ORIGINAL ARTICLE

Macroscopic Study of the Sagittal Suture – A tool for estimation of Age

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ABSTRACT

Background: Forensic significance of age estimation is vital both in civil and criminal cases. Legal matters demanding a reasonably acceptable age estimation eventually lies upon the undeniable evidence. The sudden rise in nationwide mass disaster mishaps has significantly increased the importance of age estimation as a key factor to identification. Several methods can be accustomed to determine age from different aspects including physiological parameters, dental data, developmental stages of long bones and the cranial sutures. One supersedes the other for several reasons. The peculiar issues arise in cases exceeding the age of 30. The skeletal series especially the cranium tackles all such issues along with the advantage of coping the problems of decomposition. In the cranium, the sagittal suture had been the suture of choice historically by all researchers probably because of its vital location on the skull.
Aim: To determine the age of a deceased by studying the degree of sagittal suture closure macroscopically.
Methods: All the cases for this purpose had been selected from those brought for autopsy in the Department of Forensic Medicine and Toxicology, King Edward Medical University Lahore during the year 2016.
Results: The statistical analysis revealed grossly positive correlation between the degree of sagittal suture closure both ectocranially and endocranially with advancing age. The p value was significant being less than 0.05
Conclusion: Conclusively the estimation of age could possibly be determined with certain degree of accuracy by macroscopic study of the Sagittal Suture on autopsy table.
Keywords: Macroscopic, Age, Cranial, Sagittal, Suture, Closure

INTRODUCTION

individuality formulates the grounds for identification. Establishing individuality in living, dead or even remains is vital in each and every medicolegal case.[1] Age is the first parameter that comes into play while climbing the ladder of establishing individuality. Estimation of age is desired for variety of reasons. Importance of determination of age weighs equally in civil and criminal cases. For example estimating age for marital purposes, to confer voting right, to seek employment and to manage the property all comes under the fold of civil matters. The age estimation in criminal perspectives is even more important including sexual harassment, homicide, prostitution and abduction etc.[2] A fairly acceptable determination of age in elderly class is crucial in legal, social, criminal, civil, medical and administrative matters. Age can be determined from a variety of ways. Broadly classification can be non – osseous and osseous tissues from which age can be determined[3].

The non – osseous tissue from where the age may be assessed include the physiological and anatomical parameters. In this regard attainment of certain height, development of secondary sex characteristics and arcus senalis are a few among many which may depict a certain age.[4] But such parameters are always at the verge of

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disadvantage of dissolution because of putrefaction which ensues for earlier in our part of the world. The osseous tissue like the skeletal series is always spared of such demerits and that is why it is superior to the former category[5].

The bony tissue from which age is determined historically include the dental data, the long bones, the sternal rib ends and the skull. Up to 25 – 30 years the study of dental development and eruption and epiphysio-diaphysial union of long bones can fairly help to determine the age. The problem to determine age with certain degree of accuracy arises once an individual crosses the age of 30[6].

The only significant bony tissue for macroscopic studies upon which one may rely after 30 years of age is the bony skull. The pattern of cranial suture closure for determination of age had always been subject of great interest to all the forensic experts. It is significant not only in the later part of the life where age determination is not an easy task at all but also for the reason that skull as compared to any other part is always the well preserved portion to any putrefactive change.[7]

The cranial sutures actually are the cleavages among the different skull bones during their courses of development in intrauterine life.[8] Subsequently these sutures acquire the shape of fibrous joint which keep on closing after 21 years of life till 50 years or so. This degree of closure than help in determination of age[9].

The pattern of suture closure is grossly same though affected by climate, dietary intake of the individual,

environmental and genetic factors. For such reasons the regional study of the subject is mandatory to assess differences if any.[10,11] The current study is based on estimation of age from closure of the sagittal suture to formulate a reference value applicable to the local population of Pakistan.

MATERIAL AND METHODS

The cases for the study were selected from dead bodies brought for postmortem examination in the mortuary of the department of Forensic Medicine and Toxicology, King Edward Medical University, Lahore. All the cases were collected from the autopsies conducted from January 2016 to September 2016. Standard autopsy protocol was followed and a predesigned data collection format was used for data collection. The scalp was incised via mastoid – to – mastoid incision and both the flaps were reflected to their respective sides to fully expose the sagittal suture. Every time calvaria was removed with hand saw. Extra care was exercised that the transverse incision should be fairly away from the bregma and lambda. The skull cap was prepared to prominently display the sagittal suture by removing the soft tissue. Subsequently the calvaria was let air dried to make the suture further prominent and clear. Similarly the internal surface was cleaned to assess the degree of closure endocranially. On either side of the skull the coronal and lambdoid suture were made visible in order to have fully exposed view of the sagittal suture limits and extensions. The measurements were recorded and photographs were taken each time.

The degree of sagittal suture closure was noted in four equally divided parts as S1, S2, S3, and S4 from bregma to lambda ectocranially and endocranially. The extent of the suture closure in each segment was scored as per Acsádi-Nemeskéri Scale.

RESULTS

In the first instance both the genders were dealt together to assess if a significant difference for the process of ossification can be found. Student t-tests demonstrated significant (P value < 0.05) differences between the mean closure stages for males and the comparable means for females. This is found to be in agreement with the findings of Acsádi-Nemeskéri (1970). To estimate the possible relation between suture closure and age at death, appropriate statistical tools were used (spearman rank correlation coefficients, student's t test for equality of means, SPSS software).

Statistical analysis: The score for degree of closure in each segment of the sagittal suture was calculated in terms of mean and standard deviation. The scores were compared between males and females in terms of outer (ectocranial) surface and inner (endocranial) surface by

Age versus gender distribution: The age of the subjects varied from 21 to 70 years. Age groups were classified at 10 years interval, as researched in previous studies. It had been observed that maximum number of cases were in 21– 30 years age group showing the highest age distribution of subjects. There were 32 cases (10 males and 22 females) with valid percentage as 35%. In 31 – 40 age groups there were 15 subjects (08 males and 07 females) making 16.5% of the total population under study. In age group 51 - 60

performing student t-test. Mean suture closures were also compared. Correlation coefficient were also calculated for different segments of the sutures and for gender comparison as well separately for each group. A p-value < 0.05 was taken as statistically significant. Data was analysed using software SPSS version 11.0.

Age: The age of the subjects varied from 21 to 70 years. The subjects were placed in age groups of 10 years interval as shown in figure 01. There were 32 subjects in age group 21 - 30 years. There were 15 subjects in age group 31 – 40 years, 18 subjects in age group 41 – 50 years, 14 subjects in age group 51 – 60 years and 11 subjects in age group 61 - 70 years (Fig.1, Table 1)

Sex: The sample size was 90 dead bodies out of which half were males and half were females. The number of subjects from each gender falling in different age groups (Fig. 2).
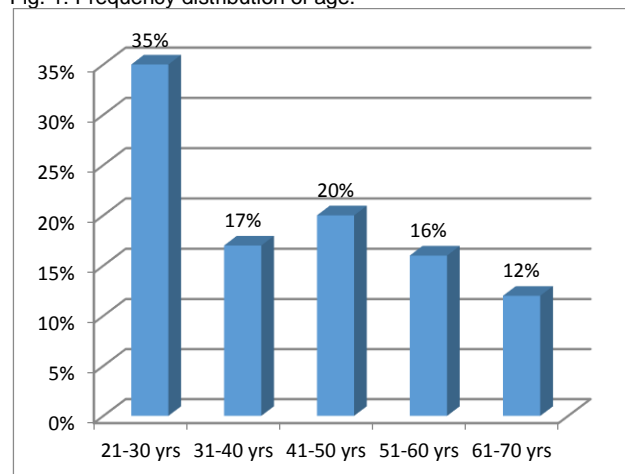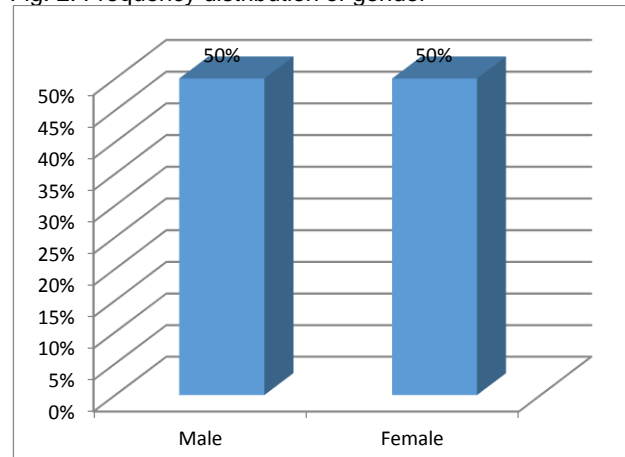
Fig. 1: Frequency distribution of age.

Fig. 2: Frequency distribution of gender

years there were a total of 14 subjects with 08 males and 06 females in it so making 15.5% of the total population. There were 11 cases in 61 – 70 age groups It constituted 12% of total population with 09 males and 02 females (Table 1).

Revealed in table 01, there were 32 (35.5%) cases in total among which 10(11.1%) were males and 22 (24.4%) were females, in age group 31 – 40 years there were 15 (16.7%) cases in total with 08 (8.9%) males and 07 (7.8%)

females and the age group 41 – 50 years constituted 18 cases (20%) comprising of 10 (11.1%) males and 08 (8.9%) females. The 15.6% with 14 cases in total were present in age group 51 – 60 years among which 08 (8.9%) were males and 06 (6.7%) were females while the age group 61 – 70 years contributed 11 (12.2%) cases to the total with 09 (10%) males and 11 (2.2%) females.

As for as sex based commencement of the closure of the sagittal suture was concerned it was found significant in terms that closure started earlier in males than in females as shown in table 02 above. Closure was more marked in endocranial suture as compared to the ectocranial suture probably because of the fact that closure physiological starts endocranially and these suture also lack closure characters as exhibited by ectocranial sutures. Conclusively the study supports the ideology of earlier closure in males and that it starts endocranially.

Suture closure analysis: In order to standardise the study the Acsádi-Nemeskéri (1970) scale was used to assess the degree of closure. The degree of suture closure was studied ectocranially as well as endocranially. In each gender the obliteration was ascertained in four subsections of the sagittal suture of the vault of the skull as already described above and shown in table 02. The degree of suture closure was scaled as (0, 1, 2, 3, 4) the one used by Acsádi-Nemeskéri (1970). The very reason for the acceptance this scale was the fact because the Acsádi-Nemeskéri description for the extent of closure into 5 simple strata's (0 = open, 1 = incipient closure, 2 = closure

in process, 3 = advanced closure, 4 = closed) made it easy to record it.

In table 03 shown above, the complete closure was observed in all subsections in 61 – 70 years age group in both male and female population. There was also complete closure subsections Ecto – S1, Endo – S2 and Endo – S4. The closure was in progress in Endo – S3 subsection in age group 31 – 40 years.

Table 4 shows the degree of closure in male population. Closure was complete in all the subsections of sagittal suture in age group 61 – 70 years. Also completely fused subsections of the sagittal suture in Endo – S1, Ecto – S1, Ecto – S3 and Endo – S4 in age group 51 – 60 years and Endo – S1 and Endo – S4 subsection in age group 41 – 50 years.

In 41 – 50 years age group there was advanced closure in Ecto – S2 and in Endo – S1 subsection of the sagittal suture in 31 – 40 years age group. Whereas closure in progress was observed in Endo – S3 subsection in age group 31 – 40 years. There was incipient closure in Ecto – S3 subsection in age group 21 - 30 years.

As shown in table 05 above there was complete closure in all the subsections in 61 – 70 years age group. Also in the age group in 51 – 60 years there was complete closure in the segments including Ecto – S1, Endo – S1, Endo – S3, Ecto – S4 and Endo – S4. The Endo – S2 subsection in age group 41 – 50 years showed advanced closure while there was closure in progress in Endo – S3 subsection in age group 31 – 40 years.

Table 1: Age versus gender distribution

Serial No.	Age Group	Male Subjects (*n*=45)		Female Subjects (*n*=45)		Total Subjects (*n*=90)	
		n	%	*n*	%	*n*	%
I.	21 – 30 Years	10	11.1%	22	24.4%	32	35.5%
II.	31 – 40 Years	08	8.9%	07	7.8%	15	16.7%
III.	41 – 50 Years	10	11.1%	08	8.9%	18	20%
IV.	51 – 60 Years	08	8.9%	06	6.7%	14	15.6%
V.	61 - 70 Years	09	10%	02	2.2%	11	12.2%

Where   *n* = number and % =Percentage

Table2: Gender Comparison for Closure Assessment

Ectocranial Sutures				
Gender	*n*	Mean	P value	Significance
Male	45	2.7178	0.001	significant
Female	45	1.9022		
Endocranial Sutures				
Male	45	3.0111	0.001	significant
Female	45	2.2733		

Table 3: Ectocranial and Endocranial closure of Saggital suture in Total Population (*n*=90)

Age (years)	*n*	Ecto -S1	Endo-S1	Ecto-S2	Endo-S2	Ecto-S3	Endo-S3	Ecto-S4	Endo-S4
		Mean ± SD		Mean ± SD		Mean ± SD		Mean ± SD	
21-30	32	1.63±0.554	1.94±0.435	0.50±0.672	1.13±0.554	0.72±0.683	1.13±0.609	1.69±0.592	1.81±0.471
31-40	15	2.33±0.488	2.73±0.594	1.47±0.640	1.87±0.640	1.67±0.617	2.00±0.756	2.27±0.458	2.60±0.507
41-50	18	3.72±0.461	3.89±.0323	2.89±0.471	3.28±0.575	2.87±0.548	3.11±0.583	3.61±0.608	3.83±0.514
51-60	14	4.00±0.000	4.00±0.000	3.57±0.514	3.86±0.363	3.86±0.363	3.93±0.267	3.93±0.267	4.00±0.000
61-70	11	4.00±0.000	4.00±0.000	4.00±0.000	4.00±0.000	4.00±0.000	4.00±0.000	4.00±0.000	4.00±0.000

Table 4: Ectocranial and Endocranial closure of Sagittal suture (Male *n*=45)

Age (years)	*n*	Ecto -S1	Endo-S1	Ecto-S2	Endo-S2	Ecto-S3	Endo-S3	Ecto-S4	Endo-S4
		Mean ± SD		Mean ± SD		Mean ± SD		Mean ± SD	
21-30	10	1.80±0.422	1.90±0.316	0.50±0.707	1.30±0.483	1.00±0.667	1.20±0.632	1.80±0.422	1.70±0.675
31-40	8	2.50±0.535	3.00±0.535	1.50±0.535	2.13±0.641	1.63±0.744	2.00±1.069	2.38±0.518	2.75±0.463
41-50	10	3.80±0.422	4.00±0.000	3.00±0.471	3.50±0.527	2.70±0.675	2.90±0.306	3.60±0.516	4.00±0.000
51-60	8	4.00±0.000	4.00±0.000	3.75±0.463	3.88±0.354	4.00±0.000	3.88±0.354	3.88±0.354	4.00±0.000
61-70	9	4.00±0.000	4.00±0.000	4.00±0.000	4.00±0.000	4.00±0.000	4.00±0.000	4.00±0.000	4.00±0.000

Table 5: Ectocranial and Endocranial closure of Sagittal suture (Female *n*=45)

Age In years	n	Ecto -S1	Endo-S1	Ecto-S2	Endo-S2	Ecto-S3	Endo-S3	Ecto-S4	Endo-S4
		Mean ± SD		Mean ± SD		Mean ± SD		Mean ± SD	
21-30	22	1.55±0.596	1.95±0.486	0.50±0.673	1.05±0.575	0.59±0.666	1.09±0.610	1.64±0.658	1.86±0.351
31-40	7	2.14±0.378	2.43±0.535	1.43±0.787	1.57±0.535	1.71±0.488	2.00±0.000	2.14±0.378	2.43±0.535
41-50	8	3.63±0.518	3.75±0.463	2.75±0.463	3.00±0.408	2.88±0.354	3.38±0.744	3.63±0.744	3.63±0.744
51-60	6	4.00±0.000	4.00±0.000	3.33±0.516	3.83±0.408	3.67±0.516	4.00±0.000	4.00±0.000	4.00±0.000
61-70	2	4.00±0.000	4.00±0.000	4.00±0.000	4.00±0.000	4.00±0.000	4.00±0.000	4.00±0.000	4.00±0.000

DISCUSSION

The degree of fusion of cranial sutures had been used and practically speaking is still in use for estimation of age in all those settings of the world where autopsies are conducted on routine basis[1,2,3,5,6]. Mean while, this method of age estimation had also been severely criticized for several reasons as not a reliable method for the purpose. 8 To some extent the answer to the criticism could be that one should be very precise in selection of the suture, age limit, its exact definition and method of assessment for determination of age[8,11].

In the current study the suture of the skull had been chosen which is visible to naked eye and is easily accessible. The morphological changes are recorded objectively. The current study revealed that gross positive correlation existed between the degree of suture closure and advancing age. This could be seen with confidence in the subjects with age 25 to 50 years of age[3,7,8,9,11].

Current study revealed that the Sagittal Suture started closing after 21 years, change being clearly evident in the age group 21 – 30 years. This observation was consistent with the observations of Todd & Lyon (1924)[13], Shetty (2007)[11], Parchake (2015)[12], Khandare (2015)[2] and Bhengra (2016)3.

The completion of closure has been observed in age group 51 – 60 years. It was found corresponding to the observations of the research by Parchake (2015)[12] and Bhengra (2016) [3]. The same was found in contrast to Pommerol (1869 [14], and Topinard (1885)[15], Shetty (2007)[11] and Khandare (2015)[2].

To the last, commencement of Sagittal Suture closure was observed at 24 years endocranially and 28 years ectocranially. Completion has been observed at 46 years at the earliest ectocranially and endocranially. Sagittal Suture closure started in the subsections of S1 and S4 followed by closure in S2 and S3. The pattern of closure, more or less was the same ectocranially and endocranially.

CONCLUSION

Determination of age from the sagittal suture of the cranium is a reliable especially in the face of putrefaction and in subjects of age above 30 years. The strongest correlation was found in age class of 31-40 years.12 Suture closure starts as earlier as 21 years endcranially and 28 years ectocranially in the current study. No segment of the sagittal suture was found unclosed endocranially in age class of 41-50 years. Ectocranially the closure was complete in all subjects of age above 60 years.

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