International Journal of Anatomy and Research,
Int J Anat Res 2018, Vol 6(3.2):5525-30. ISSN 2321-4287
DOI: https://dx.doi.org/10.16965/ijar.2018.270

Original Research Article

DETERMINATION OF AGE BY HUMAN STERNUM

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ABSTRACT

Background: Examination of any bone is important for identification of deceased and estimation of age. The present work is an attempt to study the sternum in the purview of existing parameters of the determination of age. It includes a study of fusion of manubrium with mesosternum, sternal segments, fusion of Xiphoid process with mesosternum in relation to age.

Materials and Methods: The present study was carried upon 65 sternums(46 Males and 19 Females). Sternum from cadavers in the Department of Anatomy and Sternum from Autopsy bodies in the Department of Forensic Medicine and Toxicology, People's College of

Medical Sciences and Research Centre, Bhopal. (MP).

Results: Study concluded that Fusion of sternebrae starts at the age of 20 years in male and

Fusion of sternebrae 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'.

Conclusion: Our study concluded that the fusion of sternum was reliable for determining age.

KEY WORDS: Sternum, Age, Sex, Anthropology, Medicolegal.

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Access this Article online	Journal Information
Quick Response code	**International Journal of Anatomy and Research**
	ICV for 2016 90.30
	ISSN (E) 2321-4287 | ISSN (P) 2321-8967
	https://www.ijmhr.org/ijar.htm
	DOI-Prefix: https://dx.doi.org/10.16965/ijar
DOI: 10.16965/ijar.2018.270	**Article Information**
	Received: 31 May 2018 Accepted: 07 Jul 2018
	Peer Review: 01 Jun 2018 Published (O): 10 Aug 2018
	Revised: None Published (P): 10 Aug 2018

INTRODUCTION

Lot of work has been done and ample literature is available in anatomy and Anthropology for Identification of human skeleton. For medico-legal studies, examination of human skeleton has obviously an utmost importance. Identification of male and female bone from unknown human skeletal remains or decomposed bodies is an important initial step in forensic investigation. Experts are always facing a problem in identifying whether the skeletal remains are human or not as well as estimation of correct age and sex of specimen available. Accurate determination of skeletal sex has been a critical issue in medicolegal cases. If the entire skeleton is presented for examination, male and female bone can be identified with almost cent percent accuracy. With the help of skull or pelvis it is up to 90%. But without skull and pelvis, it becomes fairly difficult to judge the age and sex accurately[1]. And the accuracy depends on the nature of material available and methods applied.

Study of human sternum as an individual parameter for determination of age and sex has been attempted by various workers. First recorded

data is by Wenzel (1788). He described the difference in the ratio between the length of manubrium and that of mesosternum in both sexes. It was followed by Fiegel (1837), Dwight (1890), and Ashley (1956). In the present study, all existing parameters have been used for determination of age and sex of an individual with the help of sternum.

The present work is an attempt to study the sternum in the purview of existing parameters of the determination of age. It includes a study of fusion of manubrium with mesosternum, sternal segments, fusion of Xiphoid process with mesosternum in relation to age. Estimation of the reasonably accurate age plays a pivotal role in civil/criminal cases like identification, fixing of criminal responsibilities, judicial punishment. Anatomists and Forensic experts are often required to estimate the chronological age of a subject for various reasons [2]. In spite of stringent ruling on compulsory birth and death registration there are many cases that do not have a birth certificate even today. It is particularly an increasing problem with advancing age above 25 years[3].

As from around 25 years until old age there are no dramatic events as eruption of tooth or the appearance of ossification centers[4].

Sternum is the bone which will give the fair idea for the guide for determination of the age. Sternal ossification that is xiphisternum with body occurs around 40 years and manubrium with body about 60 years[3].

Sternum: The sternum consists of a cranial manubrium (prosternum), an intermediate body (mesosternum), and a caudal xiphoid process (metasternum). Until puberty, the mesosternum consists of four sternebrae; from their costal relations, these appear to be intersegmental. The total length of the sternum is 17cm in males while it is less in females. The ratio between manubrial and mesosternal lengths differs between the sexes. Growth may continue beyond the third decade and possibly throughout life.

In natural stance, the sternum slopes down and slightly forwards. It is convex in front, concave behind, and broadest at the junction with the first costal cartilages. It is narrow at the manubriosternal joint, below which it widens to its articulation with the fifth cartilages, and narrows again below this.

The sternum contains highly vascular trabecular bone enclosed by a compact layer which is thickest in the manubrium between the clavicular notches. Centrally, the bone is lightly constructed, whereas laterally the trabeculae are thicker and wider.

The medulla contains haemopoietic (red) bone marrow.

Ossification: The sternum is formed by fusion of two cartilaginous sternal plates flanking the median plane. The arrangement and number of centres of ossification vary according to the level of completeness and time of fusion of the sternal plates, and to the width of the adult bone. Incomplete fusion leaves a sternal foramen. The manubrium is ossified from one to three centres appearing in the fifth fetal month.

The first and second sternebrae usually ossify from single centres that appear at about the same time. Centres in the third and fourth sternebrae are commonly paired, and appear in the fifth and sixth months, respectively, but one of either pair may be delayed until the seventh or even eighth month. The fourth sternebral centre may be absent. The xiphoid process begins to ossify in the third year or later. In some sterna, all centres are single and median, in others the manubrial centre is single and the sternebral centres are all paired, symmetric or asymmetric. Union between mesosternal centres begins at puberty and proceeds from below upwards: by the age of 25 years they are all united.

Suprasternal ossicles, paired or single, occur in about 7% of sterna. They may fuse to the manubrium or articulate posteriorly at the lateral border of the jugular notch. When well formed, they are pyramidal, and their base is articular. The ossicles are cartilaginous at birth, and ossify during adolescence[5].

MATERIALS AND METHODS

Study population

1. Sternum from cadavers in the Department of Anatomy, People's College of Medical Sciences and Research Centre, Bhopal.

2. Sternum from Autopsy bodies in the Department of Forensic Medicine and Toxicology, People's College of Medical Sciences and Research Centre, Bhopal.

Sampling procedure: The material for the present study consists of 65 sternum(46 Males and 19 Females).

All the sternum with inclusion criteria, which came for autopsy and those of dissection cadavers have been included in the study.

The sterna were removed from the cadavers by sectioning the costal cartilages just beside the costo-chondral junction.

The age of the deceased was obtained from the nearest relatives and police and was verified by necessary documents.

For estimation of age the elements of each sternum i.e. manubrium, body and xiphoid process were examined for their fusion. The manubrio-sternal and xiphi-sternal articulations and sternal segments were carefully examined for degree of fusion: complete / partial /absent.

Inclusion Criteria: Sterna without any obvious pathology above the age of 10 years.

Exclusion Criteria: Deformed, Diseased and Fractured sterna.

Evidence of Fusion: Longitudinal section of fresh bone At Manubrio-Corporal junction Full thickness creamy white cartilage at Manubrio-Corporal junction – No fusion Thinning of cartilage or complete disappearance of cartilage – evidence of fusion At Corpora- Xiphisternal junction by serial section of Xiphisternum from tip to the body – If cuts smoothly – No fusion Cuts with much resistance and grittiness – Evidence of ossification

RESULT

Fusion of sternum - Fusion of sternebrae starts at the age of 20 years in male and Fusion of sternebrae starts at the age of 20 years in female.

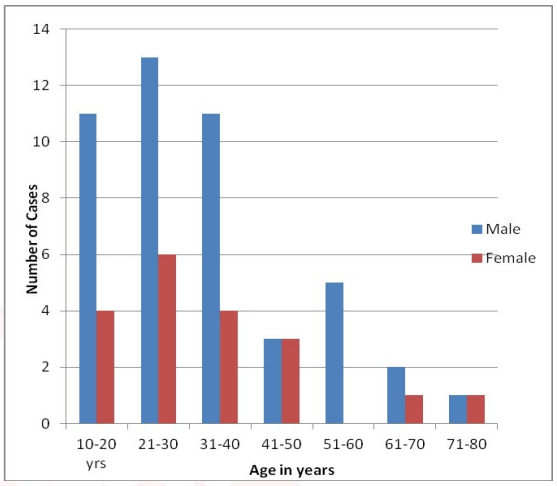
Fusion is completed at the age of 40 years in male and 45 years in female. If complete fusion in males, age is above 40 years and If complete fusion in females, age is above 45 years.

No opinion was possible from the incidence of 'no fusion'

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

Group	I	II	III	IV	V	VI	VII
Age(yrs)	10-20	21-30	31-40	41-50	51-60	61-70	71-80
Male	11	13	11	3	5	2	1
Female	4	6	4	3	0	1	1
Total	15	19	15	6	5	3	2

Graph 1: Showing age group wise and sex wise distribution of total cases.



Graph 2: Showing incidence of Total fusion cases, No Fusion and Partial Fusion age groupwise.

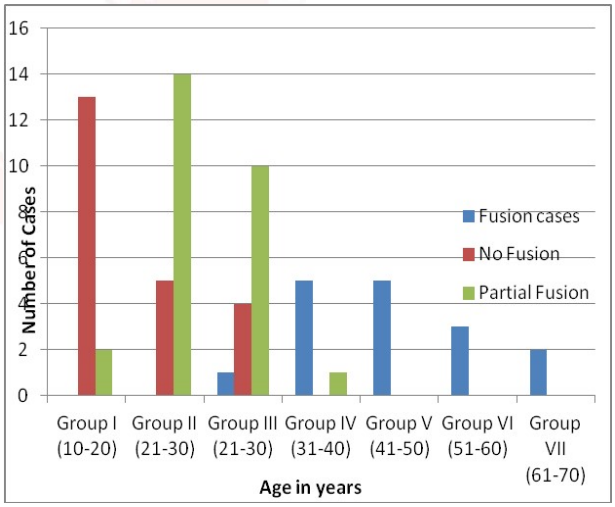


Fig. 1: Dry Sternum.

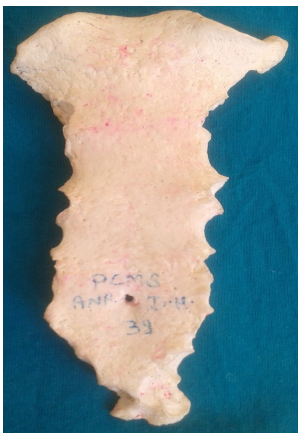


Fig. 2: Wet Sternum.

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

Group	Age of years	Fusion		Not Fused		Partial Fusion		Total
		Male	Female	Male	Female	Male	Female	
I	10-20	0	0	10/66.66%	3/20%	1/6.66%	1/6.66%	15
II	20-30	0	0	3/15.78%	2/10.52%	10/52.63%	4/21.05%	19
III	30-40	1/6.66%	0	2/13.33%	2/13.33%	8/53.33%	2/13.33%	15
IV	40-50	2/33.33%	3/50%	0	0	1/16.66%	-	6
V	50-60	5/100%	0	0	0	0	0	5
VI	60-70	2/66.66%	1/33.33%	-	-	-	-	3
VII	70-80	1/50%	1/50%	-	-	-	-	2

Table 3: Showing incidence of Total fusion cases / No fusion cases age groupwise in Number of case (Percent).

Group	Age in years	Fusion cases	No Fusion	Partial Fusion	Total
I	10-20	0	13(86.66%)	2(13.33%)	15
II	21-30	0	5(26.31%)	14(73.68%)	19
III	31-40	1(6.66%)	4(26.66%)	10(66.66%)	15
IV	41-50	5 (83.33%)	0	1(16.66%)	6
V	51-60	5(100%)	0	0	5
VI	61-70	3(100%)	0	0	3
VII	71-80	2(100%)	0	0	2

DISCUSSION

Table 4: Relation Between Fusion of Sternum & Age-Sex.

Age group (years)	Incidence	Complete				Partial				Absent			
		Jit I, Kaur H. 1989		Present Study		Jit I, Kaur H. 1989		Present Study		Jit I, Kaur H. 1989		Present Study	
		M	F	M	F	M	F	M	F	M	F	M	F
10-20	No.	0	0	0	0	14	7	-	-	23	8	10	3
21-30	No.	16	3	0	0	58	26	9	4	86	23	3	2
31-40	No.	9	3	1	0	32	17	9	2	70	10	2	2
41-50	No.	14	7	2	3	27	12	1	0	44	4	0	0
51-60	No.	9	-	5	-	12	-	0	0	20	-	0	0
>61	No.	4	-	3	2	12	-	0	0	13	-	0	0

Gautam R S, Shah G V, Jadav H R, Gohil B J(2003) they concluded fusion between third and fourth sternebrae was complete by 15 years. Between second and third sternebrae was complete by 21 years and between first and second sternebrae the fusion was complete by 21 years. The fusion of the different sternal elements takes place in relation to age, but is totally independent of the sex of the subject.

Regarding fusion of xiphoid process with body of sternum it was complete by 50 years.

Fusion of manubrium with body of sternum starts at the age of 40 and it is complete by 55 years[1].

In present study, the fusion of the different sternal elements takes place in relation to age, but is totally independent of the sex of the subject. Fusion of sternebrae starts at the age of 20 years in male and Fusion of sternebrae 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'.

Dr.Sobhan k. Das (2005) he concluded if there is fusion at Manubriocorporal junction (M+B) age

is above 28yrs, fusion at corporo-Xiphisternal (B+X) junction age may be above 32 yrs. and fusion at both the sites (M+B+X) means age above 36 yrs. No opinion is possible from the incidence of "NO FUSION". Therefore the Sternal data "Xiphisternum fuses with body at 40 yrs. and Manubrium fuses to the body by 60 yrs is not reliable and erratic[4].

In present study, Fusion of sternebrae starts at the age of 20 years in males as well as in females. 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'.

Vijay Kumar R, Waghmare (2012) concluded that if there is fusion at manubrium and body (M+B) the age is above 30 years. The Fusion of body and xiphisternum (B+X) the age is above 35 years and the Fusion of manubrium, body and xiphisternum (M+B+X) the age is above the 40 years. No opinion is possible from the incidence of the "no fusion"[3].

In present study, Fusion of sternebrae starts at the age of 20 years in male and Fusion of sternebrae 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.

Chandresh I. Tailor, Dharmesh Silajiya(2013) concluded that all four pieces of the body of sternum showed complete fusion with each other in majority of age group of 21-30 years in both sexes. The fusion of body segments of sternum in the present study was observed from below upwards i.e. starting from fourth segment to first segment and the fusion of Xiphoid process with the body of sternum was seen mostly in age of 40 years in both the sexes. The fusion of manubrium with the body of sternum was seen after 40 years and was complete by 60 years of age in both the sexes which suggests that manubrium fuses only in late advanced age. The gross fusion of manubrium sterna and Xiphoid process was observed a bit earlier than radiological fusion, but the difference of period was 2-3 years[6]. In present study, Fusion of sternebrae starts at the age of 20 years in male and fusion of sternebrae 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.

Manoharan C(2016) concluded that almost all cases above 21 years of age showed fusion between all segments of the body of the sternum. fusion of xiphoid with body occurs anywhere in between 32 – 60 years irrespective of sex [7]. In present study, Fusion of sternebrae starts at the age of 20 years in male and 20 years in female.

V B Gaur(2010) concluded that the fusion of xiphoid process and the manubrium sternum with the body has shown early fusion in age group 31-35 years where as in certain cases it has not fused even in more than 41 years age group[8]. In present study, Fusion of sternebrae starts at the age of 20 years in male and Fusion of sternebrae starts at the age of 20 years in female.

CONCLUSION

Fusion of sternebrae starts at the age of 20 years in male and Fusion of sternebrae 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'

Conflicts of Interests: None

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How to cite this article:

Rashmi Jaiswal. DETERMINATION OF AGE BY HUMAN STERNUM. Int J Anat Res 2018;6(3.2):5525-5530. **DOI:** 10.16965/ijar.2018.270