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## Mid-term analysis of age estimation from sternum in 45+ years onwards from northern India: A prospective study

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### ABSTRACT

**Background:** Age plays a vital role in determining a person's identity in legal matters, both during their lifetime and after their death. The objective of this study was to ascertain an individual's age by examining the fusion of the xiphoid process and manubrium with the sternum. **Material and methods:** A total of 112 cases were included in this study which is carried out as mid-term analysis. The cases were selected from the general public, including patients admitted to departments, their family, and police personnel attending the a tertiary care institution in Haryana. Radiographs of sternum lateral & AP view were taken. Data were analyzed using SPSS 21. **Result:** A total of 112 patients were enrolled. 64 (57.1%) were males and remaining were females. Regarding Xiphoid process, complete fusion was observed in 83% both males and females in age group 60 – 65 years. Complete fusion was observed in all male & female patients in 65 – 70 years. Regarding manubrium, complete fusion was observed in 75% males and 88.9% females in age group 50 – 55 years. Complete fusion was observed in most female patients in age group 55 – 60, 60 – 65 years and 65 – 70 years. **Conclusion:** The age can be assessed by examining the fusion of the xiphoid process and manubrium with the sternal body using radiographic examination. Moreover, the union of the xiphoid process and manubrium with the sternal body initiates after the age of 30 years, but full fusion taking place after the age of 60 years.

**Keywords:** Manubrium; xiphoid process, sternal body, age estimation.

### INTRODUCTION

Age plays a vital role in determining a person's identity in legal matters, both during their lifetime and after their death. It is particularly vital in economically disadvantaged countries

when there is a lack of accurate maintenance of birth records.<sup>1</sup> Bone is a mineralized connective tissue that is vascular, living, and constantly undergoing changes. It is distinctive due to its growth method.<sup>2</sup> Epiphyses emerge and fuse in a specific sequence, and age can be determined by examining epiphyseal lines. A prior investigation showed sexual disparities in the duration of epiphysis maturation.<sup>3</sup>

Minor deviations in the age at which fusion occurs can also be attributed to factors such as variances in geographic distribution, socioeconomic status, environmental conditions, metabolic rate, dietary habits, genetic factors, and inconsistent methodology.<sup>4</sup> The assessment of epiphyseal fusion in bones is considered a reliable and accepted method for determining age.<sup>5</sup> Determining the age of a young person is facilitated by various factors such as morphological features, tooth eruption, active ossification centers, and bone development. These factors all contribute to the most accurate estimation of age. However, senior individuals can be distinguished by certain characteristics, including the fusion of the sternum and xiphoid, fusion of the cranial sutures, and changes in the pubic symphysis.<sup>6,7</sup>

A study conducted by Reddy et al. in Bangalore, India revealed that the fusion of the xiphoid and sternum occurs between the ages of 40 and 42, while the fusion of the manubrium with the body takes place between the ages of 55 and 58.<sup>8</sup> Another study discovered that the fusing of the xiphoid and sternum, as well as the fusion of the manubrium and body, occurred at the same ages, specifically between 50 and 55 years old.<sup>9</sup> The sternum consists of three distinct components: the manubrium, the mesosternum, and the xiphoid process.<sup>10</sup> Based on the literature search, there is no existing study on determining age through the union of the xiphoid process and manubrium with the body of the sternum. The objective of this study was to ascertain an individual's age by examining the fusion of the xiphoid process and manubrium with the sternum.

## **MATERIALS AND METHODS**

A total of 112 cases were included in this study which is carried out as mid-term analysis. The cases were selected from the general public, including patients admitted to departments, their family, and police personnel attending the a tertiary care institution in Haryana. The study cases were categorized into distinct age groups. Only cases with available records of date of birth from ration card, matric certificate, birth certificate, identity card, driving license, voters card, service record, and PAN card were examined.

Individuals who did not possess any evidence of their birth during the time of exposure were provided with envelopes that had an official mark and were instructed to mail them through the postal service. This study did not take into account cases where the date of birth was uncertain. The X-Ray Sternum Lateral View was captured for the purpose of studying the patients,

following the acquisition of their written consent. This study only included individuals who are permanent residents and do not exhibit any diseases related to the anterior chest wall.

The anterior chest wall cases that were sick or damaged were discarded. The number of female cases was lower due to the inferior quality of X-Ray film caused by the obscuring of the breast tissue. The fusion status of the xiphisternum and manubrium with the body of the sternum was investigated. The decision was made not to include the partial fusion or equivocal (3) due to the inherent challenge of making comments based on X-ray images regarding partial fusion. Grade 2 (complete fusion) only included cases where there was total fusion of the joints.

In cases where there is uncertainty or absence of complete fusion, such instances were classified as grade 1: not fused. Following the aforementioned events, 10 X-ray scans revealed uncertain fusion at the xiphisternal joint, which were classified as grade E and hence excluded from the investigation of xiphisternal joint fusion.

**Table 1: Grading of fusion of Xiphisternal Joint**

| Serial number | Fusion of Joints | Grading |
|---------------|------------------|---------|
| 1             | Not Fused        | 1       |
| 2             | Complete Fusion  | 2       |
| 3             | Equivocal        | 3       |

## RESULTS

This study included 112 cases as mid-term analysis. Cases were taken randomly amongst patients, their relatives and police officers visiting the study site.

A total of 112 patients were enrolled. There were 64 (57.1%) males and remaining were females. The age ranged from 45 to 70 years with higher number of patients. (Table 2)

**Table 2: Distribution of study subjects as per age group and gender**

| Age group in years | Male      | Female   |
|--------------------|-----------|----------|
|                    | N (%)     | N (%)    |
| 45-50              | 15 (23.4) | 12 (25)  |
| 50-55              | 16 (25.0) | 7 (14.6) |
| 55-60              | 12 (18.8) | 9 (18.6) |
| 60-65              | 12 (18.8) | 12 (25)  |
| 65-70              | 9 (14.1)  | 8 (16.7) |
| <b>Total</b>       | 64 (100)  | 48 (100) |

Status of fusion in case of xiphoid process with respect to different age groups is shown in Table 3. Complete fusion was observed in 83% both males and females in age group 60 – 65 years. Complete fusion was observed in all male & female patients in 65 – 70 years. (Table 3)

**Table 3: Status of fusion in case of xiphoid process with respect to different age groups.**

| Age group in years | Complete fusion |           | Partial fusion |          | No fusion |           |
|--------------------|-----------------|-----------|----------------|----------|-----------|-----------|
|                    | Male            | Female    | Male           | Female   | Male      | Female    |
| 45-50              | 10 (66.67)      | 5 (41.67) | 5 (33.3)       | 6 (50)   | 0 (0)     | 1 (8.33)  |
| 50-55              | 11 (68.75)      | 4 (57.1)  | 3 (18.75)      | 3 (42.9) | 2 (12.5)  | 0 (0)     |
| 55-60              | 8 (66.67)       | 6 (66.67) | 2 (16.67)      | 3 (33.3) | 0 (0)     | 2 (16.67) |
| 60-65              | 10 (83.3)       | 10 (83.3) | 2 (16.7)       | 2 (16.7) | 0 (0)     | 0 (0)     |
| 65-70              | 9 (100)         | 8 (100)   | 0 (0)          | 0 (0)    | 0 (0)     | 0 (0)     |
| P value            | 0.63            |           | NA             |          | NA        |           |

Complete fusion was observed in 75% males and 88.9% females in age group 50 – 55 years. Complete fusion was observed in most female patients in age group 55 – 60, 60 – 65 years and 65 – 70 years. (Table 4)

**Table 4: Status of fusion in case of manubrium with respect to different age groups.**

| Age group in years | Complete fusion |          | Partial fusion |          | No fusion |           |
|--------------------|-----------------|----------|----------------|----------|-----------|-----------|
|                    | Male            | Female   | Male           | Female   | Male      | Female    |
| 45-50              | 3 (20)          | 7 (58.3) | 5 (33.3)       | 3 (25)   | 7 (46.6)  | 2 (16.67) |
| 50-55              | 14 (87.5)       | 5 (71.4) | 2 (12.5)       | 2 (28.6) | 0 (0)     | 0 (0)     |
| 55-60              | 9 (75)          | 8 (88.9) | 3 (25)         | 1 (11.1) | 0 (0)     | 0 (0)     |
| 60-65              | 12 (100)        | 12 (100) | 0 (0)          | 0 (0)    | 0 (0)     | 0 (0)     |
| 65-70              | 9 (100)         | 8 (100)  | 0 (0)          | 0 (0)    | 0 (0)     | 0 (0)     |
| P value            | 0.24            |          | NA             |          | NA        |           |

## DISCUSSION:

In this study, a total of 112 patients were enrolled. There were 64 (57.1%) males and remaining were females. Regarding Xiphoid process, complete fusion was observed in 83% both males and females in age group 60 – 65 years. Complete fusion was observed in all male & female patients in 65 – 70 years. Regarding manubrium, complete fusion was observed in 75% males and 88.9% females in age group 50 – 55 years. Complete fusion was observed in most female patients in age group 55 – 60, 60 – 65 years and 65 – 70 years.

According to a study conducted by Wadhawan et al, involving 100 people, it was found that the fusion of the sternum and the xiphoid process did not happen until the age of thirty. The fusion of the xiphoid process with the sternal body often begins beyond the age of thirty years.<sup>7</sup>

The findings of our investigation align with those of Negrale et al. According to a study conducted by Alaa El-Din et al, it was shown that the union of the xiphoid process with the sternal body in both males and females typically starts after the age of thirty years.<sup>11</sup> The present investigation revealed that individuals between the ages of 25 and 35, regardless of gender, did not exhibit fusion of the manubrium with the sternal body. The fusion of the manubrium with the sternal body initiates beyond the age of 40. Full fusion of the manubrium with the sternal body was found in all (100%) patients aged 60-65 years and 65-70 years, regardless of gender.

In current study, it was also observed that partial manubrium fusion with the sternal body started earlier in the female subjects than male counterparts. A previous study by analyzed x-ray films of a Punjabi ethnic group and found that majority of men up to 49 years old did not exhibit any signs of fusion between the manubrium and the body of the sternum, according to the research.<sup>12</sup> Females' incidences of partial fusion begin to increase around the age of 54, while complete fusion occurs around the age of 64.<sup>10</sup> A previous study done by Negrale et al, also reported findings.<sup>9</sup> Other previous studies also reported comparable results.<sup>12</sup> The major limitation of the study is small sample size and the samples were taken from a single center due to insufficient resources. Therefore, another study based on large sample size and multiple centers should be conducted to get better outcomes. Further research employing the same criteria on a broader scale in the Pakistani population is required in order to get a radiometric standard that is distinctive to them and can be used in age estimate practice.

The study found that the union of the partial manubrium with the sternal body began at an earlier stage in female patients compared to males. A prior study examined x-ray images of a Punjabi ethnic group and discovered that most men under the age of 49 did not show any indications of fusion between the manubrium and the body of the sternum, as reported by the research. The occurrence of partial fusion in females starts to rise at approximately 54 years of age, whereas total fusion typically takes place at roughly 64 years of age.<sup>10</sup> Negrale et al conducted a prior study and presented their findings.

Additionally, other earlier research have similarly documented similar findings.<sup>12</sup> The primary constraint of the study is the limited sample size, as well as the fact that the samples were obtained only from a single center due to inadequate resources. Hence, it is imperative to conduct another study with a substantial sample size and different centers in order to achieve more favorable results. Additional research is necessary to apply the same criteria on a larger scale within the Indian communities. This research aims to establish a radiometric standard that is specific to this group and may be utilized for age estimation purposes.

### Conclusion:

The age can be assessed by examining the fusion of the xiphoid process and manubrium with the sternal body using radiographic examination. Moreover, the union of the xiphoid process and manubrium with the sternal body initiates after the age of 30 years, but full fusion taking place after the age of 60 years. The radiation exposure to living persons should be avoided.

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