

# Using Multi-Slice Computed Tomography In Age Estimation Based on the Fusion of the Sternal Elements among Group of Egyptian Subjects

Eman Ahmed Alaa El-Din, Heba El Sayed Mostafa and Sameh Saber<sup>1</sup>

<sup>1</sup> Departments of Forensic Medicine & Clinical Toxicology and Radiodiagnosis, Faculty of Medicine, Zagazig University, AL Sharqia, Egypt.

## Abstract

**Objectives:** Determination of age from human skeletal remains for forensic and medico-legal purpose is an important matter in civil and criminal cases. Radiological examination of sternum especially fusion of sternal segments offer considerable help. Computed tomography (CT) is rapidly becoming the gold standard for analysis of skeletal and dental development in both clinical and increasingly, in forensic practice. The purpose of the present study was to estimate age from the assessment of the degree of fusion of xiphoid process and manubrium with mesosternum using the utility of multi-slice C T. **Subjects and Methods:** The study includes 100 subjects consisting of 49 males and 51 females. The age groups included in the study ranged from 30 to 60 years (yrs). The fusion status of xiphoid process and manubrium with the mesosternum were evaluated for degree of fusion: complete, partial, absent by using multislice CT scan. **Results:** fusion of xiphoid with mesosternum *In male and female groups*, began after 30 yrs of age but the fusion was not complete within 30 to 40 yrs. From 45 up to 55 yrs, closure was invariable with different degrees. From the age of 55 up to 65 yrs, all subjects showed complete fusion. Complete fusion started earlier in female group (at 35 to 40 yrs) than in male group that began (at 40 to 45 yrs). While fusion of manubrium with mesosternum *in male group* began after 45 yrs of age. The fusion was invariable in the age from 50 up to 60 yrs old. From the age of 60 to 65 yrs all subjects showed complete fusion. *In female group* partial fusion began from 40 up to 45 yrs of age. In the age from above 45 to 60 yrs the fusion was invariable. From the age of 60 to 65 yrs all subjects showed complete fusion. It was also noticed that partial fusion started earlier in female group (at 40 yrs) than in male group that began (at 45 yrs). **Conclusion:** From the previous results it can be concluded that applying multi-slice CT- based age diagnostics assessment of the degree of fusion of the xiphoid process and manubrium with mesosternum could be helpful in estimation of age. The fusion of the xiphoid process with the mesosternum began after the age of thirty. The fusion was present in uneven degrees up to the age of forty-five. In most of subjects the fusion is complete after the age of fifty. The fusion of the manubrium with the mesosternum began after the age of forty. The fusion was present in varying degrees in subjects above fifty five years. Complete fusion, when present, occurs after the age of fifty. All these data could be helpful in determination of age from sternal bone.

## Keywords

Age estimation, sternum, manubrium, xiphoid, multislice CT scan.

## Introduction

Age estimation of unidentified human skeletal remains is one of the many objectives, required to be achieved not only in forensic practice but also in physical anthropology for the

purposes of identification. The changes of developmental processes like epiphyseal-diaphyseal union, as well as those of the degenerative processes like dental attrition are useful for estimation of age of

such skeletal remains. Both these developmental and degenerative processes affect different anatomical structures of the human body at different stages of life in a more or less regular and recognizable pattern depending on the stage of life and the anatomical region being observed (Singh & Chavali, 2011).

Determination of age is an important forensic matter in many civil and criminal cases. It could be difficult for doctors to assess the age with reasonable degree of error (Gupta et al., 2007). Different aging methods are available for different anatomical regions of the human body like dentition, epiphyseal diaphyseal union, cranial suture closure, morphology of the auricular surface of ilium, fusion of sternal and sacral elements and phase analysis of sternal end of ribs; but due to destructive taphonomic processes, few or none of these age diagnostic features of bones may be available for analysis in archaeological, palaeontological or forensic materials, thus making it essential to develop reliable aging methods (Menezes et al., 2011).

Sternum has been used by researchers for estimation of sex and stature and to provide valuable clues on the age of the deceased. A sternum comprises of three distinct parts: a manubrium superiorly, a mesosternum or the main body in the middle, and a xiphoid process placed inferiorly. The manubrium joins with mesosternum by a primary or secondary cartilaginous joint (manubrio-mesosternal junction), and the xiphoid similarly unites with the mesosternum by either a primary or a secondary cartilaginous joint (mesosterno-xiphisternal junction). The ossification of human skeleton follows definite timings of appearance as well as fusion. Age estimation from sternum is, thus, based upon the analysis of the fusion of manubrium with mesosternum and fusion of xiphoid with mesosternum as well on the morphological characteristics of sternum (Atal et al., 2008).

In the past 10 years, publications regarding forensic imaging have increased dramatically. This reflects the increasing number of forensic institutes with an associated radiological facility including a computed tomography (CT) and/or a magnetic resonance imaging (MRI) scanner (Tangmose et al., 2013).

Radiological examination of sternum especially fusion of sternal segments, fusion of manubrium and xiphoid process with mesosternum offer considerable help. However, traditional or digital X-rays have limitations like one have to take more than one views and there is always possibility of overlapping of the thoracic tissue shadow (Tailor et al., 2013).

Computed tomography (CT) is preferred than conventional radiography for identification and age determination. It also provides a clear appreciation of the anatomical areas of interest without the inconvenience of superimposition of other structures which can compromise accurate interpretation, and is capable of

discerning finer detail than is possible with conventional radiography (O'Donnell et al., 2011).

The present study aimed to estimate the age from the assessment of the degree of fusion of the xiphoid process and manubrium with mesosternum using the means of multi-slice CT scan.

## Subjects and Methods

One hundred C T examinations, with proven age chronological ranging from (30 to 6<sup>o</sup> yrs) originally obtained from patients who were referred for thoracic CT examination for various clinical reasons at the period between July 2013 and June 2014 then examined retrospectively. Since the Multidetector computed tomography (MD.CT.) scans emerged during thoracic CT examination diagnostic procedures at the out private clinics.

## Ethical consideration of the study

The following study was approved by the local Ethics Committee of Faculty of Medicine and radiology center manager. Also, confidentiality of the patient's records were kept.

## Exclusion criteria

Computed tomography images of Patient having thoracic skeletal deformity, trauma or any diseases affecting skeletal development and whose ages below 30 or above 65 years old were excluded from the study.

This study group consisted of 51 female and 49 male subjects, aged between 30 and 65 years that permitted reliable examination. The xiphisternal and manubrio-sternal regions were carefully visualized by utilizing spiral multislice CT machine (Philips Inguinity 128 slice CT) and 4-row (MDCT) system (Toshiba Astion - Japan). Technical settings, 120 kV, reference mAs 120-200 using Care Dose, pitch 1.3, collimation 0.6, reconstruction increment 1.0, kernel B50f. Due to the fact that all the scans analyzed were based on high resolution thin-slice MDCT imaging, it can be assumed that the scans provided a comparable and sufficient image quality with regard to the evaluation of osseous structures.

The CT images were evaluated on screen using a workstation. The material was viewed in axial, coronal and sagittal images, multi-planar reconstruction (MPR) and maximum intensity projection (MIP) techniques. The fusion status of xiphoid process and manubrium with the mesosternum were evaluated by using the classification stages of Kaneriyia et al. (2013) as follow:

Grade I: Non fusion

Grade II: Partial fusion

Grade III: Complete fusion.

**Table (1): Chronological age distribution of male and female subjects examined in the study (no=100).**

Chronological age (years)	Female		Male	
	No.	%	No.	%
30-	10	19.6	10	20.4
35-	5	9.8	7	14.3
40-	7	13.7	9	18.4
45-	9	17.6	8	16.3
50-	6	11.8	7	14.3
55-	6	11.8	6	12.2
60–65 yrs	5	9.8	3	6.1
Total	51	100.0	49	100.0

## Results

The present study includes 100 subjects consisting of 49 male and 51 female. The age groups included in the study ranged from 30 yrs to 65 yrs (Table-1).

### a) Fusion status of xiphoid process with the mesosternum in male and female groups respectively (Table-2,3)

**In male group**, it was observed that fusion began after 30 yrs of age (30% of subjects showed partial fusion and 70% without any fusion (figure-1). In the age from above 35 to 40 yrs (28.8% of subjects showed partial fusion and 71.4% without any fusion). In the age from above 40 to 45 yrs 55.6% subjects had complete fusion between xiphoid and mesosternum (figure-3) while 33.3% showed partial fusion and non-fusion in 11.1%. In the age from above 45 up to 50 yrs, 75% of subjects showed complete fusion while only 25% with partial fusion. At the age from above 50 up to 55 yrs, 71.4% of subjects showed complete fusion, 14.3% partial fusion and 14.3% appeared without any fusion. From the age of 55 up to 65 yrs, all subjects (100%) showed complete fusion (Table-2) (figure-3).

There was a high significant difference ( $p < 0.01$ ) at age group 55-60 yrs, while, there was a significant difference ( $p < 0.05$ ) at age group 30-35, 35-40, 45-50, 50-55 & 60-65 yrs and there was no significant difference ( $p > 0.05$ ) at age group 40-45 yrs (Table- 2).

**In female group** it was noted that fusion began after 30 yrs of age (20% of subjects showed partial fusion and 80% without any fusion). In the age group from above 35 to 40 yrs, 20% of subjects showed complete fusion, 60% with partial fusion and 20% without fusion. In the age group from above 40 to 45 yrs, 28.6 % of subjects showed complete fusion, 57.1% with partial fusion (figure-2) and 14.3 % without fusion. In the age group from above 45 to 50 yrs, 66.7% of cases showed complete fusion, 25.0 % with partial fusion and 12.5 % without fusion. In the age group from above 50 to 55 yrs, 83.3% of cases showed complete fusion, 16.7% with partial fusion and

14.3% without any fusion. From the age of 55 to 65 yrs all subjects showed complete fusion 100% (Table-3).

There was a high significant difference ( $p < 0.01$ ) at age group 30-35, 55-60 & 60-65 yrs. Also, there was a significant difference ( $p < 0.05$ ) at age group 45-50, 50-55 yrs. While, there was no significant difference ( $p > 0.05$ ) at age group 35-40 & 40-45 yrs (Table-3).

### b) Fusion status of manubrium with the mesosternum in male and female respectively (Table-4,5)

**In male group**, fusion couldn't be detected from the age of 30 up to 40 yrs. Fusion began after 45 yrs of age (12.5% with partial fusion (figure-5) and 87.5% without fusion). In the age from above 50 to 55 yrs, 16.7 % of subjects had complete fusion between manubrium and mesosternum while 50% showed partial fusion and 33.3 % without fusion. In the age group from above 55 to 60 yrs, 50.0 % of subjects showed complete fusion, 33.3 % with partial fusion and 16.7% without any fusion. From the age of 60 to 65 yrs, all subjects (100%) showed complete fusion (Table-5) (figure-6)

There was a high significant difference ( $p < 0.01$ ) at age group 30-35, 35-40, 40-45, 45-50 yrs. Also, there was a significant difference ( $p < 0.05$ ) at age group 60-65 yrs while, there was no significant difference ( $p > 0.05$ ) at age group 50-55 & 55-60 yrs (Table-5).

**In female group** it was noted that fusion delayed up to 40 yrs (figure-4). Partial fusion (14.3%) began from 40 up to 45 years of age (figure-7). In the age from above 45 to 50 years 25% of subjects showed partial fusion and 75.0% without fusion. Complete fusion (33.3%) started at the age of 50 up to 55 years that also showed partial fusion in 66.7% of subjects. In the age group from above 55 to 60 years, 50.0 % of subjects showed complete fusion, 50.0 % with partial fusion. From the age of 60 to 65 years all cases showed complete fusion 100% (Table-6).

There was a high significant difference ( $p < 0.01$ ) at age group 30-35, 35-40, 45-50, 60-65 yrs. Also, there was a significant difference ( $p < 0.05$ ) at age group 40-45, 50-55 yrs and there was no significant difference ( $p > 0.05$ ) at age 55-60 yrs (Table-6).

All the subjects below the age of the 40 yrs did not show either complete or partial fusion of the manubrium with mesosternum. In cases above 45 yrs of age, pattern of fusion is tabulated as shown in (Table 5 & 6). No subject had been recorded with complete fusion below 50 yrs of age. While above 60 yrs fusion was complete (figure-8). There was no significant difference between males and females groups as regard fusion status of xiphoid process or manubrium with the mesosternum in all age groups (Table 4 & 7)

**Table-2: Chi-Square statistical analysis (X<sup>2</sup>-test) of fusion status in males (xiphoid with the mesosternum) at different age groups of the study.**

Age group	No of subjects showing fusion							X2	P.value
	No of cases	Complete		Partial		Absent			
		No.	%	No.	%	No.	%		
30-	10	0	0.0	3	30.0	7	70.0	11.1	0.004*
35-	7	0	0.0	2	28.8	5	71.4	8.14	0.017
40-	9	5	55.6	3	33.3	1	11.1	4.0	0.135
45-	8	6	75.0	2	25.0	0	0.0	10.5	0.005
50-	7	5	71.4	1	14.3	1	14.3	6.86	0.032*
55-	6	6	100.0	0	0.0	0	0.0	18.0	<0.001**
60 – 65	3	3	100.0	0	0.0	0	0.0	9.0	0.011*
Total	49	25	51.0	11	22.4	13	26.5		

P value of > 0.05 = Non-Significant .P value of < 0.05 = Significant (\*). P value of < 0.01= Highly Significant (\*\*).

**Table-3: Chi-Square statistical analysis (X<sup>2</sup>-test) of fusion status in females (xiphoid with the mesosternum) at different age groups of the study.**

Age group	No of subjects showing fusion							X2	P.value
	No of cases	Complete		Partial		Absent			
		No.	%	No.	%	No.	%		
30-	10	0	0.0	2	20.0	8	80.0	15.6	<0.001**
35-	5	1	20.0	3	60.0	1	20.0	2.4	0.301
40-	7	2	28.6	4	57.1	1	14.3	3.0	0.223
45-	9	6	66.7	2	25.0	1	12.5	7.0	0.03*
50-	6	5	83.3	1	16.7	0	14.3	10.5	0.005*
55-	6	6	100.0	0	0.0	0	0.0	18.0	<0.001**
60 – 65	5	5	100.0	0	0.0	0	0.0	15.0	<0.001**
Total	51	27	52.9	13	25.5	11	21.6		

P value of > 0.05 = Non-Significant P value of < 0.05 = Significant (\*). P value of < 0.01= Highly Significant (\*\*).

**Table-4: Chi-Square statistical analysis of fusion status (xiphoid with the mesosternum) in males and females at different age groups of the study.**

Age group	No of subjects showing fusion						P.value
	Complete		Partial		Absent		
	Male No.(%)	Female No.(%)	Male No.(%)	Female No.(%)	Male No.(%)	Female No.(%)	
30-	0(0.0)	0(0.0)	3(30.0)	2(20.0)	7(70.0)	8(80.0)	0.605
35-	0(0.0)	1(20.0)	2(28.8)	3(60.0)	5(71.4)	1(20.0)	0.162
40-	5(55.6)	2(28.6)	3(33.3)	4(57.1)	1(11.1)	1(14.3)	0.549
45-	6(75.0)	6(66.7)	2(25.0)	2(25.0)	0(0.0)	1(12.5)	0.623
50-	5(71.4)	5(83.3)	1(14.3)	1(16.7)	1(14.3)	0(0.0)	0.628
55-	6(100.0)	6(100.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	-----
60 – 65	3(100.0)	5(100.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	-----
Total	25(51.0)	27(52.9)	11(22.4)	13(25.5)	13(26.5)	11(21.6)	

---- =invalid test, P value of > 0.05 = Non-Significant

**Table-5: Chi-Square statistical analysis (X<sup>2</sup>-test) of fusion status in males (manibrium with the body) at different age groups of the study.**

Age group	No of cases	No of subjects showing fusion						X2	P.value
		Complete		Partial		Absent			
		No.	%	No.	%	No.	%		
30-	10	0	0.0	0	0.0	10	100.0	30.0	<0.001**
35-	7	0	0.0	0	0.0	7	100.0	21.0	<0.001**
40-	9	0	0.0	0	0.0	9	100.0	27.0	<0.001**
45-	8	0	0.0	1	12.5	7	87.5	16.13	<0.001**
50-	6	1	16.7	3	50.0	2	33.3	1.5	0.472
55-	6	3	50.0	2	33.3	1	16.7	1.5	0.472
60 – 65	3	3	100.0	0	0.0	0	0.0	9.0	0,011*
Total	49	7	14.3	6	12.2	36	73.5		

P value of > 0.05 = Non-Significant . P value of < 0.05 = Significant (\*). P value of < 0.01= Highly Significant (\*\*).

**Table-6: Chi-Square statistical analysis (X<sup>2</sup>-test) of fusion status in female (manibrium with the body) at different age groups of the study.**

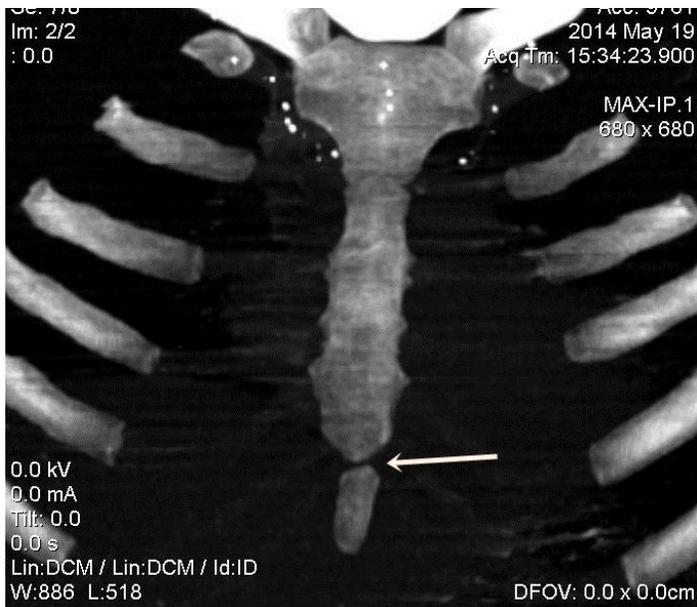
Age group	No of cases	No of subjects showing fusion						X2	P.value
		Complete		Partial		Absent			
		No.	%	No.	%	No.	%		
30-	10	0	0.0	0	0.0	10	100.0	30.0	<0.001**
35-	5	0	0.0	0	0.0	5	100.0	15.0	<0.001**
40-	7	0	0.0	1	14.3	6	85.7	13.29	0.001*
45-	12	0	0.0	3	25.0	9	75.0	15.75	<0.001**
50-	6	2	33.3	4	66.7	0	0.0	6.0	0.049*
55-	6	3	50.0	3	50.0	0	0.0	4.5	0.105
60 – 65	5	5	100.0	0	0.0	0	0.0	15.0	<0.001**
Total	51	10	19.6	11	21.6	30	58.8		

P value of > 0.05 = Non-Significant . P value of < 0.05 = Significant (\*). P value of < 0.01= Highly Significant (\*\*).

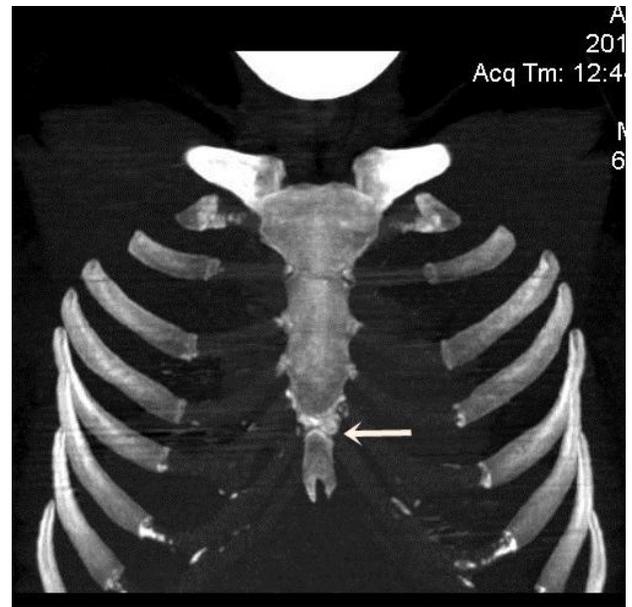
**Table-7 : Chi-Square statistical analysis of fusion status (manibrium with the body) in males and females at different age groups of the study.**

Age group	No of subjects showing fusion						P.value
	Complete		Partial		Absent		
	Male No.(%)	Female No.(%)	Male No.(%)	Female No.(%)	Male No.(%)	Female No.(%)	
30-	0(0.0)	0(0.0)	0(0.0)	0(0.0)	10(100.0)	10(100.0)	-----
35-	0(0.0)	0(0.0)	0(0.0)	0(0.0)	7(100.)	5(100.0)	-----
40-	0(0.0)	0(0.0)	0(0.0)	1(14.3)	9(100.0)	6(85.7)	0.241
45-	0(0.0)	0(0.0)	1(12.5)	3(25.0)	7(87.5)	9(75.0)	0.493
50-	1(16.7)	2(33.3)	3(50.0)	4(66.7)	2(33.3)	0(0.0)	0.289
55-	3(50.0)	3(50.0)	2(33.3)	3(50.0)	1(16.7)	0(0.0)	0.548
60 – 65	3(100.0)	5(100.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	-----
Total	7(14.3)	10(19.6)	6(12.2)	11(21.6)	36(73.5)	30(58.8)	

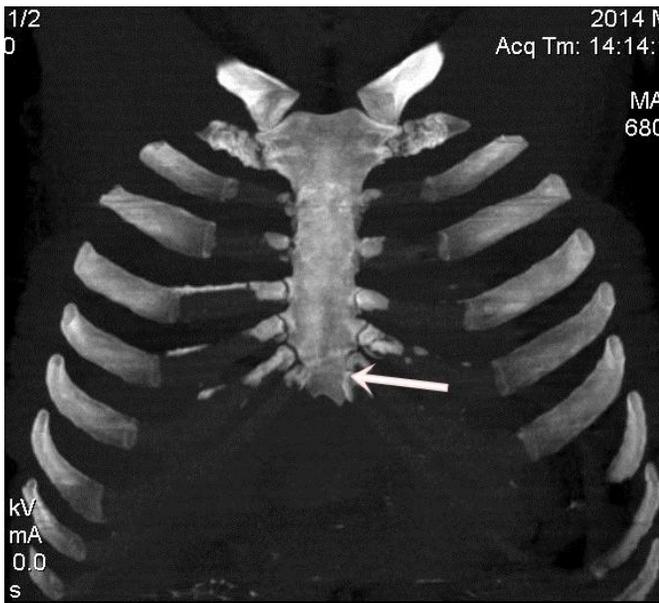
-----=invalid test, P value of > 0.05 = Non-Significant



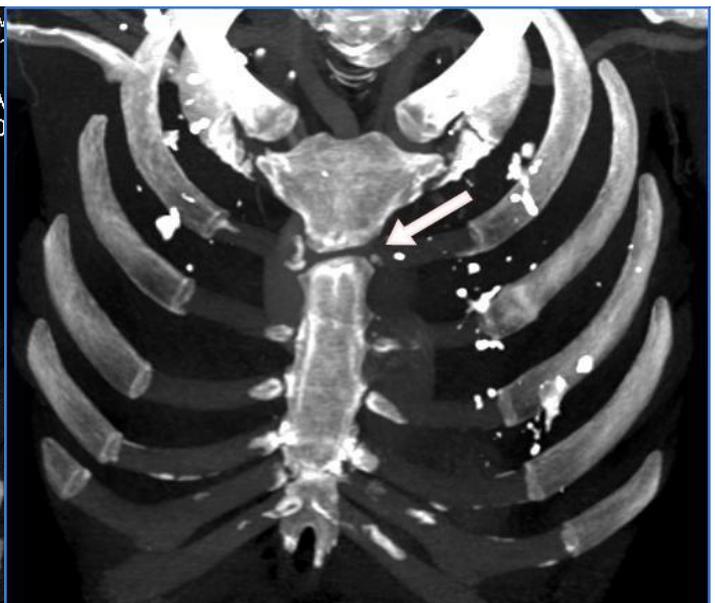
**Figure -1: MIP CT Image (Frontal views) of 35 years old male showing non-fused xiphoid process and mesosternum.**



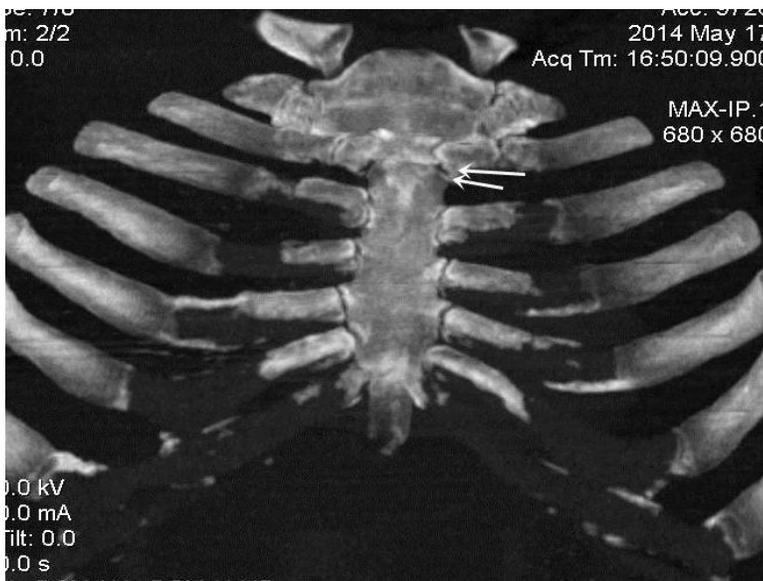
**Figure -2: MIP CT image (Frontal views) of 43 years old female showing partial fusion of xiphoid process and mesosternum**



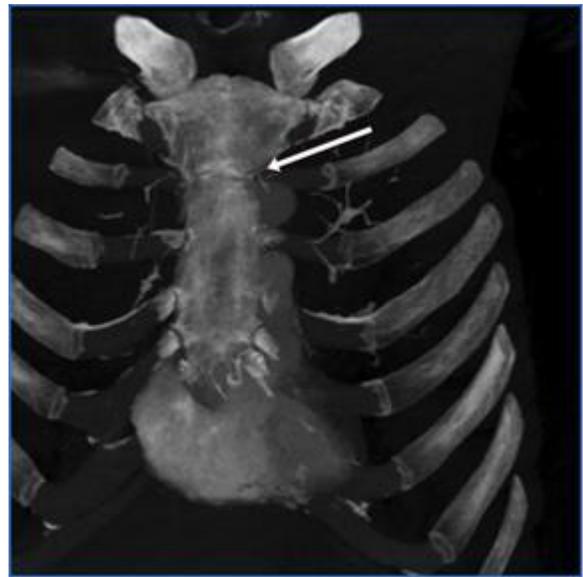
**Figure -3: MIP CT image of (Frontal views) 63 years old male showing complete fusion between xiphoid and mesosternum .**



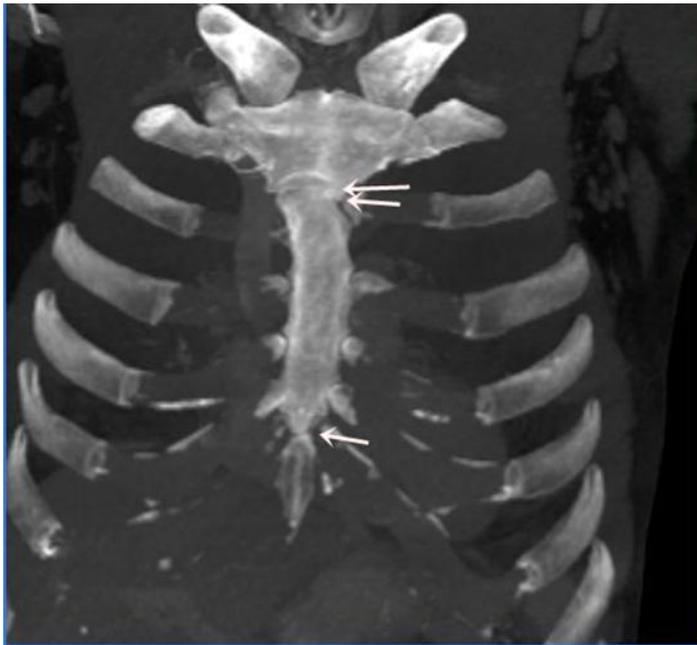
**Figure -4: MIP CT Image (Frontal views) of female 39 years showed non fusion between manubrium and mesosternum**



**Figure -5: MIP CT Image ( Frontal views) of 47 years old male showing partial fusion between manubrium and mesosternum .**



**Figure -6: MIP CT image ( Frontal views) of 62 years old male showing complete fusion between manubrium and mesosternum.**



**Figure -7: MIP CT image ( Frontal views) of 43 years old female showing partial fusion at both xiphoid and manubrium (arrow) as well as the manubrium with mesosternum (double arrow).**



**Figure -8 : MIP CT image ( Frontal views) of 65 years old male showed complete fusion at both xiphoid and manubrium (arrow) as well as the manubrium with mesosternum (double arrow).**

### Discussion

Verification or determination of the age is prerequisite for personal identification in living as well as dead.

Age estimation is one of the important tasks for a medico-legal practice (Singh and Pathak, 2013).

There is an increasing need for some other strong criteria to accurately determine the age in middle and old age groups. Due to extreme variability in time period of closure of the sutures of cranial vault and lipping of lumbar vertebra, they cannot be considered dependable for precise age estimation. In comparison, radiological examination of sternum is easy and applicable to both dead as well as living. So, fusion of xiphisternum with body of sternum and fusion of manubrium with the body of sternum can serve as an important tool for age estimation in middle and old aged persons (Wadhawan et al., 2010).

Study of sternum as an individual parameter for determination of age and sex has been attempted by various studies. 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. Then it was followed by Dwight (1890) and Ashley (1956) (Gautam et al., 2003).

**a) As regard fusion status of xiphoid process with the mesosternum in male and female groups respectively**

The result of the present study showed that, *in male and female groups*, the fusion of xiphoid with mesosternum began after 30 yrs of age but the fusion was not complete within 30 to 40 yrs. From 45 up to 55 yrs, closure was invariable with different degrees. From the age of 55 up to 65 yrs, all subjects showed complete fusion. It was also noticed that complete fusion between xiphoid process and mesosternum started earlier in female group than in male group (at 35 to 40 yrs & 40 to 45 yrs respectively).

Garg et al. (2011) observed during X- ray examination of group of Indian population, that the earliest age of fusion of xiphoid process with body of the sternum was 36 & 35 yrs for males & females respectively. The latest age of fusion of xiphoid process with body of the sternum was 59 & 56 yrs in males & females respectively. The average age of fusion of the xiphisternum with the body of the sternum is 50.04 yrs in males & 46.42 yrs in females. They concluded that at the age group of 40-50 years, only 50% of population is showing fusion at Xiphisternal Joint by lateral view radiography. In rest of 50% of population, still the fusion is incomplete.

Also, Wadhawan et al. (2010) had examined 100 subjects brought to post mortem examination in the Department of Forensic Medicine Hardinge Medical College, Delhi. They concluded that the fusion between sternum and the xiphoid process is absent in all the cases up to thirty years of age and fusion of the xiphoid process with the body of sternum began after the age of thirty years. The fusion almost invariably continues up to the age of 45 years, as no sterna was

Umap et al. (2013) had conducted prospective study at Department of Radiodiagnosis Government medical College and Hospital Miraj using the utility of spiral multislice CT. They considered that the fusion of xiphoid with sternum, in both genders began after 30 years of age but it was not complete. By the age of 40 years all women showed fused xiphoid with sternum whereas in the age group of 41 to 45 years about 71.42% men had complete fusion while 28.56% had partial fusion. Since the study had included subjects up to 45 years of age therefore the maximum age at which all subjects would show complete fusion is not known. Similarly in the age group of 36 to 40 years of age, about 14.28% of men showed non-fusion. Thus it can be considered that in women the fusion occurs at 40 years while in majority of men it occurs between 41 to 45 years of age.

**b) As regard fusion status of manubrium with the mesosternum in male and female groups respectively**

The result of the present study showed that in *male group*, fusion couldn't be detected from the age of 30 up to 40 yrs. Fusion began after 45 yrs of age. The fusion was invariable in the age from 50 up to 60 yrs old. From the age of 60 to 65 yrs all subjects showed complete fusion. *In female group*, it was noted that fusion delayed up to 40 yrs. Partial fusion began from 40 up to 45 yrs of age. In the age from above 45 to 60 yrs the fusion was invariable. From the age of 60 to 65 yrs all subjects showed complete fusion. It was also noticed that partial fusion started earlier in female group than in male group (at 40 years & 45 yrs respectively).

Recently, Silajiya et al. (2013) had studied x-ray films of group of Punjab population. The study showed that amongst males, up to 49 years of age, majority did not show even starting up of process of fusion between manubrium and body of the sternum. Between the ages of 50 to 58 years, a high number of subjects were showing that the gap between joint began to decrease. At the ages of 59 and above plenty of cases are showing complete fusion at manubrio-sternal joint. This suggest that the fusion at manubrio-sternal starts at the age of 50 years and it completes after the age or 59 years but the exact age for complete fusion at manubrio-sternal joint could not be defined. Amongst females, the cases showing partial fusion are seen increasing from the age of 54 years and complete fusion after the age of 64 years.

Further more Gautam et al. (2003) had examined 100 sternum, obtained from the cadavers brought for medico-legal post-mortem examination at Ahmedabad. They found that all the cases below the age of the 40 years did not show either complete or partial fusion of the manubrium and the body of the sternum. No case has been recorded with complete fusion below 50 years of age. Above 55 years fusion is complete/partial in all.

## Conclusion

From the previous results it can be concluded that applying multi-slice CT- based age diagnostics assessment of the degree of fusion of the xiphoid process and manubrium with mesosternum could be helpful in estimation of age. The fusion of the xiphoid process with the mesosternum began after the age of thirty. The fusion was present in uneven degrees up to the age of forty-five. In most of subjects the fusion is complete after the age of fifty. The fusion of the manubrium with the mesosternum began after the age of forty. The fusion was present in varying degrees in subjects above fifty five years. Complete fusion, when present, occurs after the age of fifty. All these data could be helpful in determination of age from sternal bone.

Owing to the findings of the present and referred studies, it is recommended to do further studies using the parameters mentioned in this study on greater sector of the Egyptian population to get a radiometric standard specific for them so as to achieve reference data usable in age estimation practice.

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## الملخص العربي

# استخدام الأشعة المقطعية متعددة المقطع في تقدير العمر اعتمادا على حالة إلتحام أجزاء عظام القص في مجموعة من المصريين

إيمان أحمد علاء الدين و هبة السيد مصطفى و سامح صابر<sup>١</sup>

تقدير العمر من بقايا الهياكل العظمية البشرية يستخدم لخدمة الطب الشرعي و الذي يعتبر عاملا مهما في العديد من القضايا المدنية والجنائية. و إن الفحص الإشعاعي لعظمة القص خاصة الإلتحام بين اجزائها قد ساهم بالكثير من المساعدات في هذا المجال. و سرعان ما اصبح التصوير بالأشعة المقطعية معيارا رئيسيا وهاما في فحص الهيكل العظمى و الأسنان في الكثير من الممارسات الطبية السريرية و الشرعية. و كان الغرض من هذه الدراسة تقدير العمر عن طريق فحص درجة الإلتحام بين التواء الخنجري و قبضة القص و بين جسم عظمة القص باستخدام الأشعة المقطعية.

**الحالات و الطرق المستخدمة:** أشتملت الدراسة على ١٠٠ شخص ( ٤٩ من الذكور و ٥١ من الاناث). و الفئات العمرية في هذه الدراسة تراوحت ما بين ٣٠ إلى فوق ٦٥ سنة. و قد تم تقييم حالة الإلتحام في عظمة القص لثلاث مراحل; التحام كامل أو جزئي أو غير ملتحم باستخدام التصوير بالأشعة المقطعية.

**النتائج:** يبدأ الإلتحام بين التواء الخنجري و جسم عظمة القص في مجموعات الذكور و الاناث بعد سن الثلاثين و لكنه يكون غير مكتمل بين سن الثلاثين و الاربعين. بينما يلاحظ درجات مختلفة من الإلتحام في الأعمار من ٤٥ و حتى ٥٥ سنة. و يكون الإلتحام كاملا في الأعمار بين ٥٥ و حتى ٦٥ سنة. حيث يبدأ الإلتحام الكامل في الظهور في مجموعة الاناث (من ٣٥ و حتى ٤٠ سنة) في وقت سابق عنه في مجموعة الذكور (من ٤٠ و حتى ٤٥ سنة). بينما يبدأ الإلتحام بين قبضة القص و جسم عظمة القص في مجموعة الذكور بعد ٤٥ سنة و يلاحظ درجات مختلفة من الإلتحام في الأعمار ما بين ٥٠ حتى ٦٠ سنة. و لوحظ ان الأشخاص في العمر ما بين ٦٠ حتى ٦٥ يكون الإلتحام كاملا. بينما في مجموعة الاناث يكون الإلتحام جزئي بدء من عمر ٤٠ حتى ٤٥ سنة و يكون الإلتحام بدرجات مختلفة في الأعمار أكثر من ٤٥ الى ٦٠ سنة. و يكون الإلتحام كاملا في الأعمار ما بين ٦٠ حتى ٦٥ سنة. كما لوحظ أن الإلتحام الجزئي بدأ في وقت سابق في مجموعة الأناث (٤٠ سنة) عنه في مجموعة الذكور (٤٥ سنة).  
**الاستنتاج:** و يتبين من النتائج السابقة انه يمكن تطبيق التصوير بالأشعة المقطعية لتحديد العمر اعتمادا على فحص درجة الإلتحام بين التواء الخنجري و قبضة القص و بين جسم عظمة القص. يبدأ الإلتحام بين عظمة التواء الخنجري و جسم عظمة القص بعد سن الثلاثين و يكون الإلتحام موجود بدرجات متفاوتة حتى سن ٤٥ و يكون الإلتحام كامل في معظم الحالات بعد سن الخمسين و بينما يبدأ التحام عظمة قبضة القص و جسم عظمة القص بعد سن الاربعين و يظهر الإلتحام بدرجات متفاوتة فوق سن ٥٥ سنة ولا يظهر الإلتحام الكامل الا بعد سن الخمسين.

<sup>١</sup> أقسام الطب الشرعي و السموم الإكلينيكية والأشعة التشخيصية -كلية الطب البشري - جامعة الزقازيق