Estimation of age from human sternum-an autopsy study

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Abstract

Background & Objectives: Estimation of age in elderly person is often required in medico legal practice. Estimation of age in elderly person is comparatively more difficult than in young persons. The aim of the study was to determine the age of an individual from fusion of various parts of the sternum.

Methods: Sterna were obtained from 53 males and 47 females aged between 14 years to 75 years from known corpses during medico-legal autopsies at Tirunelveli Medical College, Tamilnadu, India by dissection and maceration of soft tissues.

Results: When the segments of the body of sternum are fused, the age of an individual should be above 21 years. If the manubrium and body of sternum is not fused, the age of the Individual is less than 35 years in males and less than 43 years in females. If the xiphoid process and body of sternum is fused, the age of the individual is more than 32 years in males and more than 40 years in females.

Interpretation: Age estimation from union of manubrium and xiphoid with the body of the sternum seem to be reliable where the sex is already determined. Fusion of segments of body of sternum is a more reliable in estimation of age of an individual irrespective of the sex.

Conclusions: This study proves that sternum is a reliable tool to estimate the age of a person.

Key words: Sternum, Fusion, Age, Identification.

Introduction

Identification connotes the determination or establishment of the individuality of a person living or dead. Most of the time forensic medicine specialists have to mainly depend upon the bones for establishing the identity. They are often required to estimate sex, age and stature of a person from dismembered body parts and bones. Sex, age and stature are very important criteria in establishing the identity of an individual. Other findings such as racial features, moles, scars professional marks and colour/complexion which are fairly permanent throughout life may also be useful in establishing the identity of a person.

Skeletal growth changes are orchestrated by a complicated interplay of genetic, environmental and cultural factors.[1] Human biology is simply not amenable to the precision of pure or exact science. In other words, it is not possible to formulate a uniform standard data based on skeletal changes. Countable differences are noticed in the appearance and fusion of ossification centres depending on race, geographic distribution, sex, food habits, nutritional status, infectious diseases, physical activity, hormonal and metabolic disorders.[2]

Growth changes in the skeleton, although a reliable basis for estimation of age, do not permit an exact determination, but only within a range.

The young individual has various factors for age estimation such as physical and morphological features, eruption of teeth, ossification activities and growth of bones which help in establishing the age with utmost accuracy. On the contrary, the elderly persons have very few identifying factors like fusion of skull sutures, changes that occur in the pubic symphysis, degenerative changes and application of Gustafson's formula (based on the ageing and decaying changes of teeth). Age estimation in elderly person has limitations due to paucity of anatomical factors.

Skeletal growth changes are the most important criteria for age estimation. Study of changes in skeleton with respect to age, serves as a reliable and time honoured method in medico-legal work. Biological phenomena other than skeletal changes are subject to wide variation. The present study is an earnest attempt to assess the age of an individual from one of the skeletal remains, namely the sternum which is one of the superficial bones, and is spared even in a highly decomposed body. Moreover, it is a bone which can be easily procured from cadavers, without the slightest damage during a routine autopsy procedure. So considering these factors, study of the sternum has been selected as an identifying unit of age.

Materials and Methods

Study was conducted on 100 Sterna collected from known corpses during medico-legal autopsies at

Tirunelveli Medical College, Tamilnadu, India which included 53 males and 47 females aged between 14years to 75 years. Sterna were removed by dissecting along the costo-chondral junction and disarticulating the sterno-clavicular joints.[3] The attached soft tissues were removed manually. Fractured bone, sternum from unknown dead bodies, cases where exact age is not known, diseased and deformed bones were excluded from the study.

The sternum consists of three parts from above downwards - the manubrium, the body and the xiphoid process. The manubrium and body meet at an angle-the sternal angle. Body of sternum consists of four sternebrae. Xiphoid process is continuous with the lower end of body forming the xiphisternal joint. Bones were studied with naked eye examination and observed for the fusion and non-fusion of various parts the sternum. The photographic evidence of fusion and non-fusion of various parts of the sternum has been shown in Fig. 1, 2, 3 and 4.

Osteometric parameters used for analysis
1. Between the various segments of the body
2. Between manubrium and the body
3. Between the xiphoid process and the body

Data collected were recorded, tabulated and analysed.

Observations and Results
The lowest age in this sample was 14 years and the highest age was 75 years. The maximum number of cases (38, 38%) was in the 20 to 29 age group. The lowest age was 15 years for males and 14 years for females, while the highest age for males and females was 75 and 60 respectively.

i. **Age from fusion of sternal components:** Age and sex-wise fusion and non-fusion of sternal components with the percentage of fusion have been given in the Tables 1, 2 and 3. Fusion between 1st and 2nd segments has started above the age of 16 years and reaches 100% by the age of 21 years. Fusion between 2nd and 3rd segments has started above the age of 16years but 100% fusion was achieved only above the age of 16years whereas fusion between 3rd and 4th segments might have started even below the age of 14 years but fusion was 100% above 14years irrespective of sex.

ii. **Age from fusion of body with xiphoid process:** Age and sex-wise fusion and non-fusion of body and xiphoid process with the percentage of fusion have been given in the Table 4. Fusion of xiphoid process with body was not observed below 32 years in both sexes. 22% of the Males showed fusion between 30-39 years of age group. No females showed fusion in the age group of 30–39 years. Fusion started in females from 40years of age group. 50% of fusion was observed among females between the age group of 40-49 years. Above the age of 40 years the

percentage of cases showing fusion were found to be steadily increasing with advancing age. The fusion was 100% from 60 years onwards irrespective of the sex.

iii. **Age from fusion of body with manubrium:** Age and sex-wise fusion and non-fusion of body and manubrium with the percentage of fusion have been given in the Table 5. Fusion of manubrium with body was not observed below 35 years in males and 43 years in females. 33.3% of cases in the age group of 60 -69 years showed fusion and 28.57% in the age group of 50 -59 years. Non fusion of these segments was observed even at 75 years in a male and 60 years in a female.

Fig. 1:Non-Fusion of Any Sternal Parts

Fig. 2: Fusion of segments of the body

Fig. 3: Fusion of body and xiphoid process

Fig. 4: Fusion of all sternal parts

Table 1: Fusion between 3rd & 4th segments of body (N=100)

Age	Fused			Not Fused			N	% showing fusion
	Male	**Female**	**Total**	**Male**	**Female**	**Total**		
10-19	5	8	13	1	0	1	14	92.85
20-29	18	20	38	0	0	0	38	100
30-39	10	8	18	0	0	0	18	100
40-49	11	8	19	0	0	0	19	100
50-59	5	2	7	0	0	0	7	100
60-69	2	1	3	0	0	0	3	100
70-79	1	0	1	0	0	0	1	100
Total	52	47	99	1	0	1	100	99

N= Number of Cases

Table 2: Fusion between 2nd & 3rd segments

Age	Fused			Not Fused			N	% showing fusion
	Male	**Female**	**Total**	**Male**	**Female**	**Total**		
10-19	4	7	11	2	1	3	14	78.57
20-29	18	20	38	0	0	0	38	100
30-39	10	8	18	0	0	0	18	100
40-49	11	8	19	0	0	0	19	100
50-59	5	2	7	0	0	0	7	100
60-69	2	1	3	0	0	0	3	100
70-79	1	0	1	0	0	0	1	100
Total	51	46	97	2	1	3	100	97

N= Number of Cases

Table 3: Fusion between 1st & 2nd segments

Age	Fused			Not Fused			N	% showing fusion
	Male	**Female**	**Total**	**Male**	**Female**	**Total**		
10-19	2	6	8	4	2	6	14	57.14
20-29	16	19	35	2	1	3	38	92.10
30-39	10	8	18	0	0	0	18	100
40-49	11	8	19	0	0	0	19	100
50-59	5	2	7	0	0	0	7	100
60-69	2	1	3	0	0	0	3	100
70-79	1	0	1	0	0	0	1	100
Total	47	44	91	6	3	9	100	91

Table 4: Fusion between xiphoid process & body of sternum

Age	Fused			Not Fused			N	% showing fusion
	Male	Female	Total	Male	Female	Total		
10-19	0	0	0	5	9	14	14	0
20-29	0	0	0	16	22	38	38	0
30-39	2	0	2	7	9	16	18	11.11
40-49	4	4	8	7	4	11	19	42.10
50-59	2	1	3	3	1	4	7	42.80
60-69	2	1	3	0	0	0	3	100
70-79	1	0	1	0	0	0	1	100
Total	11	6	17	38	45	83	100	17

Table 5: Fusion between manubrium & body of sternum

Age	Fused			Not Fused			N	% showing fusion
	Male	Female	Total	Male	Female	Total		
10-19	0	0	0	6	8	14	14	0
20-29	0	0	0	18	20	38	38	0
30-39	1	0	1	9	8	17	18	5.5
40-49	0	1	1	11	7	18	19	5.5
50-59	1	2	3	4	0	4	7	28.57
60-69	1	0	1	1	1	2	3	33.3
70-79	0	0	0	1	0	1	1	0
Total	3	3	6	50	44	94	100	6

Table 6: Results of previous & present studies on sternum

Author	Between sternebrae	Between Xiphoid & body	Between manurium and body
Douglas J.A.Kerr[6]	6th to 25th year	40 to 50 years	In advanced life
Ashley[7]	At childhood, puberty and at 21years	Middle age	Old age
Girdany and Golden[8]	4th and 3rd between 4 and 8 years, 2nd and 1st between 12 and 25 years	Old age	Old age
P.V.Guharaj[9]	between puberty and 25th year	40 years	Hardly unites except in old age
Modi[10]	From below upwards between 14 and 25 years	40 years	Hardly unites except in old age
Parikh.C.K[11]	From below upwards between 14 and 25 years	40 years	Hardly unites except in old age
M.K.R.Krishnan[12]	From below upwards between 14 and 25 years	40 years	Hardly unites except in old age
Present study	From below upwards between 14 and 21 years	35-43 years	Extremely variable

Discussion

The search for a method to determine the actual age of the skeleton at the time of death was started in the last century by anthropologists. The first method used by anthropologists for age determination was the closure of skull suture[4,5].

The results of previous and present studies on sternum have been given in the Table 3.

According to the present study, almost all cases above 21 years of age showed fusion between all segments of the body of the sternum. No difference could be observed between males and females in the age of fusion of sternebrae. This observation seems to confirm the following previous studies with negligible variations[13,14,15,16].

Fusion between xiphoid process with body of the sternum was not observed below 32 years in males and below 40 years in females. Hence fusion of xiphoid with body occurs anywhere in between 32 – 60 years irrespective of sex. This observation is in good agreement with the following Previous studies.[17,18,19]

The fusion of manubrium with body of sternum was not observed below 35 years in males and below 43 years in females but it does not fuse even in extreme old age. This observation again seems to confirm the previous studies[20,21].

Conclusions

The distinctiveness of an individual depends and varies as per provincial and biological variations. This fact has been verified in the past and in this present study. Hence, the strongest suggestion that has been derived from this study is that, regional wise in depth studies are essential in assessing the age. However, this study demonstrates that sternum is one of the perfect means in estimation of the age of an individual.

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