

Macroscopic Study of Closure of Sagittal Suture for Estimation of Age

Gagandeep Kalsi¹, Amandeep Singh², Dasari Harish³, Ajay Kumar²

¹Junior Resident III, ²Associate Professor, ³ Professor & Head

Department of Forensic Medicine & Toxicology, Government Medical College & Hospital Chandigarh

Corresponding Author: Dr Amandeep Singh, Associate Professor, Department of Forensic Medicine & Toxicology, Government Medical College & Hospital Chandigarh

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Abstract

Estimation of age is very important in medico legal cases. The aim of this study was to evaluate the utility of sagittal cranial suture closure at autopsy for estimation of age. The suture was studied by dividing it into four equal parts, both ecto-cranially and endo-cranially applying Acsadi-Nemeskeri scale. Actual age and the scored values were plotted in a linear regression curve and estimated age was calculated. Total mean and standard deviation was calculated for each section and the results compared. It was observed that ectocranially S3 closed earliest followed by S4, S2 and S1 with total mean value of score as 2.23, 2.08, 1.69 and 1.68 respectively. Endocranially, S4 closed earliest followed by S2, S1 and S3 with total mean value of the score as 2.52, 2.45, 2.44 and 2.42 respectively.

Keywords: Identification, Sagittal suture, Age estimation, Acsadi Nemerski scale

Introduction

Identification of an individual is of paramount importance because an individual exists as an entity in society, and is dealt with as such by the legal system. Identification may be complete (absolute) where the exact identity of an individual is known or incomplete (partial) where only

some facts are known and the others remain unknown.¹ It is established by means of various physical features and biological parameters which are unique to each individual. These are external features such as birth marks, tattoo marks, scars or personal features such as clothes, speech, handwriting, etc., anthropometric measurements, finger prints, foot prints and DNA fingerprinting.

The assessment of age is important for employment, pension, insurance, inheritance claims, disputed sex and is most important in criminal cases such as persons accused of assault, rape, murder, etc. The need to identify is obvious for social and medico-legal purposes whether in living, dead or in skeletal remains, and age of the person is one of the important factors helping in it.

Estimation of age is done by various macroscopic methods based on the order of epiphyseal union of long bones, development and order of tooth eruption, closure of cranial sutures, appearance and fusion of various ossification centres as well as microscopic examination of bone in histological analysis.² Under 25 years of age, estimation of age is easily attained using the order of epiphyseal union of long bones and this is possible due to the progressive development of bones.³ The degenerative changes that occur in adult skeleton can be influenced by

factors including habitual activities and the health of an individual in addition to their age.³

After 25 years of age, the age determination of unidentified skeletons becomes more difficult for which other methods were developed such as degeneration of the pubic symphysis, rib ends, and cranial suture closure.⁴ The most reliable method for evaluating aging of adults is analysis of the pubic symphysis and auricular surface.⁵ Another method used is degenerative changes in the sternal end of the right fourth rib, however it was tested on small samples.⁶ Finally, union of cranial sutures can be utilized to estimate the age at death. The thought that cranial bones fuse progressively with age has been in existence since the 16th century.⁷ However, age estimation by this method has been quite controversial since the mid 20th century but today it is still used as one of the methods for determination of age in the absence of other evidence or with other methods.

Cranial suture closure has been mainly used for determination of age as cranium is the best preserved portion of the recovered skeleton.⁸ These sutures mostly fuse as the age increases, yet there is notable variability in closure rates and patterns and are fibrous joints that lack a synovial cavity. There are various genetic and environmental factors that influence the pattern of cranial suture such as dietary habits, daily water intake and climatic condition. The extrinsic factors that probably affect the characteristics of sutures are tensile forces, a growing brain and active muscle demands.⁹

Very few studies have been done in the Northwest region of India for age estimation from cranial suture closure at autopsy and sparse Indian literature is available for sagittal suture closure, so the present study was undertaken in the population of Chandigarh and adjoining areas.

Materials and Methodology

This prospective study was conducted to evaluate utility of sagittal suture closure on the medico-legal postmortem examination cases coming to the Department of Forensic Medicine and Toxicology, Government Medical College and Hospital, Sector 32, Chandigarh, after approval from the Institutional Research and Ethics Committees. Written informed consent for the study was taken from the legal guardian of the deceased.

A total of 100 cases were studied for the fusion of sagittal suture both ectocranially and endocranially applying Acsadi-Nemeskeri scale.¹⁰

Scale for closure: Acsadi-Nemeskeri complex method

0 = open. There is still little space left between edges of adjoining bones.

1 = incipient closure. Clearly visible as a continuous often zig-zagging line.

2 = closure in process. Line thinner, less zigzags, interrupted by complete closure

3 = advanced closure. Only pits indicate where the suture is located

4 = closed. Even location cannot be recognized.

Methodology

After obtaining consent, the sagittal sutures was studied macroscopically, both ectocranially and then endocranially after dissection during the routine postmortem examination. After reflecting the scalp, the calvarium was cleaned of soft tissues and wiped with cloth to make the sutures more prominent. The suture was divided into 4 equal sections and studied applying Acsadi-Nemeskeri scale.

For endocranial suture closure, the same scoring system was used after removing the calvaria by electric saw and removing the periosteum from the skull bone. Ectocranially, the different sections show differences in

the character of the sutures but endocranially they do not show these differences in character.

Estimated age was calculated using regression formula. Mean and standard deviation was calculated for both ectocranial as well as endocranial suture closure.

Results

In the present study, a total of 100 cases were studied of which 75 were males and the rest were females (**Table 1**). Maximum number of males and females were found to be in the age group 26-35 (**Table 2**).

Table 3 shows mean ectocranial and mean endocranial sagittal suture closure. Ectocranially, sagittal suture starts to close at 18-25 years of age (mean 0.64) to mean 2.50 at more than 76 years. Endocranial sagittal suture starts to close at 18-25 years of age (mean 0.61) and near complete closure occurs at 56-65 years of age (mean 3.92).

Table 4 shows mean and standard deviation of ectocranial sagittal suture closure scoring. Ectocranially, within the sagittal suture, S1, S2, S3 and S4 starts to close at 18-25 years of age with mean values of 0.26, 0.74, 0.74, 0.79 respectively. It was observed that S3 fused much faster at 66-75 years of age with mean value of 4. Near complete closure was observed at the age of 66-75 years in S4 with mean value of 3.

Table 5 shows mean and standard deviation of endocranial sagittal suture closure scoring wherein it was observed that S1, S2, S3 and S4 start to close at 18-25 years with mean values of 0.26, 0.63, 0.79 and 0.74 respectively. S4 closed earliest at the age of 66-75 years with a mean value of 4 followed by S1 (mean 4) at 66-75 years, S2 (mean 4) at more than 76 years and S3 (mean 4) at more than 76 years of age.

Table 6 shows the comparison between the present study and the other studies.

Discussion

Although sex determination in adults does not pose any difficulty, age determination at death in adults remains difficult and are subjected to innumerable errors. In the literature, a number of methods have been suggested to ascertain the age of individuals using different parts of the skeleton for forensic and archaeological purposes as it is often the single element recovered¹⁰. The union of cranial sutures is a part of an age-related physiological process and is still used as a method for determination of age as cranium is a well preserved bone and also the macroscopic observation does not necessitate any specific equipment. In the present study, the macroscopic findings were studied for sagittal suture closure to determine the age of an individual.

A total of 100 cases were studied, out of which 75 were males and the rest were females. Maximum number of males were found to be of the age group 26-35 years followed by 36-45 years and 46-55 years and the least were of the age group 66-75 years and more. Maximum number of females were of the age group 26-35 years followed by 18-25 years and the least were of the age group 66-75 years.

In the present study, we found that ectocranially the sagittal suture starts to close at 18-25 years. S3 fused earliest at 66-75 years of age (mean 4). S1 closes (mean 0.26 to mean 2.32 at more than 76 years), S2 closes (mean 0.74 to 2.67 at more than 76 years). Total mean value was 2.23 for S3, 2.08 for S4, 1.69 for S2 and 1.68 for S1. Thus, in present study it was found that S3 closed earliest followed by S4, S2 and S1. Parchake SB *et al.*¹¹ found that S4 fused much faster followed by S3, S2 and S1 which is in contrast to the present study but similar to study conducted by Ullasa Shetty.¹² This difference could

be due to the age group that was taken in the present study and the study conducted by Parchake SB *et al.*¹¹

Endocranially, in present study, it was observed that sagittal suture starts to close at 18-25 years and complete closure occurs at more than 66 years of age. Total mean value was 2.52 for S4, 2.45 for S2, 2.44 for S1 and 2.42 for S3. Thus, it was found that S4 closed earliest followed by S2, S1 and S3 which is in contrast to the findings observed by Parchake SB *et al.*¹¹ and Kamesh Modi *et al.*¹³

Graph 1 shows the linear regression curve for mean ectocranial suture closure with the actual age plotted against y-axis and the scored value against the x-axis. Regression formula derived was $y=8.4416x+27.651$ and the age was calculated. It was observed that the maximum difference of -39.7 was found at the age of 80 years with a scored value of 1.5 and the minimum difference of 0.1 was found at the age of 55 years with a scored value of 3.3.

Graph2 shows the linear regression curve for mean endocranial suture closure with the actual age plotted against the y-axis and the scored value plotted against the x-axis. Regression formula derived was $y=7.1882x+27.26$ and the age was calculated. It was observed that the maximum difference of -35.3 was found at the age of 64 years with a scored value of 0.4 and the minimum difference was found to be at the age of -0.2 at the age of 30 years with a scored value of 0.5.

Table 1. Gender wise distribution

Gender	Total no. (N)
Male	75
Female	25
Total	100

Table 2: Distribution of cases according to age and gender

Age Group	N	Male	Female
18-25	19	13	6

26-35	28	20	8
36-45	18	15	3
46-55	17	15	2
56-65	13	10	3
66-75	2	1	1
≥76	3	1	2

Table 3: Mean and SD of mean ectocranial and endocranial sagittal suture closure scoring

Age group		Mean S ECTO	Mean S ENDO	Total S Mean
18-25	N	19	19	19
	Mean	0.64	0.61	0.63
	SD	0.32	0.77	0.48
26-35	N	28	28	28
	Mean	1.04	1.26	1.15
	SD	0.73	1.27	0.86
36-45	N	18	18	18
	Mean	1.90	2.25	2.08
	SD	1.10	1.18	1.0
46-55	N	17	17	17
	Mean	1.78	2.43	2.10
	SD	0.94	1.11	0.92
56-65	N	13	13	13
	Mean	2.58	3.92	2.75
	SD	1.22	1.14	1.10
66-75	N	2	2	2
	Mean	3.38	3.75	3.56
	SD	0.53	0.35	0.44
≥76	N	3	3	3
	Mean	2.50	4.00	3.25
	SD	1.00	0	0.50

Table 4: Mean and SD of ectocranial sagittal suture closure scoring

Age group		S1 ECTO	S2 ECTO	S3 ECTO	S4 ECTO
18-25	N	19	19	19	19
	Mean	0.26	0.74	0.74	0.79
	SD	0.56	0.45	0.45	0.54
26-35	N	28	28	28	28
	Mean	0.61	0.93	1.32	1.21
	SD	0.88	0.77	0.67	0.99

36-45	N	18	18	18	18
	Mean	1.44	1.67	2.11	2.11
	SD	1.29	1.03	0.96	1.28
46-55	N	17	17	17	17
	Mean	1.59	1.65	1.71	2.18
	SD	1.12	1.00	0.99	1.01
56-65	N	13	13	13	13
	Mean	2.54	2.62	2.38	2.92
	SD	1.39	1.39	1.33	1.26
66-75	N	2	2	2	2
	Mean	3.00	2.50	4	3
	SD	1.41	0.71	0	1.41
≥76	N	3	3	3	3
	Mean	2.33	2.67	3.33	2.33
	SD	0.58	1.53	1.15	1.53
Total	N	100	100	100	100
	Mean	1.68	1.69	2.23	2.08
	SD	0.36	0.34	0.46	0.33

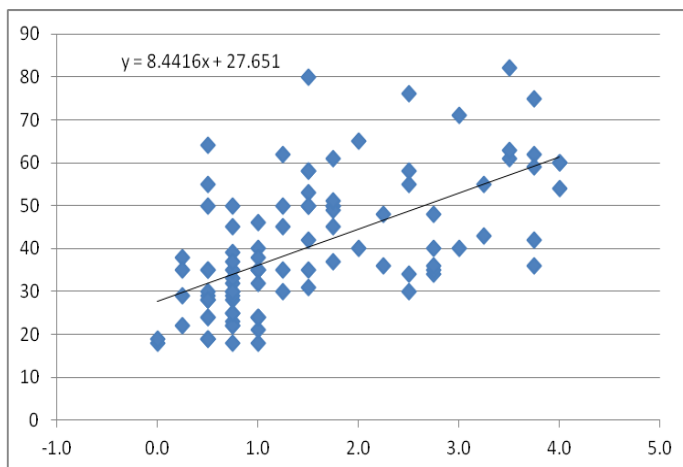
Table 5: Mean and SD of endocranial sagittal suture closure scoring

Age group		S1 ENDO	S2 ENDO	S3 ENDO	S4 ENDO
18-25	N	19	19	19	19
	Mean	0.26	0.63	0.79	0.74
	SD	0.56	0.83	0.98	0.93
26-35	N	28	28	28	28
	Mean	1.14	1.29	1.25	1.36
	SD	1.21	1.30	1.35	1.39
36-45	N	18	18	18	18
	Mean	2.39	2.28	2.11	2.22
	SD	1.29	1.23	1.18	1.22
46-55	N	17	17	17	17
	Mean	2.35	2.53	2.47	2.35
	SD	1.54	1.28	0.87	1.17
56-65	N	13	13	13	13
	Mean	2.92	2.92	2.85	3
	SD	1.12	1.26	1.14	1.22
66-75	N	2	2	2	2
	Mean	4	3.5	3.5	4
	SD	0	0.71	0.71	0
Total	N	100	100	100	100
	Mean	2.44	2.45	2.42	2.52
	SD	0.63	0.48	0.46	0.59

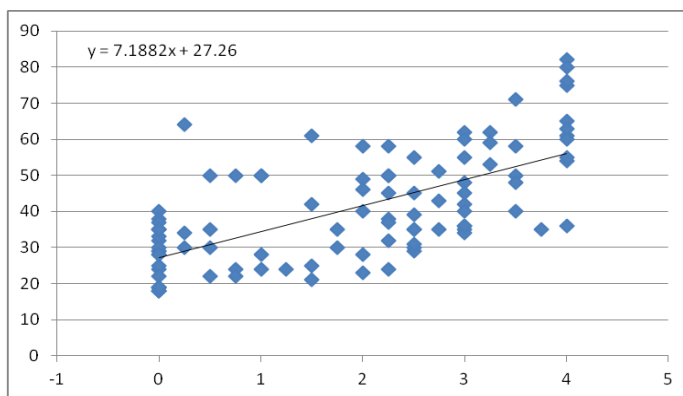
Table 6: Comparison of different studies with the present study.

	Present study	Kamesh Modi <i>et al.</i>	Parchake SB <i>et al.</i>	Ullasa Shetty
S1 Ecto Mean	1.68	2.52	1.69	1.04
S2 Ecto Mean	1.69	2.28	1.73	1.19
S3 Ecto Mean	2.33	2.23	1.95	1.46
S4 Ecto Mean	2.08	2.81	2.06	1.29
S1 Endo Mean	2.44	3.08	2.26	2.03
S2 Endo Mean	2.45	3.07	2.26	2.00
S3 Endo Mean	2.42	3.00	2.45	2.29
S4 Ecto Mean	2.52	3.17	2.59	2.20

Graph 1: Mean ectocranial sagittal suture closure



Graph 2: Mean endocranial sagittal suture closure



Conclusion

From present study it was concluded that, sagittal suture closure starts at 18-25 years both ectocranially and endocranially. It was also observed that ectocranial suture closure though started, it was never complete in the sections, viz. S1, S2 and S3 at more than 76 years of age (mean 2.32, 2.67, 2.33, respectively). Suture closure starts earlier on the endocranial surface than on the ectocranial

surface. Endocranially, complete closure occurs at more 66-75 years of age in S1 and S4 and at more than 76 years of age in S2 and S3. Thus, endocranial suture closure is more helpful in the estimation of age than ectocranial surface.

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