www.jmscr.igmpublication.org
Impact Factor 5.244
Index Copernicus Value: 83.27
ISSN (e)-2347-176x ISSN (p) 2455-0450
crossref DOI: https://dx.doi.org/10.18535/jmscr/v5i1.39

IGM Publication
Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

Determination of Age by Studying Radiological Fusion of Cranial Sutures and Sternum in Living Persons between the Fourth and Seventh Decade

Authors
Dr Imran Shaikh[1], Dr Santosh Kumar[2], Dr Gyan Prakash Gaur[3], Dr P.C.Vyas[4]
[1]Senior Resident, Dept of Forensic Medicine & Toxicology, Dr. S.N. Medical College, Jodhpur, Rajasthan
[2]Senior Demonstrator, Dept of Forensic Medicine & Toxicology, Dr. S.N. Medical College, Jodhpur, Rajasthan
[3]Sr. Demonstrator, Dept of Forensic Medicine & Toxicology, Dr. S.N. Medical College, Jodhpur, Rajasthan
Email: *gaurgp@gmail.com, Mobile no.: 9829345597*
[4]Professor & H.O.D., Department of Forensic Medicine, Dr. S.N. Medical College, Jodhpur, Rajasthan
Email: *pcvyas28@gmail.com, Mobile no.: 9413320545*

Abstract
Background: *Age estimation known as age evaluation, age determination, age diagnostics or age assessment in living individuals is a relatively recent area of applied research within forensic sciences.*
Aims & Objective: *The aim of this study to the estimation of age on the basis of radiological closure of various sutures of skull and parts of sternum (manubrium and xiphoid process to the body) of living persons in the known age group of 4th and 6th decade.*
Material & Method: *The prospective study as many cases as available between the study period i.e. June 2015 to December 2015 visiting to MLC OPD in Mahatma Gandhi Hospital, Jodhpur. All the observations will noted on a common standard proforma and later the findings would be tabulated to draw necessary conclusions. A predesigned proforma was filled up for every case, master chart was prepared. Cases were stratified into 10 year groups. The results obtained after statistical analysis will be analyzed and compared with the works of previous authors.*
Results: *We studied and compared upper, mid and lower components of sagittal, upper and lower half coronal, and lambdoid sutures in males and females, and observed that suture closure starts earlier in lower 1/3rd part of sagittal suture among both males and females, however the suture fusion is earlier in males than in females.*
Conclusion: *From the study of cranial sutures and sternal elements individual fusion, we can accurately determine the decade of age in the living. A more precise measure of determination of age in the living would be either invasive procedure or higher radiation exposure(CT scan) which is both not desirable and less feasible.*
Keywords: *Coronal suture, Sagital Suture, Lambdoid sutures, xiphoid process, manubrium.*

Introduction

Age is one of the important parameters for the identification of an individual whether individual is alive, dead or human remains. Ideally a method for skeletal age determination must be reliable, simple and applicable to all age groups. Unfortunately, such an ideal method still remains a dream of the anthropologists too. All the present methods lack one or more of the above requirements. The scientific estimation of age is

not an easy task, especially in the adult age group. Usually the estimation up to 25 years is done by physical examination, appearance of secondary sexual characters, data from dental eruption, and maturity of bones, appearance-fusion of various ossification centers. However, these data are to some extent influenced by heredity, climate, race, diet, hormonal level, disease process etc.[1]

After 25 years of age other scientific methods like tooth microscopy, Gustafson's method (for dead only), study of pubic symphysis, study of union of parts of sternum, lopping of joints and closure of cranial suture are considered for age estimation of an individual.[1]

The oldest and the most controversial age indicator is the cranial suture closure. Beginning in the sixteenth century, the cranial sutures are believed to change morphologically with age. Since then, cranial suture closure has been widely addressed. Over the years, many investigators have concluded that cranial suture closure is too variable, does not correlate with age and should therefore not be used for age estimation, whereas others favour its inclusion. Such opposition has not led toa dismissal of interest in cranial suture closure, but has inspired new generations to take up the matter in pursuit of better explanations.[2]

The needs of age determination vary from intrauterine life to old age for different persons. There is special importance for age estimation in determining the age of certain individuals without birth certificate, who are attending school, getting married, joining military draft, determining criminal responsibility and criminal abortion. It appears from all of the above that age establishment has a paramount importance in many situations.[2]

The first person to do scientific work on this issue was Pryor (1928) who undertook studying the time of appearance of ossification center of the wrist bone and Krojman (1939) who studied the time of epiphysis union. Reasonably a correct estimation of age in elderly people is essential in legal, medical, social and administrative matters i.e. to fixing of age for regularization of employment, superannuation, pension settlements, senior citizen benefits, old age and good behaviour of the prisoner. The aim of this study to the estimation of age on the basis of radiological closure of various sutures of skull and parts of sternum (manubrium and xiphoid process to the body) of living persons in the known age group of 4th and 6th decade.[2]

Material & Methods

For this prospective study as many cases as available between the study period i.e. June 2015 to December 2015 visiting to MLC OPD in Mahatma Gandhi Hospital, Jodhpur, who were fulfilling the selection criteria were selected and after proper history taken in relation to age estimation, availability of certificate indicating the age of birth, or any such relevant document, and physical examination, skiagraphy was conducted after informed consent.

Inclusion Criteria

- The cases were selected from the easily available general population to us: patients admitted in wards, their relatives and police personnel visiting the hospital.
- Of the above, those consenting for skiagraphy and history taking were included in the study.

Exclusion Criteria

- Subjects not consenting for skiagraphy.
- Subjects not having valid documentation for proof of age/ date of birth.
- Subjects having documentation for date of birth and are younger than 30 years of age.
- The cases showing any disease or damage in respect to anterior chest wall and skull vault were not considered.

Individuals of different age groups where taken up for the study. Each individual was subjected to following radiological examination

For Skull: With a view to• study the Sagittal, Coronal and Lambdoid sutures, A special view (Gaur, Sahai, and Saxena)[3] was evolved by trial in

order to get all the basic three sutures in one film. The patient was positioned for the true lateral view, but the tube head was kept at 30 degree towards feet and 15 degree towards nose, keeping the distance of the tube head at 36 inches. The following exposure factors were utilized using the grid (Moving Bucky.)

i. 20 MA s
ii. 80KVp

Advantages of this Special View:

1. All the three basic sutures were clearly visible and the study of all the three sutures could be made with one film.
2. Sutural spiking was seen more clearly and the distance from one spike to the other was visible in all three sutures Clearly in one film.
3. Details of the fusion of sutures were seen, in which a ready 'comparison could be. Made of the various portions of various sutures, which could have been practically difficult to appreciate in two different films.

Disadvantages

1. Except for the sutures the other details of the structures Of the skull were not seen.
2. Being a lateral view, yet sella turcica could not be studied in this view.

For Sternum: Lateral view chest for sternum. Patient was made to stand with his right shoulder touching the cassette in a true lateral position. Centering was done at mid-point from the most prominent portion of the sternum (xiphisternum). Tube will be kept at 36 inches distance with following exposure factors

I. 13 MAs
II. 80 kVp

All the observations will noted on a common standard proforma and later the findings would be tabulated to draw necessary conclusions. A predesigned proforma was filled up for every case, master chart was prepared. Cases were stratified into 10 year groups. The results obtained after statistical analysis will be analyzed and compared with the works of previous authors.

Results

We studied and compared upper, mid and lower components of sagittal, upper and lower half coronal, and lambdoid sutures in males and females, and observed that suture closure starts earlier in lower 1/3rd part of sagittal suture among both males and females, however the suture fusion is earlier in males than in females. Furthermore, suture closure starts within 31 years in males and 33 years in female, for each suture. Closure is earlier in males as compared to females. Overall, coronal suture was found to close early followed by sagittal and lambdoid suture respectively.

We also studied the fusion of xiphoid and manubrium to the body of sternum. The findings of which reveal that the xyphisternum starts its union with body of sternum in the above study group at age of 36 years and is fused completely by the age of 44 years in all case males as well as females. The manubrium begins to unite with the bodu of sternum at about 47years and shows complete fusion at about 54 years in males, however in females the fusion appears delayed and is respectively 47years and 57 years.

A study was made to determine the age estimated from the fusion of cranial sutures and fusion of sternal elements to come up with the age and compare it with the already known age from documents (valid id proof) and comparison was made which was almost 99.00% accurate for determining the decade of age of individual

The present study observed that Maximum numbers of subjects were from the 41-50 age group & minimum numbers of subjects were from above 70 age group (table 1). In this study median age of fusion of coronal suture upper half in males 54 years & females were 56 years and fusion of coronal suture lower half in males 34 years & females were 37 years (table2).

The Median age of fusion of sagittal suture upper 1/3rd in males is 50 years, middle 1/3RD is 56 years and upper 1/3rd is 44 years (table 3). The Median age of fusion of sagittal suture upper 1/3rd in females is 52 years, middle 1/3RD is 58 years and upper 1/3rd is 46 years (table 4).

In present study showed that mean age of fusion of lambdoid suture in males were 48 years & females were 49 years and fusion of xiphoid process to body of sternum in males was 44 years & females were 46 years (table 5&6).

Earliest age of Fusion of manubrium to body of sternum in males 54 years & females were 57 years (table 7).

Table 1: Age and gender wise distribution of case

Age group in years	Male	Female	Total
31-40	13	8	21
41-50	18	9	27
51-60	17	7	24
61-70	11	7	18
71 & above	4	6	10
Total	63	37	100

Table 2: Fusion of coronal suture in males & females

Age group in years	Number of cases		Upper half						Lower half					
	Male	Female	Non closure1		In process of fusion1		Fused1		Non closure2		In process of fusion2		Fused2	
			Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
31-40	13	8	11	0	2	4	0	4	0	1	3	1	10	6
41-50	18	9	0	0	12	4	6	5	0	0	3	3	15	6
51-60	17	7	0	0	3	1	14	6	0	0	1	0	16	7
61-70	11	7	0	0	0	0	11	7	0	0	0	0	11	7
71 & above	4	6	0	0	0	0	4	6	0	0	0	0	4	6
Total	63	37	11	0	17	9	35	28	0	1	7	4	56	32

Table 3: Fusion of sagittal suture in males

Age group in years	Number of cases	Upper 1/3rd			Middle 1/3rd			Lower 1/3rd		
		Non closure1	In process of fusion1	Fused 1	Non closure 2	In process of fusion2	Fused 2	Non closure 3	In process of fusion3	Fused 3
31-40	13	7	6	0	6	7	0	0	4	9
41-50	18	0	4	14	9	9	0	0	5	13
51-60	17	0	1	16	0	6	11	1	6	10
61-70	11	0	1	10	0	3	8	0	2	9
71 & above	4	0	0	4	0	0	4	0	0	4
Total	63	0	12	51	15	25	23	1	17	45

Table 4: Fusion of sagittal suture in females

Age group in years	Number of cases	Upper 1/3rd			Middle 1/3rd			Lower 1/3rd		
		Non closure 1	In process of fusion1	Fused1	Non closure 2	In process of fusion2	Fused 2	Non closure3	In process of fusion3	Fused 3
31-40	8	4	4	0	4	4	0	0	2	6
41-50	9	0	2	7	0	3	6	0	1	8
51-60	7	0	2	5	0	1	6	0	1	6
61-70	7	0	0	7	0	0	7	0	0	7
71 & above	6	0	1	5	0	1	5	0	1	5
Total	37	4	9	24	4	9	24	0	5	32

Table 5: Fusion of lambdoid suture in males & females

Age group in years	No. of cases		Non closure		In process of fusion		Fused	
	Male	Female	Male	Female	Male	Female	Male	female
31-40	13	8	11	7	2	1	0	0
41-50	18	9	0	0	10	6	8	3
51-60	17	7	0	0	7	2	10	5
61-70	11	7	0	0	0	0	11	7
71 & above	4	6	0	0	0	0	4	6
Total	63	37	11	7	19	9	33	21

Table 6: Fusion of xiphoid process to body of sternum in male & females

Age group in years	No. of cases		Separate		In process of fusion		Fused	
	Male	Female	Male	Female	Male	Female	Male	female
31-40	13	8	1	0	5	4	7	4
41-50	18	9	0	0	6	2	12	7
51-60	17	7	0	0	0	0	17	7
61-70	11	7	0	0	0	0	11	7
71 & above	4	6	0	0	0	0	4	6
Total	63	37	1	0	11	6	52	31

Table 7: Fusion of manubrium to body of sternum in females

Age group in years	No. of cases		Separate		In process of fusion		Fused	
	Male	Female	Male	Female	Male	female	Male	female
31-40	13	8	11	7	2	1	0	0
41-50	18	9	11	7	7	2	0	0
51-60	17	7	1	0	5	5	11	2
61-70	11	7	0	0	1	1	10	6
71 & above	4	6	0	0	0	1	4	5
Total	63	37	23	14	15	10	25	13

Discussion

In later years of life all the teeth have erupted, practically all the epiphyses have united with the diaphysis, the height and weight are of no significance to determine the age. Obliteration of skull sutures in late age, practically when all the teeth have erupted and epiphysis have fused i.e. after 21 years of age, gives a fairly accurate idea but age can only be in decades, based on sole criterion of suture obliteration addition of sternal elements fusion helps in the determination of accuracy in the decade of ageing.

However none of these critics abandoned the starting point that if any correlation with age at

death existed it had to be a positive one. This is even more noteworthy because in several publications the phenomenon of extremely old individuals with many open sutures is discussed. There are, for example, the crania of four Dutchmen, aged over hundred years, but with open sutures, described by J.B. Davis, and many others like Powers, Bolk. The above results suggest that these aged individuals with open sutures were not merely rare exceptions. There must be some underlying mechanism. The cranium may become thinner, but sutures once closed, do not open again. The question forces itself whether selection does occur.

Sagittal Suture

In our present study we have found that the sagittal suture, starts fusing at the end of 31-40 years and completion is perfected at the age of 51-60 years, and this observation conforms with that reported by Todd & Lyon (1924)[4], Modi's(1988)[5], Reddy (2006)[6], Parikh (1990)[7] while it is in contrast to the observation reported by Pommerol (1869)[8], and Topinard (1885)[9], who indicated endocranial commencement of sagittal suture at a much later age at about 40 years. These latter workers have reported on very scanty specimens so it can't be considered as Authentic. Ectocranially sagittal suture closure was never complete. It implies that lapsed union is a significant problem in ectocranial sutures. Youngest age at which sagittal suture union was seen in 31 years in upper part 35 years in mid part and 31 years in lower part.

Coronal Suture

While in the present study, fusion of coronal suture was observed as early as 31-40 years in lower half whereas upper half showed fusion in 41-50 years age group and completion by the age of 51-60 years which showed fusion of both halves in all cases by this age. Which is in conformation with Pommerol (1869)[8], Topinard (1885)[9], reported closure between 40-50 years. In coronal suture youngest age at which complete union was seen at 33years in lower half and 40 years in upper half.

Lambdoid

Lambdoid, starts fusing at the age of 41-50 years in the present context which shows that it is a year earlier than that reported by Todd and Lyon (1924)[10], while completion in our study is 50-59 years Earliest age at which complete union of lambdoid suture was seen at 46 years.

Our Indian data compare well with those of the male whites (Todd & Lyton 1925)[11]. Negro skulls however show an earlier date of commencement and closure. All the previous work was done in France, Germany and United States of America, under different climatic conditions and in diverse racial groups. Though consensus of opinion in our country is that the obliteration of the skull sutures in females is somewhat earlier than that of males, in the present study no substantial difference was noticed. This finding is in conjunction with Meindl and Lovejoy[12].

Sternum

The earliest age of fusion of xiphoid with body of sternum is 36 years in males and 37 years in females. All the cases showed fusion of xiphoid with body of sternum after 44 years in males and 46 years in females.The earliest age of fusion of manubrium with body of sternum is 54 years in males and 57 years in females. All the cases showed fusion of xiphoid with body of sternum after 54 years in males and 57 years in females.

Conclusion

From the study of cranial sutures and sternal elements individual fusion, we can accurately determine the decade of age in the living. A more precise measure of determination of age in the living would be either invasive procedure or higher radiation exposure(CT scan) which is both not desirable and less feasible. As India, is a developing country where resources should be utilised to its best the cases for age determination in the elderly can be best and most feasibly

determined with the combination of general physical examination and radiology of skull along with sternum or other bones. The procedures being quick and non-invasive have good patient acceptance and a reasonable fair degree of accuracy.

References

1. Krogman WM (1962) The Human Skeleton in Forensic Science. (1stedn), Springfield USA: Charles C. Thomas.
2. Dwight T (1890) The closure of the cranial sutures as a sign of age. Boston Med Surg J 122 : 389-392.
3. Gaur VB, Sahai V B, Singh A, Kharat A. Determination of age in living by closure of cranial sutures: A radiological study. Journal of Indian Academy of Forensic Medicine. 2007 jan;29(1):32-34.
4. Todd TW, Lyon DW (1924) Endocranial suture closure, its progress and age relationship. Part I-Adult males of the while stock. Am J Phys Anthropol 7: 325-384.
5. Jaising P Modi; C A Franklin; Modi's Textbook of medical jurisprudence and toxicology, 1988; 21. Ed.
6. Reddy KSN. Identification. In: The Essentials of Forensic Medicine and Toxicology.29th ed. Devi KS. 2010.P.72.
7. Parikh CK. Parikh's textbook of medical jurisprudence, forensic medicine and toxicology. 6th Ed. New Delhi, India: C.B.S. Publisher and Distributors; 2004. p. 2.10.
8. Pommerol F. Sur la synostose des os du crane. Paris, 1869. : 1-118.
9. Topinard P. Êléments d‟anthropologie générale. Paris, 1885: 253-284, 644-646.
10. Todd TW and Lyon DW. 1924. Endocranial suture closure, its progress and age relationship: Part I adult males of the white stock. AJPA 7:325-384.
11. Todd TW and Lyon DW. 1925a. Cranial suture closure, its progress and age relationship: Part II ectocranial closure in adult males of white stock. AJPA 8:23- 45.
12. Meindl RS and Lovejoy CO. 1985. Ectocranial suture closure: a revised method for the determination of skeletal age at death based on the lateral-anterior sutures. AJPA 68:57-66.