

Research Article

Fusion of Skull Vault Sutures in Relation to Age-A Cross Sectional Postmortem Study Done in 3rd, 4th & 5th Decades of Life

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Abstract

Introduction: Cranial suture closure is one trait that has been used since the 16th century for age estimation after 2nd decade of life. There exists considerable debate about its applicability and reliability in age estimation.

Objective: To find out the pattern of cranial vault suture closure in relation to age in 3rd to 5th decades of life; to detect bilateral and bisexual variations in cranial suture closure; and to specify any relationship between progression of union of cranial suture and age.

Materials and method: Study design: Cross-sectional observational study. Study period: November 2008 to October 2009. Sample size: 70. All the autopsy cases, between 21 to 50 years of age were studied for relation between age and cranial suture closure. Ectocranial and endocranial closure pattern were studied for sagittal coronal and lambdoid sutures.

Results: Endocranial fusion of cranial suture was more regular than ectocranial fusion, and was observed as early as 21-30 years. Coronal suture was the first to fuse. Closure was found earlier in females compared to males. No definite correlation was found to exist between age and suture closures.

Conclusion: With this study, we couldn't find any possibility for suture closure to contribute substantially as one to the factors for age estimation.

Keywords: Age; Cranial sutures; Suture closure; Forensic anthropology; Endocranial; Ectocranial; Suture

Introduction

Assessment of suture closure for age estimation dates back to 1962, when Krogman concluded that suture closure seems promising for age estimation despite a deficiency in the amount of study devoted to suture obliteration [1].

Dwight identified that the posterior portion of sagital suture and inferior portion of coronal suture shows first sign of obliteration, lambdoid closes slower than coronal and the frontal suture is the last to close [2].

Parson and box, revised the above chronology to report that lower half of the internal coronal suture is the spot for initial commencement, followed by the internal region of the sagital suture at obelion; the lambdoid suture being the last to close. Frederic was the first to announce that it is not possible to age a skull to within any more than 10 years [3,4].

Todd and Lyon [4] were the first to use scoring system, suture sites were recorded a score from zero (no closure) to four (complete closure). The different landmarks on each suture (i. e. , pars bregmatica, pars vertices, pars obelica, and pars lambdica) were averaged together and observed individually for trends in closure. Using this system, they observed that endocranial suture is more active from 26-30 years. Additionally, the ectocranial sutures are highly unreliable for age estimation.

After the works of Todd and Lyon [4], criticism of suture closure as an indicator of age continued and cranial suture closure became more of a general age indicator and the last resort for individual identification. Acsadi and nemeskeri [5] observed that there is a uniform trend of rapid closure early on followed by a slower and gradual closure with advancing age.

Perizonius in 1984 [6] added a new life to the criticism over age estimation by suture closure by adding that all sutures especially the coronal, exhibited a significant degree of positive correlation with age, in the 20-49 years of age. He also added that there is a negative correlation with age from 70 to 79 years.

In the recent times, Miendl and Lovejoy [7], tried to improve up to the existing scoring system, and concluded that cranial suture when combined with other age indicators can be a reliable method for forensic purposes.

This concluded that the problematic nature of suture closure should not be a reason for despair but a challenge for the creation of more sophisticated methodologies- the results are sufficiently promising to merit further study.

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To obtain more information on its usefulness, we undertook a study to find out the pattern of cranial vault suture closure during 3rd to 5th decades, to detect bilateral and dimorphic variations and to specify any relationship between progressions of union of cranial suture with age of an individual.

Methodology

Study design: Cross sectional study.

Study duration: Nov. 2008-Oct. 2009.

Study population: Autopsy cases done on individuals between 30 to 60 years of age belonging to Belgaum, Karnataka, India.

Sample size and characteristics: Seventy, out of which 39 cases in 21-30 age groups; 21 in 41-50 age group, and 10 from 21-50 age group. Out of 16 females, 8 belonged to 21-30 age groups.

Exclusion Criteria: cases with skull fractures and any case with pathological condition of bones were excluded.

After exposing the skull with usual scalp incision, the vault was opened using an electric oscillating saw with enough care taken to avoid any artifact that may interfere with our observation. The attached meninges were removed, and the vault along with the base examined for degree of fusion of sutures. The obliteration of the sutures was ascertained endocranially as well as ectocranially by first two authors together, and was cross checked by the third author independently, to avoid observation bias.

Age group		Endo-S1	Ecto-S1	Endo-S2	Ecto-S2	Endo-S3	Ecto-S3
21-30	N	39	39	39	39	39	39
	mean	1.28	0.64	1.79	0.69	1.23	0.58
31-40	N	10	10	10	10	10	10
	mean	2.4	1.6	2.4	1.3	2.4	1.3
41-50	N	21	21	21	21	21	21
	mean	2.63	2.38	2	0.71	1.69	1.19
Total	N	70	70	70	70	70	70
	mean	1.75	0.8	1.71	0.9	1.62	0.87

Table 1: Endocranial and ectocranial closure of sagittal suture.

Each side of coronal suture was studied in two parts- upper (RU, LU) and lower (RL, LL). Sagittal suture was examined in three partsanterior 1/3 (S1), middle 1/3 (S2) and posterior 1/3 (S3). Each side of the lambdoid suture was studied in two parts- upper (R/L1) and lower (R/L2). Examination was done for inner and outer tables separately, less than 5 point scale of 0 to 4 i. e., "0- open, 1- less than one half closed, 2half closed, 3- more than one half closed, 4- totally closed". Then mean was calculated for each component derived from all the subjects studied to know the pattern of suture closure.

Results

We studied and compared ectocranial and endocranial components of sagittal, both right and left side of coronal, and lambdoid sutures and observed that suture closure starts earlier endocranially than ectocranially. Furthermore, suture closure starts within 21-30 years for each suture. Closure is earlier in females as compared to males. Overall, coronal suture was found to close early followed by sagittal and lambdoid suture respectively.

Findings of the *sagittal suture* (Table 1) on endocranial side showed that S2 closure started early followed by S1 and S3 respectively. Once started, S1 fused fastest and S3 the slowest. Ectocranially, suture closure followed the same pattern as that endocranially. While S1 fused fastest, S2 fused slowest as against S3 endocranially.

The examination of the *coronal suture* (Table 2) on endocranial side showed that lower coronal suture closure started early compared to upper half. Once commenced, the lower part appears to fuse much faster compared to upper part. Ectocranially, the closure and fusion followed the pattern as observed endocranially. There was no significant difference in time of closure between right and left side in either sex.

Lambdoid suture (Table 3) on endocranial side showed that upper lambdoid suture closure started early compared to lower part; and once commenced, the upper part appears to fuse much faster than the lower part. Ectocranially, the pattern was similar to endocranial fusion. There was no significant difference between right and left side.

Right and left side of coronal and lambdoid sutures were compared

Age group		Endo-RU	Ecto-RU	Endo-RL	Ecto-RL	Endo-LU	Ecto-LU	Endo-LL	Ecto-LL
21-30	N	39	39	39	39	39	39	39	39
	mean	1.38	0.94	1.46	0.94	1.53	1.02	1.66	1.05
31-40	N	10	10	10	10	10	10	10	10
	mean	2.4	1.7	2.8	1.5	2.4	1.7	2.2	1.5
41-50	N	21	21	21	21	21	21	21	21
	mean	2.33	1.42	2.61	1.61	2.3	1.47	2.66	1.66
Total	N	70	70	70	70	70	70	70	70
	mean	1.81	1.2	2	1.22	1.91	1.25	2.04	1.3

Table 2: Endocranial and ectocranial closure of coronal suture.

Age group		Endo-R1	Ecto-R1	Endo-R2	Ecto-R2	Endo-L1	Ecto-L1	Endo- L2	Ecto-L2
	N	39	39	39	39	39	39	39	39
21-30	mean	1.33	0.97	1.3	0.94	1.23	0.97	1.2	0.94
	N	10	10	10	10	10	10	10	10
31-40	mean	2.5	1.8	2.5	1.8	2.6	1.9	2.6	1.9
	N	21	21	21	21	21	21	21	21
41-50	mean	2.43	1.23	2.33	1.23	2.42	1.48	2.47	1.38
	N	70	70	70	70	70	70	70	70
Total	mean	1.71	1.17	1.78	1.15	1.78	1.24	1.78	1.21

Table 3: Endocranial and ectocranial closure of lambdoid suture.

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both ectocranially and endocranially. There were no significant difference in closure after applying student't' test (P value>0.05) implying that there is no bilateral variation in ectocranial and endocranial suture closures. No definite age group could be ascertained as to the time of closure of a particular component.

Discussion

In our study, endocranial fusion of coronal suture was observed as early as 20-29 years. Other researchers reported closure between 40-50 years; however, they did not specify whether it was ectocranial or endocranial, and whether it was commencement or termination. In coronal suture, youngest age at which we observed complete union was 21 years endocranially and 28 years ectocranially. There was no significant variation in the pattern of coronal suture closure on right and left sides both ectocranially and endocranially [8].

Fusion of sagittal suture, on endocranial surface, starts towards the end of 21-30 years and this observation is similar to that reported by Todd and Lyon [4]. In sagittal sutures, S2 closure started early followed by S1 and S3 respectively; and S1 appeared to fuse much faster whereas, S2 seems to close at a much slower pace. We observed that, lambdoid suture fusion starts at the age of 21-30 years; one year earlier than that reported by Todd and Lyon [4].

The other workers have not reported on lambdoid suture. Our data compares well with those reported for the white males [9].

On the other hand the Negroid skulls show an earlier date of commencement and closure. We also found that the upper portion of lambdoid suture closes and fuses early compared to lower part, an observation similar to other studies [4,9-11]

In summary, we report that, all the three main sutures of the skull started closing earlier in females compared to males, like that seen in long bones where the metaphyses fuses earlier in females [12]. Moreover, endocranial union is a far better parameter for age determination than the ecotocranial union, a fact earlier established by Todd and Lyon [4,9-11] and Dwight [2].

Conclusion

Our analyses strengthen the view that, with techniques available

at present, an assessment regarding the precise age of an individual, gauzed only on the degree of closure of the vault sutures of the skull, is a hazardous and highly unreliable procedure. We further conclude that, after certain age, suture growth is unrelated to age and is controlled by other biological factors that are poorly understood. However, it is still important to refine the methods of quantifying these structures, in order to render the methods of quantification as unbiased as possible.

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