br/>100.0%</b> | <b>4<br/>100.0%</b> | <b>770<br/>100.0%</b> |

Pearson Chi-Square = 30.139, DF = 20 p value = 0.0676, NS

Table No. 3: Association of age with fusion of 2<sup>nd</sup> to 1<sup>st</sup> segment

| Age          | Fusion of 2 <sup>nd</sup> to 1 <sup>st</sup> segment |                     |                      |                       |
|--------------|--|---------------------|----------------------|-----------------------|
|              | Complete   | Partial             | Non-fusion           | Total                 |
| <15 year     | 0<br>0.0%  | 0<br>0.0%           | 14<br>31.82%         | 14<br>1.82%           |
| 16-20 year   | 56<br>7.76%  | 2<br>50.0%          | 24<br>54.55%         | 82<br>10.65%          |
| 21-25 year   | 76<br>10.53%   | 2<br>50.0%          | 4<br>9.09%           | 82<br>10.65%          |
| 26-30 year   | 94<br>13.02%   | 0<br>0.0%           | 0<br>0.0%            | 94<br>12.2%           |
| 31-35 year   | 97<br>13.43%   | 2<br>4.55%          | 0<br>0.0%            | 99<br>12.86%          |
| 36-40 year   | 76<br>10.53%   | 0<br>0.0%           | 0<br>0.0%            | 76<br>9.87%           |
| 41-45 year   | 79<br>10.94%   | 0<br>0.0%           | 0<br>0.0%            | 79<br>10.26%          |
| 46-50 year   | 61<br>8.45%  | 0<br>0.0%           | 0<br>0.0%            | 61<br>7.92%           |
| 51-55 year   | 65<br>9.00%  | 0<br>0.0%           | 0<br>0.0%            | 65<br>8.44%           |
| 56-60 year   | 66<br>9.14%  | 0<br>0.0%           | 0<br>0.0%            | 66<br>8.57%           |
| >60 year     | 52<br>7.20%  | 0<br>0.0%           | 0<br>0.0%            | 52<br>6.75%           |
| <b>Total</b> | <b>722<br/>100.0%</b>                                | <b>4<br/>100.0%</b> | <b>44<br/>100.0%</b> | <b>770<br/>100.0%</b> |

Chi-Square = 363.872, DF = 20 p value = 0.0000, Sig

## Discussion:-

In our study, fusion of sternal body segment in relation to various age groups showed that there was complete fusion irrespective of the age and that the correlation between fusion and age estimation was statistically not significant ( $P > 0.05$ ).

According to available Literature:

- Reddy,<sup>4</sup> Vij,<sup>5</sup> Modi<sup>6</sup> and Pillay<sup>7</sup> state that the fusion of body of sternum occurs from below upwards, between 14 to 25 years; while Bardale mentions that the fusion of all sternal segments is complete by 25<sup>th</sup> year.<sup>3</sup>
- In our study, the correlation between age and sternal body segment fusion was inconclusive, thus our study is inconsistent with available literatures.

## Conclusion:-

Estimation of age from sternal body segment fusion is not reliable, as per our study, so all other anthropometric parameters should be taken in account before giving opinion in relation to age of unknown deceased person.

**Conflict of Interest:** None

**Financial Assistance:** None

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## Original Research Paper

# Awareness Regarding Consumer Protection Act among Medical Students

<sup>1</sup>Pragnesh Parmar

### Abstract:

**Background:** Consumer Protection Act (CPA) is a quasijudicial mechanism working at district, state, and national levels. Consumers can file their complaints in consumer forums which are empowered to award compensation. **Materials and Methodology:** A total of 137 medical students were exposed to pre-tested and pre-validated Likert scale type questionnaire (1 to 7, 1 . Not at all true, 7 . Very true) regarding awareness of Consumer Protection Act. Data obtained was analyzed via median score and tabulated. **Results:** Most of the students had heard about Consumer Protection Act and felt that Consumer Protection Act is against the doctor and in favor of patients. Many students agreed that good doctor patient relationship can prevent issues in Consumer Protection Act. Most of the students wanted that Consumer Protection Act must be taught to every medical graduate. Students were not much aware of structure of courts, monetary limits for appeal at district, state and national level as well as time limit for filing complaint as per Consumer Protection Act. Many students were aware regarding medical indemnity insurance. Most of the students were not aware that patient can lodge a complaint without lawyer in Consumer Protection Act. **Conclusion:** Basic awareness regarding Consumer Protection Act is present among medical students but actual awareness of court structure, fine limits and time limits of complaint are very poor among them.

**Key Words:** Consumer Protection Act, Medical students, Awareness.

### Introduction:

Trust and confidence are essential parts of a good doctor patient relationship. In the current era, commercialization of medical profession has spoiled this good bonding between the doctor and patients.<sup>1</sup> The Consumer Protection Act<sup>2</sup> was enacted in 1986 in India for protection of the rights of the consumer and redressal of their grievances. In 1995, the hon'ble Supreme Court brought medical profession under Section 2(1) (0) of Consumer Protection Act, 1986 in reference to case of Indian Medical Association vs VP Shantha.<sup>3</sup> Consumer Protection Act (CPA) is a quasijudicial mechanism working at district, state, and national levels.

Consumers can file their complaints in consumer forums which are empowered to award compensation.<sup>4</sup> In the present study, the awareness among medical students regarding Consumer Protection Act was assessed.

### Materials and Methodology:

A total of 137 medical students of 2<sup>nd</sup> MBBS of GMERS Medical College, Gujarat were exposed to pre-tested and pre-validated Likert scale type questionnaire (1 to 7, 1 . Not at all true, 7 . Very true) regarding awareness of Consumer Protection Act after obtaining their informed written consent. The study was undertaken after obtaining ethical approval from the Institutional Ethics Committee. Data obtained was analyzed via median score and tabulated.

### Results:

One hundred and thirty seven students of 2<sup>nd</sup> MBBS participated in the present study, of which 120 properly filled and responded questionnaires were taken into

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consideration for data analysis, while the rest were discarded. Of the 120 respondents, 71 were males and 49 were females.

Most of the students had heard about Consumer Protection Act. Many students felt that Consumer Protection Act is against the doctor and in favor of patients. Many students agreed that a good doctor patient relationship can prevent issues in Consumer Protection Act. Most of the students wanted that Consumer Protection Act must be taught to every medical graduate. Students were not much aware of structure of courts, monetary limits for appeal at district, state and national level as well as time limit for filing complaint as per Consumer Protection Act. Many students were aware regarding medical indemnity insurance. Most of the students were not aware that patient can lodge a complaint without lawyer in Consumer Protection Act (Table 1).

**Table 1: Awareness among medical students regarding Consumer Protection Act. (Likert scale: 1 to 7, 1 – Not at all true, 7 – Very true)**

| Sr. No. | Perceptions of students  | Median score |
|---------|--|--------------|
| 1       | I have heard about Consumer Protection Act.  | 6            |
| 2       | Consumer Protection Act is against the doctor.                                       | 6            |
| 3       | Consumer Protection Act is in favor of patients.                                     | 7            |
| 4       | Good doctor patient relationship can prevent issues in Consumer Protection Act.      | 5            |
| 5       | Consumer Protection Act must be taught to every medical graduate.                    | 6            |
| 6       | I know structure of courts for Consumer Protection Act                               | 3            |
| 7       | I know monetary limits for appeal at district, state and national level              | 2            |
| 8       | I am aware of medical indemnity insurance.   | 5            |
| 9       | I know time limit for filing complaint as per Consumer Protection Act.               | 3            |
| 10      | I know that patient can lodge a complaint without lawyer in Consumer Protection Act. | 3            |

## Discussion

The Consumer Protection Act, 1986, is one of the best examples in the history of socioeconomic legislation to protect the interests of the consumers in India.<sup>5</sup> Litigations against health professionals fall into Section 88 of the Indian Penal Code (IPC).<sup>6</sup> Liability of the health professionals under Section 304-A of the IPC was different. This Section reads as causing death by negligence - Whoever

causes the death of any person by doing any rash or negligent act not amounting to culpable homicide shall be punished with imprisonment of either description for a term which may extend to two years, or with fine, or with both.<sup>7</sup>

Consumer Protection Act empowers the patients to file a case against doctor in consumer court.<sup>8</sup> The Supreme Court also believes that a simple lack of care, an error of judgment, or an accident is not a proof of negligence on part of health professionals.<sup>9</sup> So, as long as a doctor follows a practice acceptable to the profession of that day in the region, he/ she cannot be held liable for negligence merely because a better alternative course/treatment was also available. When it comes to failure of taking precautions, what has to be seen is whether those precautions were not taken which the ordinary experience of professionals has found to be sufficient, is held for liability of negligence.<sup>10</sup>

Singh K, et al observed that the mean awareness score was about 15.06.<sup>11</sup> Kachare RV, et al., in their study on junior doctors from Latur, observed that the mean awareness score was 12.99.<sup>12</sup> Singh S, et al found that the mean knowledge score of the respondents was 15.83 (range 4-24).<sup>13</sup>

## Conclusion

Basic awareness regarding Consumer Protection Act is present among medical students but actual awareness of court structure, fine limits and time limits of complaint are very poor among them. In depth teaching of Consumer Protection Act in undergraduate curriculum is very much necessary to increase awareness among medical students.

**Conflict of Interest:** None

**Financial Assistance:** None

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## Original Research Paper

# An Autopsy Based Correlation Study about Developing Standards for Estimation of Stature from Foot Anthropometry in Female Population of Central India Region (Indore, M.P.)

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## Abstract:

Identification of an individual is very important in criminal cases like assault, murder, rape, disputed paternity, impersonation etc.; and in civil cases like marriage, inheritance, disputed sex, etc. Estimation of stature from extremities and their parts plays an important role in identifying the dead body in forensic examinations. The aim of the present study was to find the correlation between foot anthropometry and stature of an individual and to derive a regression formula to estimate the stature from foot anthropometry in the Central India population. This cross-sectional study was carried out on 250 deceased females of age 21 years and above, brought for postmortem examination to the mortuary of the Forensic Medicine department, M.G.M. Medical College and M.Y. Hospital, Indore (M.P.). The mean right foot length and left foot length was  $21.29 \pm 1.96$  cm and  $21.18 \pm 1.97$  cm, respectively, whereas the mean stature was found to be  $156.46 \pm 5.43$  cm. Mean foot breadth for both right and left foot was found to be  $7.75 \pm 0.53$  cm. In this study, the maximum stature in females was found to be 171.1 cm and the minimum stature was found to be 145.0 cm. The correlation between foot length and stature was found to be a better predictor of stature than foot breadth.

As the first step in forensic analysis is establishing the identity of the person in question, where stature remains one of the primary characteristics of identification, so the findings of the present study are useful for forensic experts and anthropologists.

**Key Words:** Identification, Anthropometry, Stature, Foot Length

## Introduction:

Identification of individual is the mainstay of forensic investigations. Age, sex, stature and race are popularly referred to as the four pillars of identity of a person.

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Among these big four of forensic anthropology, estimation of stature and sex is considered the main parameter of personal identification in forensic examinations. In the recent times, due to natural disasters like earthquakes, tsunamis, cyclones, flood and manmade disasters like terror attacks, bomb blasts mass accidents war plane crashes etc, establishing identity of the remains has become important for both legal as well as humanitarian reasons. In medicolegal autopsies also, establishing personal identity of the victim is often required.

Anthropometry is the systematic measurement of the physical properties of the human body, the primary dimensional descriptors of body size and shape.<sup>1,2</sup> It is the single most portable universally applicable inexpensive and noninvasive technique of assessing the size, proportion and composition of the human body. Anthropometry helps in

reconstruction of the biological profile of the deceased based on characteristics such as age, sex, ethnicity and stature.<sup>3</sup>

Stature is an important measure of physical identity. Human height is the vertical distance from the bottom of the feet to the top of the head in standing erect position.<sup>4</sup> In medico-legal autopsies, establishing personal identity of the victims is often required. Estimation of stature and sex from extremities and their parts plays an important role in identifying the dead body in forensic examinations. In the past, many studies have been conducted on estimation of stature from various measurements on different parts of human body. The relationship between humerus, radius, ulna, femur, tibia, fibula and clavicle with the stature have been topics of research interest for decades.

Ossification and maturation in the foot occurs earlier than the long bones and therefore, during adolescence age, height could be more accurately predicted from foot measurement as compared to that from long bones. Morphology of human feet is greatly influenced by the combined effects of heredity and living style of man that determines the size and shape of the feet footprints and thereby makes them unique data to establish human identity. Clinicians, anthropologists, anatomists and forensic scientists have studied the various aspects of foot, over a long period of time.

The aim of the present study was to find the correlation between foot anthropometry and stature of an individual and the correlation of various measurements of the feet with stature so as to derive regression formula to estimate the stature from foot anthropometry in females in the Central India population. The data presented in this study will be of benefit for fellow researchers in forensic science, investigators and legal experts to aid in stature determination of a person from the dimensions of the feet.

### Materials and Methodology:

The present Cross Sectional study was carried out on a sample of 250 deceased females brought to the mortuary of the Department of Forensic Medicine, Mahatma Gandhi Memorial Medical College and M.Y.

hospital, Indore (M.P.) after obtaining approval from the Institutional Ethics Committee. In the present study, convenient sampling procedure was done. Study subjects were all female cases of postmortem examination, of age more than 21 years. Subjects with skeletal abnormalities, deformities, amputated lower limbs, mutilated and decomposed bodies were excluded. Written informed consent of the relatives was taken prior to the research after giving detailed information regarding the study.

Firstly, detailed history was taken - both regarding the incident and complete clinical history, including operative procedures. Detailed individual demographic data including the height, sex, age etc. was also recorded on the pre-structured proforma prepared for the study. Anthropometric measurements of the foot, i.e., foot length and foot breadth were taken independently of the left and right side of each individual. Stature of each subject was also recorded. All the measurements were taken in daylight. The measurements were taken twice for accuracy, using standard anthropometric instruments in with graduations in centimeters to the nearest millimeters. Proper care was taken to avoid any excessive compression of underlying tissues and to record the measurements precisely.

Human height is the vertical distance from the bottom of the feet to the top of the head in standing erect position. Stature is defined, as the vertical distance between the highest point of vertex and the heel touching the floor using Standard measuring tape.<sup>4</sup> Foot length: The straight distance between the most backward point on the heel of the foot (pternion) and the most forward placed point on the longest toe of the foot (acropodian) when the foot is fully stretched (right and left).<sup>5</sup> Foot breadth: The distance between the points of the anterior epiphyses (distal) of the 1st metatarsal, the most prominent of the inner side of the foot (metatarsal-tibiale), and the joint of the anterior epiphyses of the 5th metatarsal, the most prominent of the outer side (metatarsal-fibulare) (right and left).<sup>5</sup> Foot index: Was calculated individually for both feet in males and females by using the formula: Foot index = (foot breadth/foot length) X 100.<sup>5</sup>(Figure 1)



**Fig. 1 : Showing Landmark Points of the Foot Length and Foot Breadth**

The mean values & standard deviation (SD) of foot dimensions were calculated. Paired sample t-test was performed to find the right and left side differences in foot dimensions. p-value of less than 0.05 was considered as significant.

### Results:

The present study was carried out on a sample of 250 deceased females in mortuary of Department of Forensic Medicine, Mahatma Gandhi Memorial Medical College and M.Y. hospital, Indore (M.P.). **Table 1** shows the age-wise distribution of the study subjects. The mean age of the study subjects was found to be  $34.95 \pm 11.29$  years. Maximum number of cases were in age group of 25+ to 30 years ( $n = 61, 24.4\%$ ), while minimum number of cases were in age group 70+ to 75 years ( $n = 01, 0.4\%$ ). **Table 2** shows that the mean stature in the subjects was  $156.46 \pm 5.43$  cm. The maximum height recorded was 171.1 cm, while the minimum height was 145.0 cm. The range in height of female subjects was from 145.0 to 171.1 cm.

**Table 1: Age-wise Distribution of Study Subjects**

| S. No. | Age group (years) | No. of Cases | Percentage (%) |
|--------|-------------------|--------------|----------------|
| 1.     | 21+ -25 years     | 60           | 24.0           |
| 2.     | 25+ - 30 years    | 61           | 24.4           |
| 3.     | 30+ - 35 years    | 37           | 14.8           |
| 4.     | 35+ - 40 years    | 21           | 8.4            |
| 5.     | 40+ - 45 years    | 33           | 13.2           |
| 6.     | 45+ - 50 years    | 13           | 5.2            |
| 7.     | 50+ - 55 years    | 10           | 4.0            |
| 8.     | 55+ - 60 years    | 9            | 3.6            |
| 9.     | 60+ - 65 years    | 3            | 1.2            |
| 10.    | 65+ - 70 years    | 2            | 0.8            |
| 11.    | 70+ - 75 years    | 1            | 0.4            |
| 12.    | 75+ - 80 years    | 0            | 0.0            |
| 13.    | 80+ - 85 years    | 0            | 0.0            |
| 14.    | 85+ - 90 years    | 0            | 0.0            |

**Table 2: Distribution of height among study subjects**

| Variables     | Mean   | Standard deviation | Maximum | Minimum | Range          |
|---------------|--------|--------------------|---------|---------|----------------|
| Height in Cms | 156.46 | 5.43               | 171.10  | 145.0   | 145.0 - 171.10 |

**Table 3** shows the statistical analysis for foot length in study subjects. The mean foot length on right side ( $21.29 \pm 1.96$  cm) was more than that on the left side ( $21.18 \pm 1.97$  cm) in the study subjects. This can be attributed to effect of foot dominance on foot measurements. The maximum foot length was 24.4 cm, while the minimum was 16.9 cm on right side and the range was from 16.9 to 24.4 cm, whereas the maximum foot length was 24.4 cm and minimum was 16.8 cm on left side and the range was from 16.8 to 24.4 cm. The average foot length was found to be  $21.22 \pm 1.96$  cm. Maximum average foot length was 24.4 cm while minimum foot length was 16.85 cm.

**Table 3: Statistical Analysis for Foot Length**

| Variables          | RFL in cm | LFL in cm | Av. FL in cm |
|--------------------|-----------|-----------|--------------|
| Mean               | 21.29     | 21.18     | 21.22        |
| Standard deviation | 1.96      | 1.97      | 1.96         |
| Maximum            | 24.4      | 24.4      | 24.4         |
| Minimum            | 16.9      | 16.8      | 16.85        |
| Range              | 16.9-24.4 | 16.8-24.4 | 16.85-24.4   |

**Table 4** shows the regression equation of right foot length with stature. The equation obtained was  $109.00 + 2.229$  RFL,  $109.54 + 2.214$  LFL and  $109.21 + 2.225$  AvFL. The stature can be calculated by putting the value of RFL, LFL & AvFL in the equation.

**Table 4: Association of Different Variables for Foot Length with Stature (N=250)**

| Factors     | Regression Equation      |
|-------------|--------------------------|
| HT vs. RFL  | HT = 109.00 + 2.229 RFL  |
| HT vs. LFL  | HT = 109.54 + 2.214 LFL  |
| HT vs. AvFL | HT = 109.21 + 2.225 AvFL |

**Table 5** shows the statistical analysis for foot breadth in study subjects. The foot breadth on the right side ( $7.79 \pm 0.43$  cm) was more than that on the left side ( $7.71 \pm 0.43$  cm) in study subjects. In the present study, maximum right foot breadth was 8.7 cm and minimum was 6.4 cm, while the maximum left side foot breadth was 8.6 cm and minimum was 6.4 cm. The average foot breadth in the study subjects was  $7.75 \pm 0.43$  cm, range being 6.4 to 8.65 cm.

**Table 5: Statistical Analysis for Foot Breadth**

| Variables     | RFB in cm | LFB in cm | Av. FB in cm |
|---------------|-----------|-----------|--------------|
| Mean          | 7.79      | 7.71      | 7.75         |
| Standard dev. | 0.43      | 0.43      | 0.43         |
| Maximum       | 8.7       | 8.6       | 8.65         |
| Minimum       | 6.4       | 6.4       | 6.4          |
| Range         | 6.4-8.7   | 6.4-8.6   | 6.4-8.65     |

**Table 6** shows the regression equation of foot breadth with stature in females & by putting the value of foot breadth in the equation, stature can be measured. The average foot index in female was  $36.72 \pm 2.45$ .

**Table 6: Association of different variables for foot breadth with stature in female (N=250)**

| Factors     | Regression Equation     |
|-------------|-------------------------|
| HT vs. RFB  | HT = 93.29 + 8.378 RFB  |
| HT vs. LFB  | HT = 93.57 + 8.424 LFB  |
| HT vs. AvFB | HT = 92.06 + 8.539 AvFB |

**Table 7** shows the correlation between various variables of the female subjects. Statistically significant, positive correlation was seen between all the parameters. In the present study, both the right foot length and the left foot length ( $r=0.863$ ), as well as the right foot breadth and the left foot breadth ( $r=0.982$ ) were found to be strongly correlated, while foot length ( $r=0.470$ ) and foot breadth ( $r=0.357$ ) were positively correlated with stature in females.

## Discussion:

The present study was carried out on a sample of 250 deceased females in mortuary of department of Forensic Medicine, Mahatma Gandhi Memorial Medical College and M.Y. Hospital, Indore (M.P.). An attempt was made to correlate the foot length with stature and derive regression equations to calculate

stature from foot length. On the basis of this foot length and foot breadth, stature was found to be positively correlated and the association was highly significant. The foot length and stature correlation coefficient ( $r$ ) in females was 0.470. The foot breadth and stature correlation coefficient ( $r$ ) was 0.357. The mean stature of female subjects was found to be  $155.83 \pm 11.28$  cm, which was slightly lower than the findings of the other studies.<sup>6-7</sup>

**Table 7: Correlation Between Different Variables in Female Subjects**

| Variables                   | Correlation Coefficient (r) | Correlation   |
|-----------------------------|-----------------------------|---|
| Correlation between HT&RFL  | 0.393, P=0.000              | Weak, positive, statistically significant correlation |
| Correlation between HT&LFL  | 0.472, P=0.000              | Weak, positive, statistically significant correlation |
| Correlation between HT&AvFL | 0.470, P=0.000              | Weak, positive, statistically significant correlation |
| Correlation between HT&RFB  | 0.354, P=0.000              | Weak, positive, statistically significant correlation |
| Correlation between HT&LFB  | 0.355, P=0.000              | Weak, positive, statistically significant correlation |
| Correlation between HT&AvFB | 0.357, P=0.000              | Weak, positive, statistically significant correlation |

HT – Height RFL – Right Foot Length LFB – Left Foot Breadth  
LFL – Left Foot Length RFB – Right Foot Breadth Av. FL – Average Foot Length AvFB – Average Foot Breadth

The regression equation obtained was  $109.00 + 2.229$  RFL,  $109.54 + 2.214$  LFL and  $109.21 + 2.225$  AvFL. There is a variation in mean stature between same sex groups of different studies.<sup>8-10</sup> The stature is determined by several factors which include genetic and environmental factors. This is the reason for the wide variation in mean stature amongst individuals of same sex belonging to different endogamous groups. In our study, the mean foot breadth of female subjects was found to be  $7.75 \pm 0.43$  cm, which was found similar to the study by Chikhalkar, et al.<sup>9</sup> Again, the correlation coefficient was found to be ( $r=0.357$ ), which showed a strong correlation between foot breadth and stature in females. This was found to be on the higher side in the study of Narde, et al,<sup>11</sup> and on the lower side as per the study by Ozaslan, et al.<sup>15</sup> The regression equation for estimation of stature in females from foot length and foot breadth was calculated and it showed a different pattern than earlier studies.<sup>12-14</sup> There are variations in

the regression equations in different ethnic groups in India. So regression equations of the present study cannot be applied to the other population groups.

There is a dimensional/ proportional relationship between specific body segments and the whole body.<sup>4</sup> Anatomically, limbs exhibit consistent ratio relative to the total height of a person and these ratios are linked to the age, sex and race. So the principle of biological correlation of the body parts with each other is applied to estimate stature on an individual. Foot length was found to be a better predictor of stature than the foot breadth. In the present study, a significant correlation was found between foot dimensions and foot index as well as between stature and foot index. The equations derived in this study can be used to estimate differences related to age, sex and race in forensic and legal sciences.

Anthropometric measurements (stature and built) differ in different sex and ethnic groups due to demographic factors and are strongly influenced by genetic and environmental factors, suggesting the need for different normograms for each endogamous group. Furthermore, the need for the alternative formulae for the genders is also proved as the rate of skeletal maturity in both sexes vary during the course of development.

### Conclusion:

These types of studies are of medicolegal importance, as the first step in forensic analysis is establishing the identity of the person in question, where stature remains one of the primary characteristics of identification. The findings of the present study will be useful for forensic experts and anthropologists. These studies also help to know the differences between various ethnic groups and populations separated by different environmental conditions, as in India.

**Conflict of Interest:** None

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## Original Research Paper

# Pattern of Drug Dependence in Cases Admitted for Detoxification in a Tertiary Care Hospital of South Eastern Rajasthan: A Retrospective Study

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## Abstract:

Present study is an effort to find out the pattern of drug dependence in South Eastern part of Rajasthan. This is a retrospective study, wherein 1984 patients admitted for detoxification during the last nine years (from 2010 to 2018) were included. Results of the study revealed that Heroin was the most common type of drug causing dependence. Majority of the cases were male, young individuals, of urban background & belonging to Hindu community. Multiple drug dependence & Benzodiazepine dependence cases required the longest & shortest mean duration of hospitalization, respectively. The average period of hospitalization was six days. Opium substitution therapy was found an effective method to reduce the burden of hospitalization.

**Key Words:** Drug Dependence, Substance Abuse, Southeastern Rajasthan.

## Introduction:

Drug dependence is a major public health concern, worldwide. Common substances of abuse in south eastern Rajasthan are Opioids, Alcohol, Cannabis, Benzodiazepines & solvents.

The word Alcohol comes from the Arabic word *%alkuhl*,+ meaning essence<sup>1</sup>. When yeast grows in sugar solution without air, most of the sugar is converted (fermented) into Alcohol & Carbon dioxide.<sup>1</sup>

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Opiates refers to the alkaloids compounds found as natural product in Opium poppy plant, *%Papaver Somniferum*+. The term Opioid describes a class of psychoactive compounds which act on opioid receptors.<sup>2</sup> Morphine is a naturally occurring compound, whereas Heroin (diacetylmorphine) is a semisynthetic & Methadone & Buprenorphine are synthetic derivatives of Opiates.

Cannabis is derived from the plant Cannabis Sativa, which grows in the wild all around the world. It is used in various forms such as Bhang (leaves of the plant), Ganja (dried flowering stem of the plant), Charas or hashish (extracted from the resin covering the plant). The active compounds in Cannabis products are called Cannabinoids. Most potent among them is Tetra-Hydro-Cannabinol (THC).<sup>3</sup>

Benzodiazepines are prescribed as anxiolytic & sedative hypnotic agents, but are addictive, when used for prolonged period. Volatile substances (glues, thinner, correction fluids, aerosol sprays, petrol), also known as inhalants or solvents, are chemicals that give off vapors & fumes at room temperature. Dependence syndrome is a cluster of physiological, behavioral, & cognitive phenomena.<sup>4</sup> World Drug Report<sup>5</sup> 2017 estimated that 29.5 million people globally

suffer from drug use disorders, opioids being the most harmful among them. The magnitude of the harm caused by drug use is underlined by the estimated 28 million years of healthy-life (disability-adjusted life years (DALYs)) lost worldwide, as a result of premature death & disability caused by drug use<sup>5</sup>.

The prevalence of tobacco, alcohol and other substance use disorder in India was 20.9%, 4.6%, respectively according, National Mental Health Survey<sup>6</sup> of India, 2015-16. Studies regarding regional variations are very limited, so the present study was an effort to find the pattern of drug dependence in south eastern part of Rajasthan.

### Materials & Methodology:

This was a retrospective study conducted at a tertiary care hospital in south eastern Rajasthan. After Ethical Clearance for the study, data was extracted from available case records from January 1, 2010 to March 31, 2018. A total of 1984 cases admitted for detoxification of all types of substances during the above mentioned period were included in the study. However cases who were admitted

for mental disorders with substance abuse were excluded from the study. Statistical analysis was done by using software SPSS - 21.

### Observation & Discussion:

Total 1984 cases admitted for detoxification were analyzed. Majority (70.8%) of the cases were from Kota district, followed by Baran (12.6%), Bundi (7.0%), Jhalawar (4.8%), & other districts (2%) of Rajasthan. 2.8% cases were from neighboring districts of Madhya Pradesh (**Figure - 1**).

Since January 2010, the number of indoor cases increased till 2013. Thereafter, it started declining, particularly of heroin & opium dependence cases (**Figure - 2**). The reason for this declining trend was the initiation of Opium Substitution Therapy (OST) center in the department of Psychiatry. Cases of heroin & opium dependence were managed on methadone & buprenorphine substitution. Methadone & buprenorphine have clinical effects similar to opium & heroin, thus the chances of withdrawal symptoms & hospitalization were greatly reduced.

Figure 1: Place wise distribution of cases.

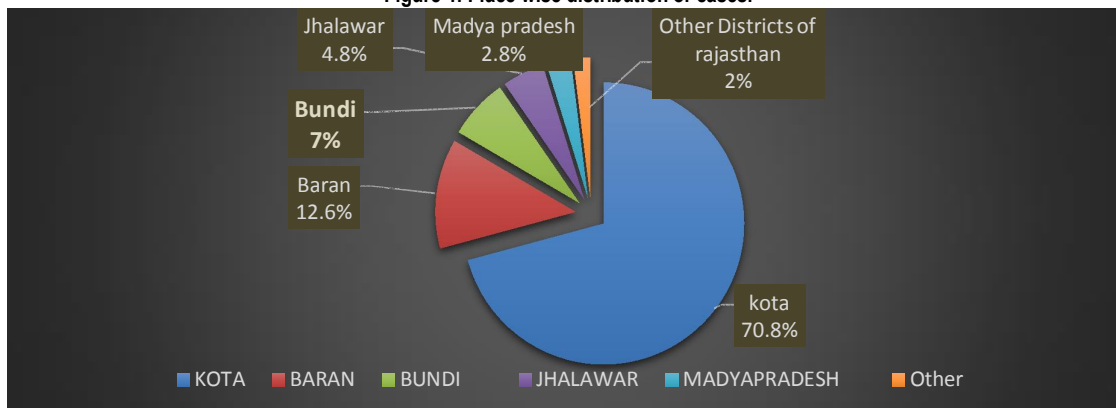


Figure 2: Year wise distribution of cases.

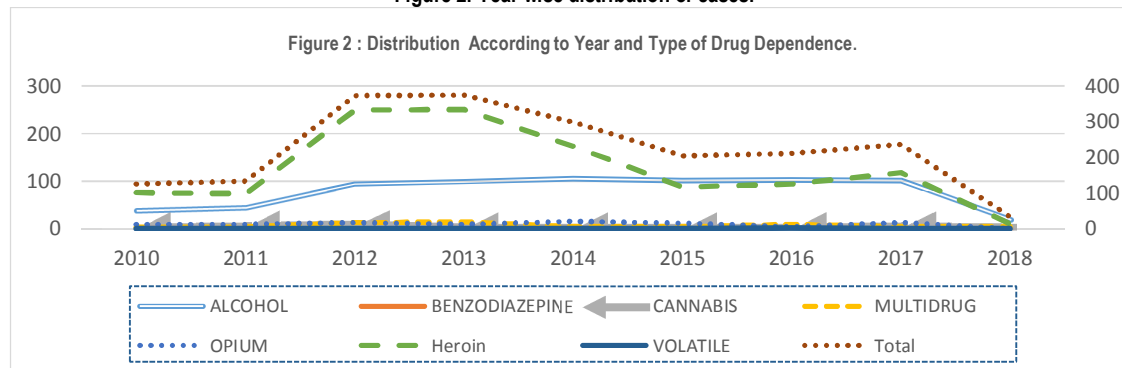


Figure 3: Month-wise Distribution of Cases.

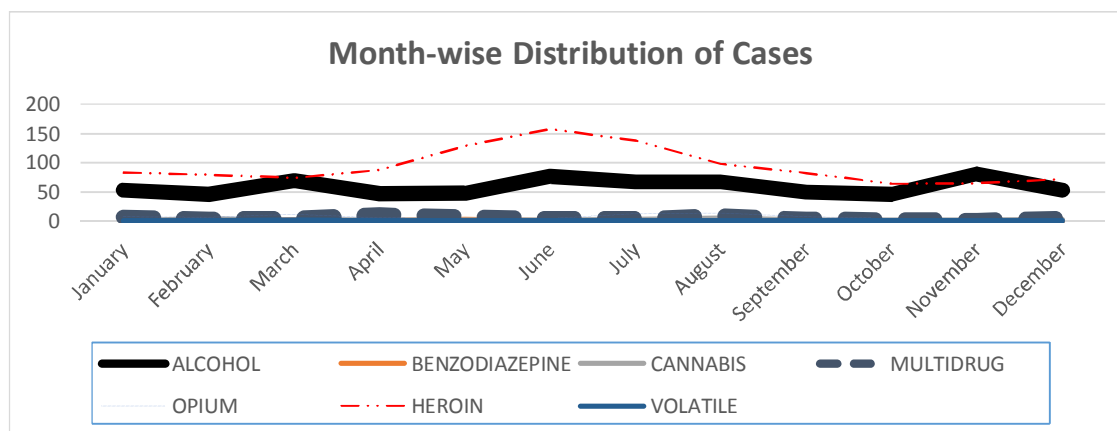
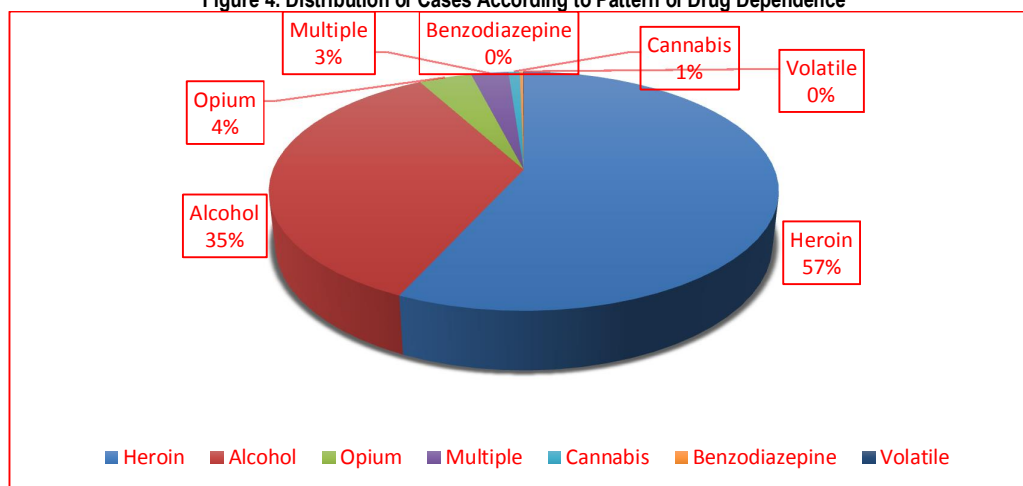


Figure 4: Distribution of Cases According to Pattern of Drug Dependence



Although the cases were admitted throughout the year for detoxification, maximum (42.4%) cases were admitted during the period of May to August (**Figure-3**). This can be explained by the fact that the farmers & labourers engaged in agriculture work, usually finish their work by the end of April. After that they are comparatively free & utilize this period for treatment of drug dependence.

It was observed that majority (56.8%) of the cases were of heroin dependence, followed by alcohol (35.2%), opium (4%), multiple (more than one) drugs (2.8%), cannabis (0.9%), benzodiazepines (0.3%), & volatile substance (0.1%) dependence (**Figure-4**).

This can be explained by the fact that southeastern Rajasthan & adjacent area of Madhya-Pradesh is an opium growing region & government gives license for its cultivation.

This is purchased by the government & used for medicinal purposes. It is believed that some of the opium is illegally used in making heroin.

Similar to our study, ICMR Task force project (Mohan et al)<sup>7</sup> & Awasthi, et al<sup>8</sup> also reported that opium was the most common substance of abuse. However, studies by Vinay Kumar, et al,<sup>9</sup> Kadri, et al,<sup>10</sup> (Syed Qadri et al),<sup>11</sup> Basu, et al,<sup>12</sup> Ray, et al<sup>13</sup> and National Mental Health Survey,<sup>16</sup> reported that alcohol was the most common substance of abuse.

In India, as per World Drug Report (2009) out of 81,802 treatment seekers, 61.3% reported use of opioids, 15.5% Cannabis, 4.1% sedatives, 1.5% cocaine, 0.2% amphetamines & 0.9% used solvents. (Table-1)<sup>14</sup>

Almost all the previous studies reported that most of the cases of drug dependence were males & only very few



cases of females were reported. Similarly, we also found that 99. % of the cases were males & only 1% were females. On further analysis, it was found that in males, majority (56.8%) were of heroin dependence, followed by alcohol (35.3%), multiple drugs (2.7%), opium (4%), Benzodiazepines (0.2%), & volatile substance (0.1%) dependence. Likewise, in females, majority (57.9%) were of heroin dependence, followed by alcohol (26.3%), multiple drugs (10.5%) & Benzodiazepine dependence (5.3%). No case of opium, cannabis & volatile substance dependence was found in females. (**Table 2**). This is a unique finding of this study as female heroin dependence was not so commonly reported in previous studies. It was

also observed that in almost all the cases husband & wife were heroin dependent & females started taking it with the husband & or partner.

Among the study cases, majority (38.7%) were of the age group of 31- 40 years, followed by the age group 21-30 years (30.7%). Thus, the maximum cases (69.4%) were aged between 21 to 40 years. This is particularly important as this is the most productive period of life & valuable disability-adjusted life years (DALYs) were lost. The youngest case was of a 13 years old male of heroin dependence & the eldest were two 70 years old males (1- Cannabis, 1- Alcohol). The mean age of cases was 36.3 years (**Table 3**).

Table 1: Comparison with Various Studies

| Study   | Age (Year) / Sex                    | Result  |
|---|-------------------------------------|---|
| ICMR Task Force Project (Mohan, et al.) <sup>7</sup> 1993 | Age group 21 to 30 yr. Male- 97-99% | Alcohol-15-35%, Opiates-42-80%  |
| A.M. Kadri et al 2003 <sup>10</sup>                       | Mean age 31.2-34.2                  | Alcohol-70.20%, Brown sugar-13.8%, Opium-7.5% Tobacco-3.6%, Others-8.9%.            |
| Ray, et al. 2004 <sup>13</sup>                            | Mean age 35 Male-97%                | Alcohol-44% ,Opium-26%, Heroin- 11%, Cannabis -12%, Other Opiates 6% .              |
| Syed Qadri, et al. 2013 <sup>11</sup>                     | Mean age15.2 Males-69.81%           | Alcohol-44.49%, Cannabis 8.45%, Opiates6.46%, Opium 0.41%, Volatile inhalant 2.61%. |
| Basu, et al 2012 <sup>12</sup>                            | Mean age 33 to 34. Male -99%        | Alcohol-48-49%, Opiates 37-53, Cannabis 7-13%                                       |
| World Drug Report <sup>14</sup> 2009                      |                                     | Opioids-61.3%, Cannabis15.5% Sedatives4.1%, Cocaine1.5%, Solvents0.9%.              |
| Vinay Kumar, et al 2013 <sup>9</sup>                      | Male-99%                            | Alcohol-33.78% Heroin-10.74%, Opium-4.60%, Multiple-34.16% volatile-0.38%           |
| Avasthi, et al 2018 <sup>8</sup>                          | Mean age 31.78 Male-99.66%          | Opioids-74.00%, Alcohol-68.33%), Tobacco-52.00%), cannabinoids-29.33%               |

Table 2: Distribution of cases according to socio-demographic variables and types of drug dependence

| Drug     | Sex         |           | Domicile    |            | Religion    |            |           |
|----------|-------------|-----------|-------------|------------|-------------|------------|-----------|
|          | Male        | Female    | Urban       | Rural      | Hindu       | Muslim     | Sikh      |
| Heroin   | 1116(56.8%) | 11(57.9%) | 848(42.7%)  | 279(14.1%) | 749(48.5%)  | 374(89%)   | 4(21.1%)  |
| Alcohol  | 694(35.3%)  | 5(26.3%)  | 581(29.3%)  | 118(6%)    | 666(43.1%)  | 28(6.6%)   | 5(26.3%)  |
| Opium    | 79(4%)      | 0         | 50(2.5)     | 29(1.5%)   | 61(3.9%)    | 8(1.9%)    | 10(52.6%) |
| Cannabis | 17(0.9%)    | 0         | 9(0.5%)     | 8(0.4%)    | 15(1%)      | 2(0.5%)    | 0         |
| BZD      | 4(0.3%)     | 1(5.3%)   | 5(0.3%)     | 0          | 5(0.3%)     | 0          | 0         |
| Volatile | 1(0.05%)    | 0         | 1(0.05%)    | 0          | 0           | 1(0.2%)    | 0         |
| Multiple | 54(2.8%)    | 2(2.7%)   | 43(2.1%)    | 13(0.7%)   | 49(3.2%)    | 7(1.7%)    | 0         |
| Total    | 1965(100%)  | 19(100%)  | 1537(77.5%) | 447(22.5%) | 1545(77.8%) | 420(21.2%) | 19(1%)    |

Table 3: Distribution According to Age Group

| Age group | Heroin    | Alcohol   | Opium     | Cannabis | Multiple | Benzodiazepine | Volatile |
|-----------|-----------|-----------|-----------|----------|----------|----------------|----------|
| N (%)     | N (%)     | N (%)     | N (%)     | N (%)    | N (%)    | N (%)          | N (%)    |
| 10 to 20  | 52(2.6)   | 35(3.1)   | 11(1.6)   | 0        | 2(11.8)  | 4(7.2)         | 0        |
| 21 to 30  | 609(30.7) | 389(34.5) | 175(25.1) | 13(16.5) | 7(41.2)  | 23(41.1)       | 1(100)   |
| 31 to 40  | 768(38.7) | 426(37.8) | 283(40.5) | 37(46.8) | 3(17.7)  | 17(30.4)       | 0        |
| 41 to 50  | 405(20.4) | 212(18.8) | 167(23.9) | 16(21.3) | 2(11.8)  | 7(12.5)        | 0        |
| 51 to 60  | 127(6.4)  | 58(5.2)   | 53(7.6)   | 9(11.3)  | 2(11.8)  | 5(8.9)         | 0        |
| >60       | 23(1.2)   | 7(6.2)    | 10(1.5)   | 4(5.1)   | 1(5.9)   | 0              | 1(20)    |

Mean age - 37.26 year

Several other studies reported similar findings, like by Avasthi, et al,<sup>8</sup> Kadri, et al,<sup>10</sup>

Basu, et al,<sup>12</sup> Ray, et al.<sup>13</sup> (**Table 1**) Giri, et al<sup>16</sup> reported mean ages of alcohol & opium

dependence were 37 years & 36 years respectively. In our study, maximum number of cases were of heroin dependence in all age groups, except the age group of 60 years & above. Alcohol dependence was found most common in the age group of 60 years & above. (**Table 3**)

In the present study, majority (77.5 %) of the cases were of urban background. If we further classify the urban cases, it is evident that 42.8% cases were of heroin, 29.3% of alcohol, 2.5% of opium, 2.17% of multiple drugs, 0.5% of cannabis, 0.3% of benzodiazepine & 0.05% of volatile substance dependence were found, likewise among the rural population, 14.1% cases of heroin, 6% of alcohol, 1.5% of opium, 0.7% of multiple drugs and 0.4% of cannabis dependence were found. No cases of benzodiazepine & volatile substance dependence were found in rural area (**Table 2**). So, both the rural & urban area, heroin was found the most common type of drug dependence. Unlike our study, Vinay Kumar, et al<sup>9</sup> reported majority (59.3%) of cases from rural area than the urban (36.7%) & suburban (4%) area. National Mental Health Survey, 2015-16, by G. Gururaj et al<sup>6</sup> reported that alcohol & tobacco abuse was more common (24.1%) in rural area, however other substance use disorders were more prevalent in urban metro area. A meta-analysis by Reddy & Chandrashekhar<sup>16</sup> revealed that an overall prevalence of substance abuse in India was 6.9/1000, with urban & rural rates of 5.8 & 7.3/1000 population respectively. The rates among men & women were 11.9% & 1.7% respectively.

Again, majority of our cases were from Hindu community (77.9%), followed by Muslims (21.2%) & only 1 % were from the Sikh community. On further analysis, it was evident that in Hindus & Muslim community, heroin (48.5% & 89%) was the most common substance of dependence, followed by alcohol (43.1% & 6.6%), opium (3.9% & 1.9% ) and multiple drug (3.2 % & 1.7%) dependence. In Sikh, the majority of cases (52.6%) were of opium dependence, followed by alcohol (26.3%) & 21.1% heroin (Table-2). Kumar Vivek et al<sup>17</sup> & Patra, et al<sup>18</sup> also reported that higher number of cases were from Hindu

community in both alcohol (94.6% & 58%) & opioid (88% & 52%) groups.

Majority of the cases (94.1%) admitted for detoxification, were discharged within 10 days. Mean duration of hospitalization was 5.96 days & only 1.5% cases stayed for more than 3 weeks. The longest mean duration (6.7 days) of stay was found in multiple drug dependence & minimum (3.8days) in Benzodiazepines dependence (**Table 4**). Since the multiple drug dependence patients had more severe withdrawal symptoms & required longer time for management. 38 cases (22 - alcohol, 13 - heroin, 2 - opium, 1 - cannabis dependence) out of 1984 developed serious medical or surgical complications during detoxification & were shifted to medical, surgical ward or ICU. These cases were shifted back to de-addiction ward or discharged after recovery from their medical / surgical illness. However, 2 cases of alcohol & 3 cases of heroin dependence could not be saved.

**Table 4: Distribution According to Mean Days of Stay & Type of Substance**

| Substance      | Mean duration of stay (days) |
|----------------|------------------------------|
| Heroin         | 5.8                          |
| Alcohol        | 6.1                          |
| Opium          | 6.3                          |
| Multiple       | 6.7                          |
| Cannabis       | 5.7                          |
| Benzodiazepine | 3.8                          |
| Volatile       | 5.0                          |

#### **Limitation of the Study:**

This study included only indoor cases & did not include OPD cases. So the data cannot be generalized for the community.

**Conflict of Interest:** None

**Financial Assistance:** None

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## Original Research Paper

# A Study of Pattern of Fatal Head Injuries Sustained During Road Traffic Accidents in Western Uttar Pradesh

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### Abstract:

Road traffic accident is one among the top five causes of morbidity and mortality in South-East Asian countries, including India. Head injury is the single most common cause of mortality in road traffic mishap. Present study signifies that majority of the victims of road traffic mishap are young adult males of age group (21-30 years), and are either pedestrians or two wheeler occupans, without helmets. Most accident occurred between 6:00 p.m to 8:59 p.m. Head injury was reported in 77.6% of cases. Fatal injuries to head were the leading/ sole cause in 227 (50.4%) fatalities. Subdural hematoma was found in 57.6 % cases; 69.4 % had fracture of skull or face bone. Left temporal bone was the most common bone fractured in fatal head injury (45.3%). Present study clearly signifies the use of preventive measurements like helmet can significantly reduce mortality & morbidity.

**Key Words:** Road traffic accidents, Head Injury, Fatalities, India.

### Introduction:

Fatalities due road traffic crash are defined by WHO as incidents in which one or more persons involved in the crash died within 30 days of the incident due to its direct effect or its complication.<sup>1</sup>

Ever since the first death due to motor vehicle in world was reported in 1896,<sup>2</sup> casualties due to road traffic mishap have risen with a tragic rate to about 1.25 million in 2013.<sup>3</sup> India is witnessing an algorithmic rise in population & average per capita income of middle class person. It has caused a disproportionately great rise in the vehicular density on roads. Without proper training of drivers and road users, road vehicular mishaps are increasing at a catastrophic rate with 1,39,091 casualties in India and 15109 deaths in UP alone.<sup>4</sup>

Globally, road traffic injuries are reported as one of the leading cause of death among young people aged 15. 29 years.<sup>5</sup>

The head being the most vulnerable part of the body, is involved frequently in road traffic accidents (RTA). Head injury is the single most important cause of mortality in road traffic accidents. It has been defined as, %a morbid state, resulting from gross or subtle structural changes in the scalp, skull, and/or the contents of the skull, produced by mechanical forces+<sup>6</sup> The extent and degree of injury to the skull and its content is not necessarily proportional to the quantum of force applied to the head, any type of cranio-cerebral injury is possible with any kind of blow on any sort of head.<sup>7</sup>

The main purpose of this study was to analyze the pattern of head injuries in vehicular accidents, their correlation with factors such as age, sex, type of road user, anatomical sites involved, type of vehicle involved hence try to figure out their vulnerability factors.

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### Materials and Methodology:

The study was carried out in the Department of Forensic Medicine & Toxicology and Mortuary of S.N. Medical College, Agra U.P. after getting approval of the study from

the institutional Ethics Committee. Data for one year, i.e. from 01-02-2012 to 31-01-2013 was compiled and presented here. During this period, a total of 2027 medico legal autopsies were conducted, of which 450 cases with clear inference of death due to road traffic mishaps were studied in detail, among which head injury was present in 413 (91.8%) cases and was one of fatal injuries in 335 (74.4%) cases, it was the leading/sole cause in 227(50.4%) cases.

A Performa was prepared and the information regarding age, sex, residence, marital status, date and time of mishap and of death was gathered from relatives of deceased, police inquest report, panchnama/ dead body challan, etc. Details of external & internal injuries were noted during autopsy examination. All data of the study period was carefully collected & analyzed

### Observations:

During the study period, a total of 2027 medico legal autopsies were conducted, of which 450 cases with clear inference of head injury, were included in study. Of these, 390 (86.7%) were male, majority were in age group of 21-30 years (n= 121; 26.9% cases), followed by age group of 31- 40 years (n= 100; 22.2%) cases.

Maximum incidence was observed during the rush hour, between 6.00 p.m. to 8:59 pm, with 81 (18%) casualties, closely followed by morning hours between 09:00-11:59 hour with 75 (16.7%) losses. (Table 1)

Table 1- Distribution of Cases According to Time of Occurrence

| S.No. | Time of Accident | Number | %    |
|-------|------------------|--------|------|
| 1     | 00:00-02:59      | 26     | 5.8  |
| 2     | 03:00-05:59      | 40     | 8.9  |
| 3     | 06:00-08:59      | 54     | 12   |
| 4     | 09:00-11:59      | 75     | 16.7 |
| 5     | 12:00-14:59      | 58     | 12.9 |
| 6     | 15:00-17:59      | 71     | 15.8 |
| 7     | 18:00-20:59      | 81     | 18   |
| 8     | 21:00-23:59      | 45     | 10   |
| Total |                  | 450    | 100  |

Majority of the victims were pedestrians (n= 129; 28.7%), followed by those who were riding light motor vehicle like car, jeep etc. (116; 25.8%). Occupants of

motorized two wheeler (motorcycle, scooter etc.) constituted 104 (23.1%) cases, where as bicyclist were 32 (7.1%). Combining together motorized two wheeler and bicycle occupants, total two wheeler occupants constitutes (n= 136, 30.2%) cases, outnumbering the pedestrians. Head injury (HI) was found in 413 (91%) victims, of which 349 (77.6%) were fatal in nature and the HI was the leading/ sole cause in 227 (50.4%) deaths. Among the total pedestrians, 109 (84.5%) received fatal head injury, of these, head injury was the leading/ sole cause of death in 73 (56.6%) victims. (Table 2) In the same manner, 26 (81.2%) cyclists received fatal head injuries, of whom, in 19 (59.4%) cases, head injury was the sole/ leading cause of death. Among the motorized two wheeler riders, 84(80.8%) received fatal head injury, which was the sole/leading cause of mortality in 69 (66.3%) cases. Among the occupants of light vehicles, 100 (86.2%) sustained serious head injury, while 63.1% of the medium vehicle occupants & 60.1% of heavy vehicle occupants received significant head injury. (Table 2)

Table 2- Distribution of Cases According to Fatal Injury(S) in Different Road Users

| Road Users                         | Total fatalities | Head Injury found in | Fatal Head injuries found in | Head Sole/ leading caue |
|------------------------------------|------------------|----------------------|------------------------------|-------------------------|
| Pedestrians                        | 129              | 124 (96.1)           | 109(84.5)                    | 73(56.6)                |
| Cyclist                            | 32               | 30 (93.8)            | 26(81.2)                     | 19(59.4)                |
| Occupants of motorized two wheeler | 104              | 102 (98.1)           | 84(80.8)                     | 69(66.3)                |
| Occupants of light vehicles        | 116              | 100 (86.2)           | 86(74.1)                     | 32(27.6)                |
| Occupants of Medium vehicles       | 19               | 14 (73.7)            | 12(63.1)                     | 6(31.6)                 |
| Occupants of heavy vehicles        | 20               | 16 (80)              | 12(60)                       | 9(45)                   |
| Others                             | 30               | 27(90)               | 20(66.7)                     | 19(64.6)                |
| Total cases                        | 450              | 413 (91.8)           | 349 (77.6)                   | 227 (50.4)              |

Of the total 349 victims who received fatal head injuries, 242 (69.4%) had fracture of skull or face bone. 201(57.6%) had Subdural hematoma. 156 (44.7%) victims had Subarachnoid hematoma. 42 (12%) extradural hematoma. 120(34.4%) had Brain parenchyma

injury. 55(15.8%) had Herniation and compression of brain. (Table 3)

**Table 3- Fatal head injuries & their distribution**

| Regional injuries                | Total, n = (450) |
|----------------------------------|------------------|
| Head injury                      | 349              |
| Fracture skull & face            | 242 (69.4%)      |
| Subdural hematoma                | 201(57.6%)       |
| Subarachnoid hematoma            | 156(44.7%)       |
| Extradural hematoma              | 42(12%)          |
| Brain parenchyma injury          | 120(34.4%)       |
| Herniation and brain compression | 55(15.8%)        |

In the present study; skull fracture was observed in 242 victims of road traffic mishap. Among them, majority (204; 45.3%) had fracture of left temporal bone, followed by the fracture of right sided temporal bone (186 cases). Least fractures were seen in occipital bone (n=88; 19.6%). [Table 4]

**Table 4: Distribution of Skull Fractures**

| Region                                 | Right              | Left       |
|--|--------------------|------------|
| Frontal                                | 108 (24%)          | 126(28%)   |
| Parietal                               | 132(29.3)          | 168(37.3%) |
| Temporal                               | 186(41.3%)         | 204(45.3%) |
| Occipital                              | 65(14.4%)          |            |
| Base                                   | 88(19.6%)          |            |
| <b>Total skull &amp; face fracture</b> | <b>242 (69.4%)</b> |            |

## Discussion:

In the present study, 86.7% (390) victims were male, the male: female ratio being 6.5:1. Many authors too have reported a clear-cut preponderance of males over females amongst the road traffic accidents.<sup>8,9</sup> According to the National crime record bureau's (NCRB) data (2012), a total of 118533 males died in fatal road traffic accidents in contrast to 20558 female, the ratio being 5.77:1. It also states that in Uttar Pradesh alone - 12887 males died in RTA, in comparison to 2222 female, the ratio being 5.8:1.<sup>10</sup> This is due to the fact that in Indian culture, most of the outside work is usually carried out by males, and they spend most of their time outdoor. Also males have natural tendency to feel thrill in breeching rules & regulations, so they are more prone to road traffic accidents.

Commonly affected age group in both sexes was 21-30 years, with 121 (26.9%) cases, closely followed by 31-40 years, with 100 (22.2%) cases. Similar pattern was

reported by other authors like Singh H,<sup>9</sup> Palimar, et al<sup>11</sup> and Kachre, et al.<sup>12</sup> This is due to the fact that this is the most active phase of a person's life engaged in outside job and other outdoor activities, making them more vulnerable to RTA.

Maximum number of incidence was observed during the rush hour between 6.00 pm to 8:59 p.m. Similar pattern was observed in other studies also.<sup>9,13,14</sup> It, being road congestion time, coupled with the fact that as everybody is in hurry to return back to home from jobs during evenings and lighting conditions are poor on most of the roads, particularly on the outskirts of city as well as surrounding sub urban and rural areas.

Our study signifies that riders of two wheeler (cyclist & motorized two wheeler combined) constitute 30.2% of cases, closely followed by the pedestrians (n=129; 28.7%). It can be explained by the fact that pedestrians are not protected by any safety covering, like body of vehicles as in cases of occupants of motorized vehicles. Also there is a lack of proper zebra crossing, footpath, over bridge in region; similar trends were seen by Pathak, et al,<sup>15</sup> and Kyada, et al.<sup>16</sup>

Three forty nine (77.6%) victims had fatal head injuries. Head injury was found most in pedestrians (109; 84.5%), cyclists (81.2%), motorcyclists (80.7%) and light vehicles, accounting for death in 31.9% and 36.8% cases, respectively. Similar findings were noted by other authors.<sup>9</sup> Many factors make head injuries extremely lethal. Head is the most exposed part of body, skull bones make head a rigid compartment which causes countercoup injuries. Cranium as a rigid compartment can't expand in case of haemorrhage/haematoma or increased intracranial pressure so it leads to increased intracranial pressure which causes further lowering of blood flow. This causes edema & further increase in ICT which is a vicious cycle. Also, vessels in brain are most fragile & neurons are most susceptible to hypoxia.

In our study, 242 (69.4%) victims sustained fracture of skull or face bone. 201(57.6%) had Subdural hematoma. 156 (44.7%) suffered Subarachnoid hematoma, 42 (12%) extradural hematoma, 120 (34.4%) had brain parenchyma injury and 55 (15.8%) had

herniation and compression of brain. Similar finding was observed by other authors.<sup>9,17-</sup>

<sup>21</sup>Although extradural hemorrhage is the most common of any external parenchymal injury but it is generally limited due to attachment of dura to skull, thus it causes less severe damage & fatalities.

Again, 242 victims were found to have skull fracture, maximum (204; 45.3%) had fracture of left sided temporal bone, followed by fracture of right sided temporal bone with 186 cases. Least number of fractures were found in occipital bone, 88 (19.6%) cases. Study by Singh,<sup>9</sup> Kumar, et al<sup>17</sup> and Sharma BR, et al<sup>21</sup> also support that Temporal bone was most commonly involved, followed by parietal bone.

### Conclusion:

Distribution and causes of head injury are more or less similar to the pattern found in most of other studies. The accidents occur most commonly in age group of 21-30 years, with significant male predominance. Riders of motorized two wheelers were most commonly involved, neither driver nor passenger of motorized two wheelers were wearing helmet. The rate of incidence is higher in India because of lower rate of proper formal training to driver & lax law enforcements. The lack of preventive measures such as helmets in motor cyclists, seatbelts in automobiles, poorly controlled traffic conditions and poor road conditions are other factors responsible for injuries.

### Recommendations:

Results of study signify that a multi factorial approach is needed and essential measures must be taken at various levels such as:-

#### A. Training & Road safety education from school level-

1. Policy makers should make arrangements for driving classes & road safety education as subject/optional subject at high/senior secondary school level.
2. Media can also participate.
3. Mandatory time bound revision of Commercial vehicle driver's license & training.
4. First aid kit in commercial vehicle should be made compulsory

#### B. Enforcement of Law-

1. Good enforcement of law is an integral part of road safety; legislation embodies codified set of rules. These are enforced by state to prevent accidents.
2. Setting an enforcing speed limit and its strict implementation.
3. Increasing helmet wearing through the enforcement of law, as their use is important, Helmets should be properly ventilated and designed as per comfort of occupants, so that its utilization increase.

#### C. Road user must-

1. Be careful while driving on defective and narrow roads, defective layouts of crossroads, speed breakers, pedestrians crossing and traffic signals.
2. Avoid poor lighting and overloaded, overcrowded vehicles.

**Conflict of Interest:** None

**Financial Assistance:** None

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### Corrigendum

#### **UV Spectrophotometric Detection of Carbapenem Antibiotics in Forensic Samples**

***J Indian Acad Forensic Med. April - June 2018, Vol. 40, No. 2:179-83***

The designation of Mr.Suraj Kataria, M.Sc Student, Forensic Science Section, Department of Anthropology, Delhi University, and author of this manuscript, was written as PhD student. He was a M.Sc student at the time of publication.

The error is deeply regretted.



## Case Series

# “It Shouldn’t Hurt To Be A Child”: A Case Series on Battered Child Syndrome

<sup>1</sup>Deepa Durga Roy

### Abstract:

Battered child syndrome is a well known entity with many names like battered baby syndrome, shaken baby syndrome, child abuse syndrome, Caffey’s syndrome, etc. But when that silent child presents at our doorstep, do we really recognise the many faces of battery before it pushes the child to his grave?

The battered child syndrome is ubiquitous, yet under-diagnosed and a sparsely reported phenomenon in India, where corporal punishment is common and its severity, unchecked. This report brings forth the cruelty in five such cases of battered child syndrome.

**Key Words:** Battered Baby Syndrome, Child Abuse Syndrome

### Introduction:

John Caffey, in 1946, wrote an article “Multiple fractures in the long bones of infants suffering from chronic subdural hematoma, even as he failed to comprehend the aetiology and identify the true nature of the cases.”<sup>1</sup> In 1962, Kempe, et al gave widespread recognition to this syndrome.<sup>1</sup> The World Health Organisation has estimated 40 million children as victims of abuse and neglect around the world.<sup>2</sup> Given the enormity of the WHO data, very few cases have been reported in various journals from all over India.<sup>3-9</sup>

The battered baby syndrome is a condition characterized by repeated non accidental trauma, injuries of different types and ages, with often a delay in bringing the child to the hospital, and a significant discrepancy between the history given by the parents and the clinical findings.<sup>10</sup>

The present case series is being reported after approval from the Institutional Ethics Committee for the same.

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### Case Series:

#### Case 1

A 7 month old female baby was brought to the casualty of Safdarjung Hospital by her parents, with history of baby being unresponsive. Following which, after resuscitative attempts she was declared dead and shifted to mortuary. Inquest papers reported multiple nodules over the chest of the baby, which the parents attributed to skin disease. The baby was the youngest amongst four other girls.

On examination, multiple oval shaped contusions of varying ages were present on either side of chest, back and both arms (**Figure 1**). Contusions of varying ages were also present over both knees and ankles. Multiple nodules were present on both sides of the chest. Multiple partially healed rib fractures, in various stages of healing, with callus formation (appearing nodular on surface of skin) were present on both sides (**Figure 2**). Left kidney was contused. Labia minora and vaginal orifice had dried blood and was contused. Vaginal orifice and fourchette showed tears. Vaginal wall was contused, vaginal canal had multiple tears and clots of blood. Hymen had multiple lacerations. Depressed fracture was present on left temporal bone and subdural haemorrhage in left half of brain.

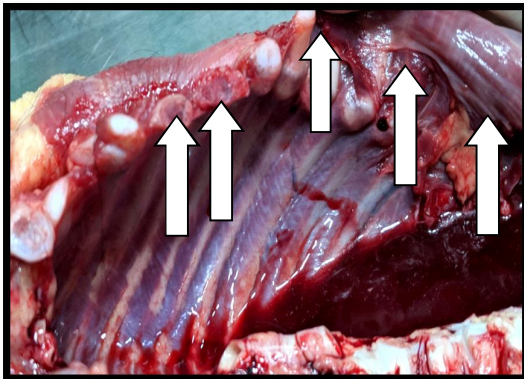
#### Case 2:

A 3 year old female child was brought to our hospital by parents, with complaints of fever, loose stools and altered sensorium. The

**Figure 1: Multiple contusion (nodular) present over chest (Case 1)**



**Figure 2. Multiple rib fractures (Case 1)**



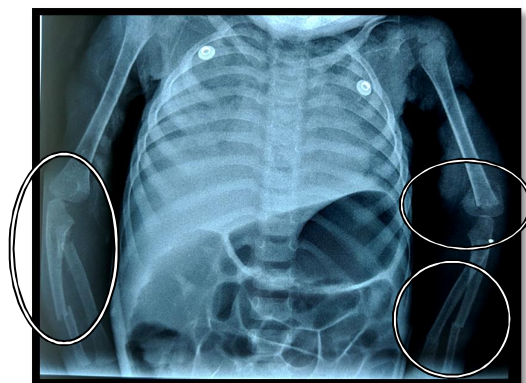
child received treatment in the Safdarjung casualty for a few hours, following which she suddenly collapsed and was declared dead. The child was then shifted to mortuary. The child was emaciated, pale, having sunken eyes, and multiple old scar marks over lower back, buttocks and left thigh. Multiple abrasions and contusions in varying stages of healing were present all over the body. Lacerated wounds were present over the inner aspect of lips and back of right pinna, which also had nail mark abrasions. Multiple punched out circular crater like reddish burn marks (cigarette burn marks), were present on the under-surface of chin, left cheek, back of both pinna and back of scalp in occipital region (**Figure 3**). Black scabbed linear pressure abrasion encircling the right wrist, suggestive of ligature mark was present around right wrist. Hematoma was present over the lower abdomen. Multiple healing fractures of long

bones of upper limb were noted (**Figure 4**). Subdural haemorrhage was present in the frontal and bilateral parietal region. On further investigation, it was found that the parents of the deceased were separated and the child lived with her paternal grandmother and father. The child was the youngest among three other siblings.

**Figure 3. Cigarette burn marks (Case 2)**



**Figure 4. Multiple fractures of long bone (Case 2)**



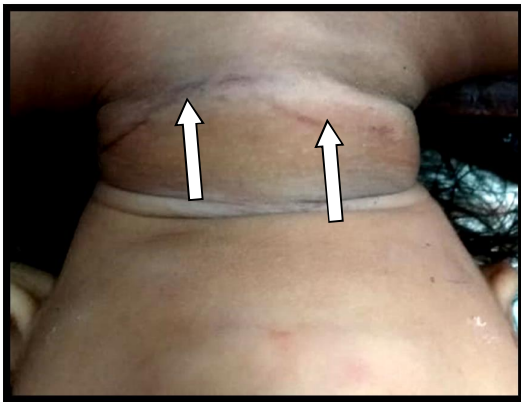
### Case 3

A 4 month old male child was brought to the mortuary for postmortem examination with the history of loose stools, fever and a single episode of seizure. On external examination, multiple contusions of different

ages were present all over the lower back and buttocks. Petechial haemorrhages were present in conjunctiva. An incomplete ligature mark, 0.2 cm in width, was present over front and both sides of neck, at the level of thyroid cartilage, suggestive of ligature strangulation (**Figure 5**). On neck dissection, extravasation of blood was seen in neck muscles. Petechial haemorrhages were scattered throughout the brain parenchyma

On further history taking, the father, a daily wages labourer, was an alcoholic and suspected the mother of having an illicit relationship. He used to regularly beat her and the children.

Figure 5. Ligature mark around the neck (Case 3)



#### Case 4

A 14 year old female was brought to the mortuary with flame burn injuries. There was a history of being set on fire after being sexually assaulted by her uncle, with whom she lived, as her own father had died. She was declared brought dead at the casualty of the hospital. On examination, antemortem burn injuries were present on neck, front and back of chest and abdomen. Multiple contusions and abrasions of varying stages of healing were present on outer aspect of both arms and back of both thighs. Vaginal orifice was dilated and contused. Vaginal wall was contused. Multiple tears of vaginal wall present. Hymen showed multiple lacerations.

#### Case 5

A 2 month old female baby was brought to the mortuary with history of negligence by doctors in treating the baby when she presented with seizures, following which the baby died on the same day. On

examination. hypostasis was present in anterior aspect of the body with pallor around nose and mouth (**Figure 6**). Conjunctiva and brain showed petechial haemorrhages. These findings were consistent with smothering. Multiple partially healed rib fractures were present on either side of chest. Cause of death was opined as asphyxia due to smothering. The baby was the fourth born girl child, the previous babies, who were all female, died within a few months of birth, from unknown causes.

Figure 6. Smothering (Case 5)



#### Discussion:

In one of the largest surveys on child abuse in India, conducted in 2007, it was noted that two out of every three children were physically abused, of which, 88.6% were victims of their own parents, which is in concurrence with the present case series.<sup>11</sup>

In the above case series, all the 5 cases presented with multiple and different types of injuries, of different ages, history not corroborating with the autopsy findings, which is consistent with reference studies.<sup>3-9</sup>

Three out of 5 of the deceased children discussed in the case series above, belonged to age group where they couldn't verbalise the history of abuse. 4 were females, 2 of whom were subjected to penetrative sexual assault. The children were usually the youngest of the siblings, unwanted, belonging to low socio economic strata, coming from troubled homes, starved and neglected, and where the abuser was a family member.

India has several Acts and laws to regulate and punish the offences of child abuse, like:

- POCSO 2012<sup>12</sup>

- Goa Childrens Act, 2003<sup>13</sup>
- Food Security Act (2013)<sup>14</sup>
- Right to Free and Compulsory Education Act (2009)<sup>15</sup>
- Prohibition of Child Marriage Act (2006)<sup>16</sup>
- The Commissions for Protection of Child Rights Act (2005)<sup>17</sup>
- Juvenile Justice (Care and Protection of Children) Act 2000, amended in 2006<sup>18</sup>
- Right to Information Act (RTI) 2005<sup>19</sup>
- The Child Labour (Prohibition & Regulation) Act, 1986 (two notifications in 2006 & 2008)<sup>20</sup>
- I.P.C. (1860) 319, 320, 375, 354, 377, 511<sup>21</sup>

Furthermore, India has several agencies looking after and working for child protection:

- The Ministry of Women and Child Development (MWCD).
- The National Commission for Protection of Child Rights, set up in 2007
- NGOs and civil organizations and forums
- The news media.
- National Policy for Children (2012)

Even as these laws, acts and agencies exist to safeguard child welfare, still a lot needs to be done to protect the children against battery from their guardians. A few suggested steps are:<sup>22</sup>

- Training of medical professionals to identify and report cases of child abuse.
- Education of the underprivileged communities through media, street plays, counselling during national immunisation programmes and night schools.
- The child's voice should not be dismissed. History given by a child should be carefully understood and recorded by authorities.
- Strict implementation of laws for child protection.

Awareness and intolerance to child abuse is the need of the hour.

**Conflict of Interest:** None

**Financial Assistance:** None

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### Corrigendum

The Affiliation of Dr. Prateek Rastogi, Corresponding Author of the "Original Research Papers" -

#### **1. Road Safety in Mangalore – An Observation**

<sup>1</sup>Prateek Rastogi, <sup>2</sup>Donald Xavier, <sup>3</sup>Esha Mallik, <sup>4</sup>Siddharth Shankar, <sup>5</sup>MS Kotian

***J Indian Acad Forensic Med. Jan.- March 2018, Vol. 40, No. 1 ISSN 0971-0973; at page 57***

and

#### **2. Gender Identification from hyoid bone - An autopsy study**

<sup>1</sup>Astha Guliani, <sup>2</sup>Prateek Rastogi, <sup>3</sup>MS Kotian, <sup>4</sup>Raghavendra Babu YP

***J Indian Acad Forensic Med. July – September 2018, Vol. 40, No. 3 ISSN 0971-0973; at page 307***

was inadvertently published incomplete.

The **Correct affiliation and designation** of Dr. Prateek Rastogi, should read as  
Professor & Head,  
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The error is deeply regretted.

## Case Series

### Concealed Homicides

<sup>1</sup>Hemant Kumar Kanwar, <sup>2</sup>Antara DebBarma, <sup>3</sup>Arijit Dey, <sup>4</sup>Abhishek Yadav, <sup>5</sup>Sudhir K Gupta

#### Abstract:

In Medico-legal autopsies conducted routinely in death due to thermal injury, the absence of ante-mortem signs of burns on the body of the deceased is evidence enough for it to be a post-mortem burn. In most of the cases, the postmortem burns are a result of an afterthought, mainly to conceal the true crime. Such burns are done in the perimortem period, making the diagnosis during autopsy more difficult. The charring present in the post-mortem burns makes the diagnosis more dubious. The post-mortem burning of the body is a phenomenon repeated again and again by the assailants to hide the findings of the antemortem homicidal attack, thus misleading the investigators of law. The ignorance, lack of experience or misinterpretation by a Forensic Pathologist conducting the autopsy may misguide the investigation agencies. We report two such cases where the bodies were burnt to conceal the true crime and also the identity of the individual. A thorough postmortem examination revealed the true nature of crime in both instances.

**Key Words:** Postmortem Burns, Concealed Homicide, Perimortem Burns.

#### Introduction:

Postmortem burns are usually the result of afterthought after committing a crime to conceal its detection and evidence. Postmortem findings in these cases are vital clues to the police investigators as the investigating officer does not have the requisite medical expertise to differentiate between antemortem burn injuries from postmortem. They will merely present the case to the autopsy surgeon as a death due to burn injuries, leading to misdiagnosis of the case. The medico-legal investigation in case of deaths due to burns, particularly in cases of spot deaths, is highly dependent on the Postmortem findings like time since death, the nature of burn injuries i.e. ante-mortem or post-mortem, presence of injuries etc.

Examination of victims who have died due to burn injuries may reveal additional internal findings from smoke inhalation like soot in the nostrils and mouth as well as coating of the larynx, trachea, and bronchi with soot particles at autopsy<sup>1</sup>. The complete charring associated with the post-mortem burns makes the diagnosis more doubtful. The ignorance, lack of experience or misinterpretation during autopsy by the autopsy surgeon may lead to many crucial evidences being missed resulting in misguiding of the investigation agencies. We present two cases in which were presented as death due to burns and if the autopsy surgeons would not have done the meticulous postmortem examination the two homicides would have gone undetected leading to miscarriage of justice.

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#### Case 1:

In September 2017, a partially decomposed body was recovered from the jungle area of a semi-rural place (**Picture 1 & 2**), in Delhi. Several salt packets were also found at the site. FIR was lodged at the concerned police station the same day. Identity of deceased could not be established. Eventually autopsy was done at the mortuary of the department of Forensic Medicine, AIIMS, New Delhi, after fourteen days, when identification could not be established.



**Picture 1: The Crime Scene****Picture 2: The Dead Body at the Scene****Autopsy Findings:**

It was a partially decomposed male dead body (in varying degrees of decomposition). Length of the body was 5'6" and the approximate age was 20-25 years. There were presence of mud stains, salt particles, and vegetation over different areas of the body. Singeing of scalp hair was present. Burns were present over entire face, neck, anterior and posterior aspects of chest and abdomen, both upper and lower limbs, constituting about 95% of the total body surface area. After the meticulous examination of the burnt area, the burns were concluded to be postmortem (**Picture 3**). Whole body X-ray was done and fracture of right cornu of Hyoid bone and right greater horn of thyroid cartilage was observed and confirmed during

**Picture 3: Postmortem Burns on the Body**

dissection (**Picture 4**). There was also fracture of right 5<sup>th</sup> to 8<sup>th</sup> ribs on the anterior axillary line. Tongue was clenched between teeth. Teeth were not charred. All internal organs were softened and converted into a blackish pulpy mass. Brain matter was liquefied. Soot particles were not present in tracheal lumen (**Picture 5**). The cause of death was opined as Manual strangulation.

**Picture 4: Showing Fracture Hyoid****Picture 5: Absence of Soot Particles in the Trachea****Case 2:**

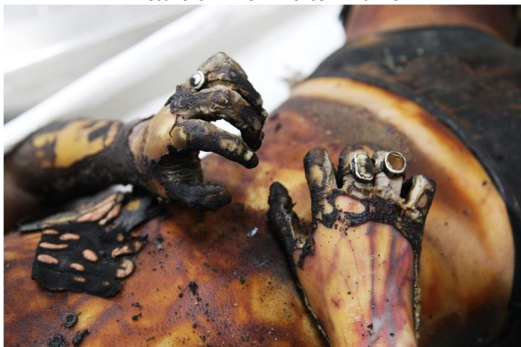
In October 2017, at around 6.25 a.m, a burnt body of a female was recovered by police in Delhi with both her legs tied of by a piece of cloth. FIR was lodged U/s 302, 201 IPC. Body later identified to be of a 26 year old married female.

**Autopsy Findings:**

The deceased was wearing partially burnt and charred clothes. Soil was adherent over right forehead and hair. Postmortem burns (**Picture 6**) were present over the entire body surface, except over gluteal regions, back, inter-scapular area, both thighs and legs, at places, constituting about 80% the total body surface area. Right and left soles were also partially involved. Scalp hair, eye brows and eye lashes showed singeing. Smell of inflammable material was appreciable from the body. No soot particles were present in the trachea (**Picture 7**). On dissection of neck, extravasation of blood was present over

medial sternal end of left sternocleidomastoid and muscles near right greater horn of thyroid (**Picture 8**). All internal organs were congested. The cause of death was opined as asphyxia due to antemortem compression of neck.

**Picture 6: ? Peri-mortem Burns**



**Picture 7: No Soot in Trachea**



**Picture 8: Extravasation of Blood near Cornu of Thyroid**



### Discussion:

The post-mortem burning of the body is a phenomenon repeated again and again by the assailants to hide the findings of the antemortem homicidal attack. In the famous ~~Naina Sahni~~ Tandoor case, the initial autopsy mentioned the cause of death to be due to burns, but in the repeat autopsy, it was revealed that the victim was shot prior to her death and the same findings helped in linking the accused to the crime and their prosecution.<sup>2,3</sup>

In the first case, after the cause of death was communicated to the police, the case was investigated and it was found that a close relative had committed the homicide and tried to burn the body to hide the identity. He further added salt packets as per his wisdom so as to enhance the decomposition. In the second case, the police subsequently recovered the CCTV footage which showed that the husband of the deceased was carrying the dead body on his shoulder towards the site where dead body was recovered and coming back empty handed. He had the same intention to prevent the identification of body and detection of crime. So if the autopsy surgeons had misdiagnosed the cases, the accused would have escaped from the clutches of law.

In such type of cases it is important to first differentiate between Antemortem and Postmortem burns which are characterized by absence of vital reaction, absence of line of redness, no soot particles in the trachea and bronchus, no cherry red color of blood, and absence of reparative process. Vesicles may be present both in the ante-mortem and post-mortem burns. The blisters of the postmortem burns contain mostly air and the little fluid containing very little albumen, with no chlorides and have a dull, yellow, dry hard base. While increased enzyme reaction is present in the periphery of antemortem burns, no enzyme activity is present in cases of post-mortem burns.<sup>4,5</sup> The same findings were recorded during the autopsy of both the cases.

Soot particles and antemortem thermal injuries indicate that the patient was alive and breathing in smoke filled environment. Though absence of soot particles does not necessarily prove that the patient was already dead when the fire started, but it still gives raise to reasonable doubt for an autopsy surgeon to suspect %burns+ as the cause of death, particularly in cases where the person had died on spot. The cases in which there was no soot in the larynx or trachea, and then analysis of blood for Carboxyhemoglobin may also be done for detection of Carbon monoxide inhalation.

Taghaddosinejad studied 47 cases of burns and found that carboxyhaemoglobin was positive in some of the cases of ante mortem



burns and was negative in all of the postmortem burns cases.<sup>6</sup> Tümer studied a series of thirteen cases of homicide involving post-mortem burning of the body and observed that the level of carboxyhaemoglobin was less than 10% in all the cases. In 12 cases, there were no soot particles in the respiratory or gastrointestinal tract and only one case contained soot particles, and that too in the oropharyngeal area only. They further noted that there was no line of hyperemia or redness in any of the case.<sup>7</sup>

Similar cases have been reported where post-mortem burning of the body was done to conceal murder. In Sheena Bora murder case, which shocked the nation, the accused also tried to burn the body to destroy the evidence.<sup>8</sup> A very well known and recent example of this is the most common error which can happen in such cases by the autopsy doctor is rely upon the preliminary investigation of the police which itself in a nascent stage and is dependent upon the autopsy report to lead the investigation.<sup>9-11</sup>

### Conclusion:

The investigation technique of the police in our country is more based on circumstantial evidence and the statements of the witnesses, rather than relying upon the scientific evidences. Timely and correct interpretation of autopsy findings by the doctor in criminal cases leads to detection of a crime. Postmortem examination of death due to thermal injuries, particularly in spot death cases, requires a cautious approach, as there may be a hidden homicidal cause of death. In the above reported cases, both bodies were burnt to conceal the true crime and also identity of the individual. Cases of burns where the death is at the spot of the incident should be carefully looked for the signs of assault like gunshot, strangulation, stab injuries, head injuries, poisonings etc. We should apply the expertise and knowledge thoroughly, instead of relying upon history given by police/relatives for the sake of natural justice to the deceased.

**Conflict of Interest:** None

**Financial Assistance:** None

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## Case Report

# Crime Scene Visit, a Valuable Tool for an Atypical Unfamiliar Hanging Death

<sup>1</sup>Sasank Shekhar Maharik, <sup>2</sup>Manas Ranjan Sahu, <sup>3</sup>Vikash Chandra, <sup>4</sup>Preetam Kumar Lenka

### Abstract:

The foremost objective of medico-legal autopsy is to determine the cause of death. Sometimes, it is a challenge for the autopsy surgeon to establish the manner of death as well. Crime scene visit prior to post-mortem examination, or after, is an essential tool for the autopsy surgeon to establish the manner of unfamiliar deaths where the investigation is in dilemma. Suicide by means of hanging, using personal belongings like saree, dhoti, lungi, rope, wire, etc, as a ligature material is very common amongst Indian population, irrespective of age, sex, and socio-economic status. We, report a case of hanging death at an isolated place in the reserve forest where a creeper plant, used as a ligature material, aroused suspicion of homicide. However, in this suspicious case, post-mortem examination and a meticulous observation of the crime scene, by the autopsy surgeons, aided in ascertaining the actual manner of death as suicide

**Key Words:** Medicolegal Autopsy, Crime Scene, Suicidal Hanging, Ligature Material.

### Introduction:

Crime scene is always a vital source of information in a medico-legal investigation.<sup>1</sup> Visiting of the scene of crime by an autopsy surgeon is an useful aid to opine regarding the nature and manner of many suspicious deaths. In India, commonly, police visits the scene of crime to conduct the inquest, collect the evidence and bring the body for autopsy; but due to lack of medical expertise, sometimes important pieces of evidence are lost. Autopsy surgeons usually do not visit the scene of crime and solely rely upon data mentioned in the inquest, which may be insufficient for a definite opinion, especially when the body is decomposed and found in unusual condition.

Hanging is a form of asphyxia caused by suspension of the body by a ligature encircling the neck, the constricting force being the weight of the body.<sup>2</sup> In Odisha, hanging is one of the common methods of committing suicide, followed by poisoning.<sup>3</sup> Partial hanging is always suicidal unless otherwise proved.<sup>1</sup> We report a case with the allegation of murder, where the dead body was found on the ground, having a ligature (creeper) in situ, with advanced decomposition, in a reserve forest.

### Case History

A dead body of a male, aged 30 years, working as a school teacher, was brought for post-mortem examination, in an advanced stage of decomposition, with the alleged history of foul play. On 1st July 2014, the body of the deceased was found lying on the ground of a reserve forest near a small tree with a creeper plant around the neck. [Figure - 1] The knot was present just below the left angle of the mandible. [Figure - 2] When the ligature was removed, a grooved pressure abrasion of dark brown colour was found around the neck except nape of the neck at the level of thyroid cartilage.

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Figure 1



Figure 2



It was more or less transverse on both sides of the neck with maximum width of 0.75 cm on the right side. Apart from the ligature mark, no other injury was present on the body. On dissection, the skin underneath pressure abrasion was dry, brownish and parchmented. Soft tissues of the neck along with muscles, cartilages and hyoid bone, were intact and without any extravasation. Air passage was intact and free. Other organs were intact and soft due to decomposition. The brain matter was partially liquefied.

The ligature material, which was a creeper plant, consisted of a single noose of 30 cm with a fixed knot at one end. The other end was ragged and 20 cm away from the knot. Ligature material was strong enough to bear the weight of the deceased.

Opinion regarding the cause of death was given as asphyxia resulting from constriction of the neck by hanging and that the ligature mark was antemortem in nature. Considering the features of decomposition, the time since death was given as three to five days, at the time of autopsy. On subsequent hue and cry by the public and dissatisfaction on the opinion, query was made by the police

about the atypical ligature material, point of suspension and the possibility of death by hanging. To solve misperception, our autopsy team visited the scene of crime.

There was a tree of circumference 24 cm at the bottom and branched at 8 feet above the ground. A bunch of dried creeper plants was dangling from that branch. One of the creepers was encircled twice and tied to that branch at one end and another end was torn and suspended, [Figure - 3] which was identical and corresponding with the torn portion of the ligature material. [Figure - 4] There were no other signs of the struggle. So, after the visit and reconstruction of the scene, we concluded the cause of death as asphyxia by partial hanging which was suicidal in manner.

Figure - 3

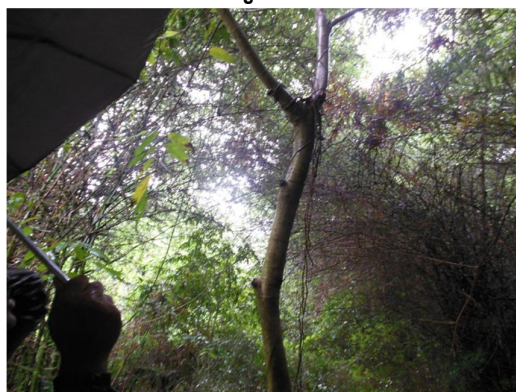


Figure - 4



## Discussion

The scene of a violent death usually shows significant findings for understanding, reconstructing and solving the problems related to cause and manner of death.<sup>2</sup> Antemortem ligature mark with ligature material in situ, always indicates asphyxial

death. But an uncommon ligature around the neck in a case of advance decomposition always needs circumstantial evidence to strengthen the opinion. The visit to a scene of death crystallizes the circumstances surrounding it and adds substantially to the total knowledge of the case. Furthermore, an on-the-spot study of the circumstances of death prompts one to look for things that would not ordinarily come to mind if the scene were not visited. Therefore, if there is the slightest suspicion, one should examine the scene.<sup>4</sup> Not examining a body at the scene is a potential pitfall for the pathologist in a medicolegal death investigation.<sup>5</sup>

The medicolegal expert, on visiting the scene of crime, should use his eyes first and most, hands second and less, mouth the last and the least.<sup>1</sup> The function of a pathologist at any scene of suspicious death is to observe the situation, to conserve any fragile evidence, to supervise the removal of the body and offer an opinion, based on experience, about the nature of death where this can reasonably be done.<sup>6</sup> Investigators should document the scene with diagrams and photographs.<sup>7</sup> Here, we visited the scene and collected the other half of ligature present on the tree and photographed along with surrounding. The free end of recovered ligature was matching to the torn end of the ligature present in situ on the body and justified hanging. Absence of any disturbance of scene excluded any untoward violence. Again, unusual positions like kneeling or reclining on the ground are almost diagnostic of suicide.<sup>2</sup> As it is assumed that the creeper plant will not be of sufficient strength to carry out complete suspension, so thinking about creeper as a ligature material is very uncommon, however, Phad, et al reported one case.<sup>8</sup>

## Conclusion

Without substantial evidence, opining regarding asphyxial death due to hanging in an unusual situation and advanced decomposition always questions the credibility of an autopsy surgeon and encourages hue and cry. So in such controversial cases, we must visit the scene of crime and collect the technical shreds of evidence to support the facts and autopsy findings to conclude the cause and manner of death.

**Conflict of Interest:** None

**Financial Assistance:** None

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## Case Report

### A Rare Case of Fatal Pig Attack

<sup>1</sup>Upender Kishore, <sup>2</sup>Mohit Gupta

#### Abstract:

Animal related fatalities are not uncommon, though injuries and deaths due to attack by pigs have been rarely reported. We report a case of a 3 year old child who wandered away from his home and was devoured by a pig. The case highlights the importance of maintaining supervision on young children and to be careful in the presence of pigs.

**Key Words:** Pig Attack, Fatal, Death, Medico-legal Issues.

#### Background:

Animal related fatalities are not uncommon, especially, in a developing country like India. The total number of human deaths in attacks by wild animals during 2012-2015 were 166.<sup>1</sup> Deaths usually happen because of attacks by animals, or road traffic accidents or fear. The top five animals responsible for these deaths were elephants, leopards, tigers, sloth bears and stray dogs.<sup>2</sup> However, deaths because of pigs are reported with relatively less frequency. As per Mayer J, only four fatal cases of pig bites were reported in United states between 1825 and 2012.<sup>3</sup> Here, we present a case where a pig has attacked and caused a human death.

#### Case report:

It was in a summer afternoon, when a 3 year old boy was being fed roti by his mother, sitting in their courtyard. Due to some work, the mother went inside the house. In the meantime, the boy wandered off into backyard of the house. After two minutes, when the mother came back and saw that the child was missing, she started searching for him. She found that a female adult pig was eating the child while her off-springs were standing nearby. After beating away the pig, the child was brought to hospital where he was declared brought dead.

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The body was brought for post-mortem examination. As per history, the total time that the child was missing was about 5 minutes.

On post-mortem examination, it was a body of male child. There were gnawing marks present all over the body. The soft tissues of face and thorax were missing, exposing the underlying teeth and bones with extravasation of blood in the injured area. The eyeballs were missing from sockets. The ribs were fractured and the thoracic contents i.e. the lungs and heart was missing. Multiple antemortem lacerations were present over the front of abdomen. [Figures 1, 2 & 3]

Figure 1: Missing eye balls from socket and damage to skin of face and thorax. Skin shows gnawing marks.

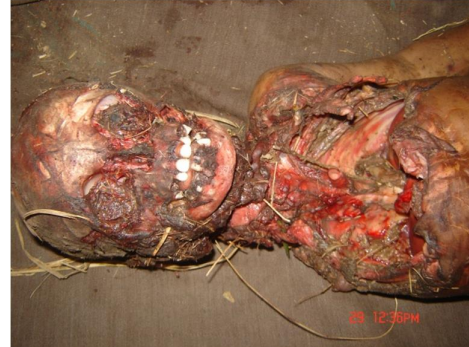
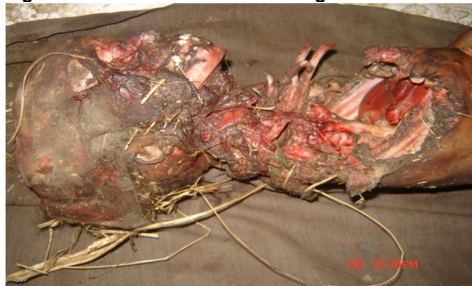


Figure 2: Fractured ribs and missing thoracic content



Figure 3: Fractured ribs and missing thoracic content



### Discussion:

Pigs belong to the genus *Sus*. They are omnivorous animals. They are considered highly social and intelligent animals.<sup>4</sup> Generally considered peaceful, they can become highly aggressive if their young offspring are threatened.<sup>5</sup> In the present case, it is possible that the pig felt that the young boy was a threat to her off-springs and therefore attacked the boy. Injuries are caused by biting, slicing or tearing into muscles,<sup>6</sup> however they may also cause damage to bones. Infections are common following pig bites in surviving patients due to organisms like alpha and beta streptococci, *Pasteurella* sp, *Bacteroides* sp, *Proteus* sp, *Ecoli* and coliform species.<sup>6</sup> Barnham M<sup>6</sup> states that common site of injury due to pig bite is back of thigh, due to the height of the animals and their unseen approach from behind.

In present case, head and thorax sustained severe injury while the back, upper limbs, abdomen and lower part of body were spared. This could be attributed to the height of the pig. Shearing away at the ribs, leaving the other soft tissues of the body, indicates the threat perceived by the animal, the strength of the pig and enabling the animal to do such extensive damage in such short span of time (around five minutes). It has been shown that the size and speed of large animal can generate force similar to that produced by motor vehicle accidents.<sup>7</sup>

The injuries present on the body of deceased and the fact that eyewitnesses, including the mother, saw the pig eating the parts of deceased, left little doubt as to any other cause of death. All injuries sustained were perimortem in nature. There was no evidence of any other trauma or poison on post mortem examination. As per the author's knowledge there is no reported case of fatal pig attack on human from India.

### Medico-legal perspective:

Since long, the pigs have been domesticated for their meat and leather. It is possible that such domesticated pigs may also injure the owner or a casual passerby. As per Indian law, in such a case the police may register a case against the owner of the pig under sections 289 IPC (Negligent conduct with respect to animals) and 304 (A) IPC (Causing death by negligence).<sup>8</sup> In the present case however the pig was not domesticated.

### Conclusion:

This case highlights the importance of keeping the young children under supervision. It also highlights that pigs, although considered harmless, can be highly dangerous and threatening to humans who breed them or who are in vicinity of them. The owners of such pigs should be careful and should be aware of methods to neutralize this threat quickly mainly because of the power and strength associated with these animals.

**Conflict of Interest:** None

**Financial Assistance:** None

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## Case Report

# Right Atrio-Ventricular Thrombus Masquerading as Myxoma

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### Abstract:

Intra-cardiac thrombus is an important pathological condition due to its potentially fatal complications. Thrombus in the right side of the heart is a relatively uncommon event and most are coincidentally discovered during the autopsy. Intra-cardiac causes of thrombus development include atrial fibrillation, valvular diseases, blood stasis in atrial appendages, pacemaker associated thrombosis, dilated cardiomyopathy, myocardial infarction, ventricular aneurysm, etc. The hemodynamic consequences of intra-cardiac mass such as thrombus, depend on its size and location; the most common hemodynamic disturbance is related to obstruction of the inflow-outflow tract and interference with the functioning of the atrio-ventricular valve. Therefore during autopsy sudden cardiac death as a cause of death should always be kept in mind in seemingly normal individuals.

We report a case of sudden cardiac death because of right atrio-ventricular thrombus in a young adult.

**Key Words:** Thrombus; Myxoma; Sudden cardiac death; Autopsy

### Background:

Sudden cardiac death (SCD) is defined as *Death due to cardiac causes, in which the time and mode of death are unexpected, in an individual with or without pre-existing cardiac disease, which occurs within 1 hour of the onset of the symptoms*.<sup>1</sup> The frequency of SCD ranges from 36 to 128 per 100,000 populations per year in different areas of the world.<sup>1-5</sup> Intra-cardiac thrombus is an important pathological condition due to its potentially fatal complications. Thrombus in the right side of the heart is a relatively uncommon event<sup>6</sup> and most are coincidentally discovered during the autopsy.

However, they are diagnosed more frequently at present times due to improved imaging modalities.<sup>7</sup> Such thrombi may develop due to underlying cardiac condition or systemic vascular disorders. Intra-cardiac causes of thrombus development include atrial fibrillation, valvular diseases, blood stasis in atrial appendages, pacemaker associated thrombosis, dilated cardiomyopathy, myocardial infarction, ventricular aneurysm, etc.<sup>6-8</sup> The presence of cardiac thrombi also is associated with autoimmune diseases such as Behçet disease, amyloidosis and Chagas disease.<sup>6,7</sup> Intra-cardiac thrombi may also develop as a consequence of deep vein thrombosis especially in the right side of the heart.<sup>7</sup> Intracardiac thrombi may lead to a fatal outcome due to pulmonary or systemic emboli formation. We report a case of sudden cardiac death because of right atrio-ventricular thrombus in a young adult with no traceable extra-cardiac origin.

### Case report:

As per the testimony of eyewitnesses, a 30-year old male suddenly collapsed on the road on way to his home. He was taken to a nearby hospital where attempts were made for

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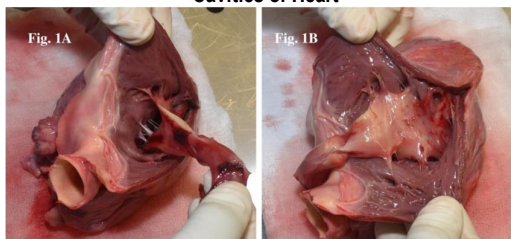
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resuscitation but the subject could not be saved and was declared dead.

External examination revealed a body of a 30-year old male of average built and nutrition. The body weighed 59 kg and measured 166 cm in length. Rigor mortis was appreciable in all the major joints. Post mortem staining was present over the back and dependent parts of the body and was fixed in nature. There were no external injuries over the body. On dissection, all the internal organs were congested. The stomach contained about 100 ml yellowish coloured fluid with congested gastric mucosa. Both lungs were adherent to the chest wall at various sites. On cut section, lungs were congested, oedematous and showed blood exudates admixed with froth and pus. Basal lobes of lungs showed areas of consolidation at places. The pericardial sac and epicardium didn't show any gross abnormality. Heart weighed 302g and was dissected in the conventional inflow-outflow way. On dissection of the right atrial appendage, a pedunculated mass measuring 11.0 cm X 4.4 cm X 0.4 cm was observed in the cavity of the right side of the heart. The mass was pink in colour with a creamish hue. The mass had attachments to chorda tendinae of the right ventricle and supero-lateral part of right atrium with its freely mobile stalk inside the pulmonary trunk. The mass demonstrated haemorrhagic areas at places. (Fig. 1A & 1B)

Fig 1A, 1B- Showing Intra-mural Thrombus in Right Side Cavities of Heart



Atrial wall thickness was 0.3 cm, right ventricular wall thickness was 0.5 cm and left ventricular wall thickness was 1.5 cm. Valves, intra atrial and intraventricular septae, were unremarkable. Aorta didn't show any evidence of atherosclerosis. The mass was subjected to histopathology for its atypical features. The sections from the mass confirmed it as a well organised thrombus in the right side of the heart. (Fig 2A) Left circumflex and left anterior

descending artery showed early atherosclerotic changes. Sections of the lungs showed findings of bronchopneumonia with chronic passive venous congestion with non necrotizing epithelioid cells and heart failure cells. (Fig 2B) On the perusal of gross and microscopic examination cause of death was opined as cardiac insufficiency due to intramural thrombi in the setting of bronchopneumonia and chronic passive venous congestion

Fig 2A- Organised Mural Thrombus in Heart (H&E, 10X)

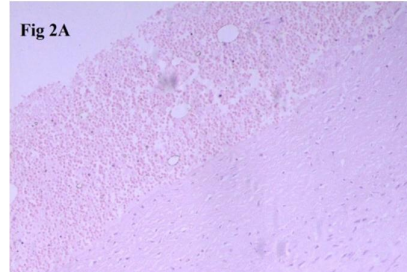
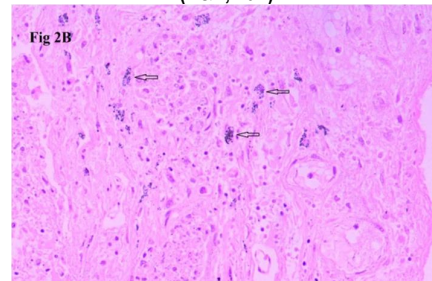


Fig 2B- Congestion and Heart Failure Cells (arrow) in Lung (H&E, 10X)



### Discussion:

In routine autopsies, it is unusual to encounter thrombus in the right cardiac chamber with no extra-cardiac origins/extensions. Right heart thrombi can be grouped under three patterns: Type A thrombi are serpiginous in morphology, highly mobile and associated with deep vein thrombosis and pulmonary embolism. Type B thrombi are formed in situ, non mobile and related to underlying cardiac pathology. Type C thrombi are rare, highly mobile and similar in appearance to myxoma.<sup>9,10</sup>

Myxomas are the most common type of primary cardiac tumour in all age groups and are often discovered coincidentally at autopsies. They have a female predilection and are more common in the third to the sixth decade.<sup>11</sup> Myxomas are usually seen as gelatinous appendages, which are pedunculated on a fibro-vascular stalk. Most of the myxomas are solitary and would



demonstrate myxoma cells embedded in glycosaminoglycans stromal matrix. They often arise from the interatrial septum near the fossa ovalis and are firm in consistency, sometimes with few haemorrhagic areas. It is often difficult to differentiate cardiac myxoma from thrombus on gross examination, especially when a thrombus presents with atypical coloration and resembles in consistency to a myxoma. In few cases, intracardiac thrombi may have stalked which may further complicate the spot diagnosis. Thrombi are much more common than myxoma, located more commonly in atria and in the left side of the heart.<sup>12</sup> Sometimes a mass in the right atrium could be the extension of an abdominal tumour by invading inferior vena cava, such as hepatic or renal cell carcinoma. Intracardiac thrombosis in the right heart is frequently iatrogenic in origin. Predisposing factors include indwelling vascular catheters, pacemaker, prosthetic valves, etc.<sup>13</sup>

Right ventricular thrombus secondary to blunt chest trauma causing obliteration of flow in right ventricle and subsequent right heart failure has been reported in the literature.<sup>11</sup> Mural thrombi adherent to the endomyocardium have been reported in patients with endomyocardial fibrosis and Löffler's endocarditis. The aetiology is unknown but in most cases, this occurs secondary to viral infection or inflammation.<sup>11</sup> Other conditions that have an association with right sided thrombosis are right ventricular infarction, cardiomyopathy with subsequent systolic dysfunction, Behçet's disease, atrial fibrillation, hypercoagulable states, etc.

Histological findings in the reported case were consistent with a well organized thrombus in the right side of the heart in the background of bronchopneumonia and chronic passive venous congestion in lungs. No evidence of malignancy was found. No histological features of valvulitis or valvular degeneration were found. The hemodynamic consequences of intra-cardiac mass such as thrombus depend on its size and location; the most common hemodynamic disturbance is related to obstruction of the inflow-outflow tract and interference with the functioning of the atrio-ventricular valve which proved fatal as in the reported case.

## Conclusion:

In the present case, there was no past history of any cardiac illness or any genetic disorder in the deceased and his family members. There was no history of trauma to the thoracic region. Evidence of thrombus in the heart is a significant finding, particularly in cases of road traffic accident, fall from height etc., wherein this finding could be a potential cause of the mishap. It is not very common in general population to present with sudden cardiac death in a young adult. Therefore, during autopsy, sudden cardiac death as a cause of death should always be kept in mind in seemingly normal individuals, as was observed in the present case.

**Conflict of Interest:** None.

**Financial Assistance:** None.

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### Corrigendum

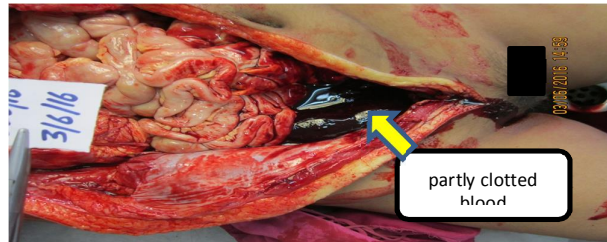
JIAFM. 2018;40(3):385-6

#### Meticulous Autopsy Revealed Ruptured Fallopian Tube: A Case Report

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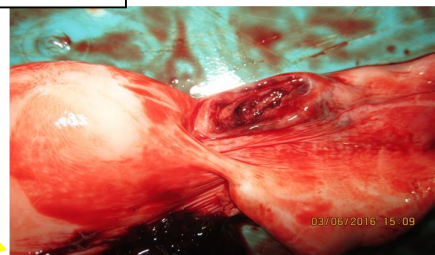
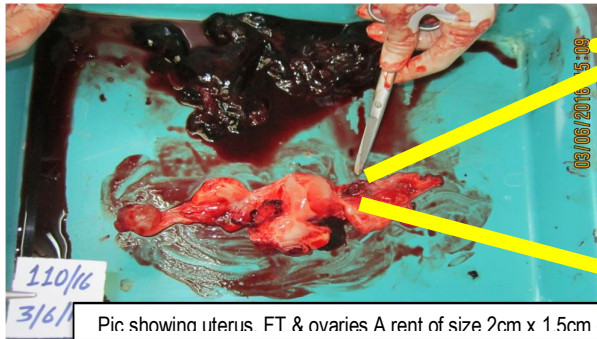
#### Photographs:

#### Photo 1

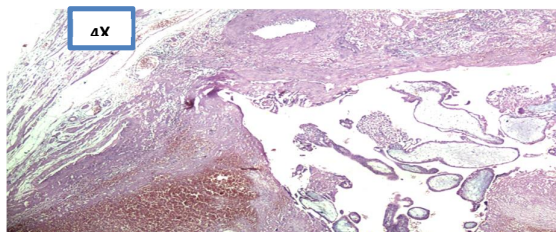


Product of conception not found due to severe & extensive retroperitoneal hemorrhage. Hence, viscera & uterus with adnexa preserved for histo-pathological examination.

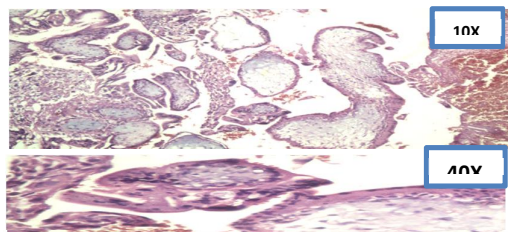
#### Photo 2 & 3



Pic showing uterus, FT & ovaries. A rent of size 2cm x 1.5cm on posterior surface of isthmus region of right fallopian tube.



Lumen (L) of FT showing chorionic villi (V) along with surrounding hemorrhage



Villi showing central mesenchyme (MC) surrounded by cytotrophoblast (C) and syncytiotrophoblast (S) cells

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