

## ORIGINAL RESEARCH

### Study of Age Estimation from Sternum: An Institutional Based Analysis

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#### ABSTRACT

**Introduction:** Age estimation is one of the major parameters in the estimation of skeletal remains in forensic anthropology casework series. The present investigation is an attempt to study the fusion of manubrium and xiphoid process with mesosternum in 70 sterna (49 males and 21 females) of known age obtained during autopsy. The current study has been conducted to estimate the age of an individual based on the fusion and non-fusion of the sternum.

**Materials and Methods:** After obtaining prior permission from the institutional ethical committee, the study sample included those in the age range between 10 – 80 years that might include both the gender. This study included 70 sternums from the cadavers that include 49 males and 21 females.

**Results:** Age group of 21 – 30 reported to have greater study samples followed by 0 – 20 and 31 – 40. Greater number of fusions is seemed to be reported in Group – II (21 – 30 years).

**Conclusion:** To conclude, as the age progresses, the proportion of male and female cases, showing fusion at mesosterno-xiphisternal and manubrio-mesosternal junctions increases. Manubrio-mesosternal junction was seemed to be very variable with regard to its fusion status as the joint remained unfused even in some of the elderly ages. Fusion is completed at the age of 40 years in male and 45 years in female.

**Keywords:** Age Estimation, Manubriosterni, Autopsy, Forensic Medicine.

#### INTRODUCTION

Across the country, there were many people who do not have any documentary evidence to show as a proof of their age. Therefore, the forensic experts are in a position to be regularly consulted about the exact age determination of an individual whether in the middle aged as well as old age or geriatric people in certain civil as well as in criminal cases.<sup>1</sup>

Decades ago, sternum has been greatly applied by certain researchers in order to determine the sex and the stature of an individual<sup>2,3</sup>; in order to provide valuable ideas in the age determination of the deceased. Anatomically, a sternum basically comprises of three distinct parts: a manubrium superiorly, a mesosternum or the main body in the middle and a xiphoid process that has been placed inferiorly. The manubrium joins with mesosternum by a primary or secondary cartilaginous joint (manubrio-mesosternal junction) and the xiphoid likely unites with the mesosternum by either a primary or a secondary cartilaginous joint (mesosterno-xiphisternal junction). The ossification of human skeleton majorly follows certain definite timings on their appearance as well as timing of fusion. Age estimation from

sternum is, thus, based upon the analysis of the fusion of manubrium with mesosternum and fusion of xiphoid with mesosternum<sup>4,5</sup> as well on certain morphological characteristics of sternum.<sup>6</sup>

The present work is a quick attempt in order to study the sternum in the outline of existing parameters of the determination of age. The parameters basically include a study of fusion of manubrium with mesosternum, sternal segments, fusion of Xiphoid process with mesosternum in association with relation to their age. Evaluation of the reasonably accurate age displays a pivotal role in certain civil and majority of the criminal cases like identification, fixing of criminal responsibilities, judicial punishment. Anatomists and Forensic experts are often in need to evaluate the chronological age of a subject for various reasons.<sup>7</sup> In spite of having strict rules on providing compulsory birth and death registration there are reportedly many cases that do not have a birth certificate even today. It is particularly an increasing worrisome problem with advancing age in those above 25 years.<sup>7</sup> As from around 25 years until old age there are no dramatic events as eruption of tooth or the appearance of ossification centers.<sup>8</sup> Therefore the current study has been conducted to estimate the age of an individual based on the fusion and non-fusion of the sternum.

## **MATERIALS AND METHODOLOGY**

This study was adopted as a cross-sectional study which was planned to be conducted in the Department of Forensic Medicine, Jorhat Medical College, Jorhat, Assam, India. After obtaining prior permission from the institutional ethical committee, the study sample included those in the age range between 10 – 80 years that might include both the genders. The major inclusion criteria that were followed in this study include those within the stipulated age range, those without any deformity and those that were referred for the medico-legal autopsy. There were certain exclusion criteria that were followed in this study include those sternums from the foetus, unknown bodies and those with deformed, diseased and fractured sterna. This study included 70 sternums from the cadavers that include 49 males and 21 females.

In order to view the sternum, a primary “I” incision was given that extends from the chin to the pubis and the skin; underlying subcutaneous tissues, fats and muscles were promptly separated. Ribs were dissected laterally to the costochondral junction and the sternum was removed after disarticulating sternoclavicular joints bilaterally. After obtaining the sterna, soft tissues were carefully removed by placing the bone in water for almost around 4 weeks. The sterna were then cleaned, dried and visually examined thoroughly for the fusion of xiphoid with mesosternum and manubrium with mesosternum. A thorough maceration of sternum was performed to make sure precision in visual inspection of the joints for fusion status. Later radiological examination was performed to note the state of fusion in sterna where visual examination was seemed to be inconclusive.

The data obtained were analysed using Statistical Package for Social Sciences (SPSS) version 11.0 computer software (SPSS, Inc., Chicago, IL, USA). Level of significance was set at standard p value of less than 0.05.

## **RESULTS**

Fusion of sternabrae starts at the age of 20 years in male and Fusion of sternabrae starts at the age of 20 years in female. Fusion is completed at the age of 40 years in male and 45 years in female. If complete fusion in males, age is above 40 years and If complete fusion in females, age is above 45 years. No opinion was possible from the incidence of ‘no fusion’

Table – 1 showed the age and sex wise distribution of all the cases that have been included in this study. Age group of 21 – 30 reported to have greater study samples followed by 0 – 20 and 31 – 40. Table – 2 showed the comparison of the cases of fusion/ non-fusion and partial

fusion of sternal joints. Similarly greater number of fusion is seemed to be reported in Group – II (21 – 30 years)

**Table 1: Showing age group wise and sex wise distribution of total cases**

Group	G – I	G – II	G – III	G – IV	G – V	G – VI	G – VII
Age (years)	10 – 20	21 – 30	31 – 40	41 - 50	51 – 60	61 – 70	71 – 80
Male	12	14	11	3	6	2	1
Female	4	7	4	4	0	1	1
Total	16	21	15	7	6	3	2

**Table 2: Showing comparison of total incidence of Fusion/Not Fused/Partial fusion Manubrium with Mesosternum and Mesosternum with Xiphisternum age group-wise in percentage (%)**

Group	Age (years)	Fusion		Non-fusion		Partial fusion		Total
		Male	Female	Male	Female	Male	Female	
I	10 – 20	0	0	11	3	1	1	16
II	21 – 30	0	0	3	2	11	4	20
III	31 – 40	2	0	2	2	9	2	15
IV	41 – 50	3	4	0	0	1	-	8
V	51 – 60	5	0	0	0	0	0	5
VI	61 – 70	2	2	-	-	-	-	4
VII	71 – 80	1	1	-	-	-	-	2

## DISCUSSION

At around 6<sup>th</sup> week of intrauterine life (IUL) the mesenchymal mass known as pre-sternal mass gives rise to the cartilaginous primordia of manubrium which then begins to ossify at the 5<sup>th</sup> month of IUL which later becomes recognizable appearance by the 6<sup>th</sup> month post-partum. The lateral sternal plate, a pair of mesenchymal masses which appears at the 6<sup>th</sup> week of IUL gets embedded in the anterior chest wall starts fusing and chondrifying at the 9<sup>th</sup> week of IUL in the cranio-caudal direction thus directly rises to cartilaginous primordia of all four sternbrae at varying numbers; Ossification usually begins mostly from single centre for upper two and lower two from two or more centres which then further allows the shaping of the sternum into Ashley's Type-I, II and III patterns.<sup>10</sup>

The ossification centers of sternbrae appear in the sequence 5<sup>th</sup> to 6<sup>th</sup> month IUL for 1<sup>st</sup> sternbrae, 7<sup>th</sup> to 8<sup>th</sup> Month IUL for 2<sup>nd</sup> & 3<sup>rd</sup> sternbrae and at around 1 year age for 4<sup>th</sup> sternbrae. The ossification for xiphoid begins at 3- 6 years of age or remains cartilaginous even into advanced age in certain situations.<sup>11</sup> However; the fusion between different components of the sternum is highly variable in few studies. Gautam RS et al (2003)<sup>11</sup> concluded that the fusion between third and fourth sternbrae was almost completed by 15 years. Between second and third sternbrae, fusion was seemed to be completed by 21 years and between first and second sternbrae the fusion was completed by around 21 years. The fusion of the different sternal elements takes place in association to age but is reported to be totally independent of the gender of the subject.<sup>5</sup>

Considering the fusion of xiphoid process with body of sternum, it was completed by 50 years. Fusion of manubrium with body of sternum starts at the age of 40 and it is complete by 55 years.<sup>5</sup> In the present study, the fusion of the different sternal elements takes place in relation to age. In present study, fusion of sternbrae commences at the age of 20 years in male and Fusion of sternbrae starts at the age of 20 years in female. Fusion is completed at the age of 40 years in male and 45 years in female. If complete fusion in males, age is above

40 years and If complete fusion in females, age is above 45 years.<sup>5,11</sup> Manoharan C(2016) concluded that almost all cases above 21 years of age displayed the fusion between all segments of the body of the sternum and the fusion of xiphoid with body occurs anywhere in between 32 – 60 years irrespective of sex.<sup>12</sup> In this study, fusion of sternabrae starts at the age of 20 years in male and 20 years in female. VB Gaur(2010) postulated that the fusion of xiphoid process and the manubrium sternum with the body has shown early signs of fusion in age group 31-35 years whereas in few cases it has not fused even in more than 41 years age group.<sup>13</sup> In this study, fusion of sternabrae begins at the age of 20 years in male and fusion of sternabrae commences at the age of 20 years in female.

Ashley<sup>11</sup> contributed that the early synostosis to a persistent synchondrosis in place of symphysis. Owing to the developmental phenomenon,<sup>14</sup> sclerotic fusion is considered to be degenerative in nature and cannot be confused with matrical synostosis. In the present study, the sternum was macerated, and the fusion status was promptly analysed by direct inspection method. Direct inspection method is the most commonly used method in forensic anthropology in many of the developing countries primarily due to its cost-effectiveness. Radiography could not be conducted on all the dead bodies/ sternum in the present research despite of the financial constraints of the study and limited facilities.

## CONCLUSION

To conclude, as the age progresses, the proportion of male and female cases, showing fusion at mesosternoxiphisternal and manubrio-mesosternal junctions increases. Manubrio-mesosternal junction was seemed to be very variable with regard to its fusion status as the joint remained unfused even in some of the elderly ages. Fusion is completed at the age of 40 years in male and 45 years in female.

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