

# Study of Sexual Dimorphism in the Closure of Sagittal Suture – A Postmortem Study

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## ABSTRACT

**Background:** Performing identity is a prime task in medicolegal and postmortem examinations. Age is the first parameter that has to be determined followed by sex. There are several techniques through which sex can be determined. As well there are different anatomical, physiological and pathological parameters determination of sex.

**Aim:** To determine the sexual dimorphism in the cranial 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 early closure in males than in females both ectocranially and endocranially with advancing age in the sagittal suture of cranial vault. The p value was found significant being less than 0.05 thereby establishing the fact that sexual dimorphism in the cranial sagittal suture exists.

**Conclusion:** Conclusively the determination of sex is possible from the pattern of Cranial Sutures closure on autopsy table.

**Key words:** Sex, Sagittal, Suture, Cranial

## INTRODUCTION

Composing data profile of an individual whether in living or dead would always be incomplete without assessing age and sex. Researcher used the skeletal data including the cranial sutures for determination of gender for more than a century.<sup>1</sup> A huge research material is available on morphological examination of skull sutures regarding determination of the gender by forensic anthropologists.<sup>2</sup> The prime objective of analyzing skull sutures, in the first instances, had always been estimation of age and sex. Beside that several research aspirants were interested in determination of gender from cranial sutures as well.<sup>3</sup>

Sex determination is possible from naked eye assessment of the cranial sutures but it better should be assessed in combination with other tools for sex determination into a complex method.<sup>1,4</sup> Todd and Lyon were of the view that sex determination was not possible or not significant in relation to the closure of cranial sutures although all the subjects under study were males.<sup>3</sup> Brooks was totally of different opinion regarding sex determination of an individual from cranial sutures. She observed the suture of the cranium to remain open longer in females than males at the same time of age thus explaining the sexual dimorphism of the sutures of skull. Further she said this must be incorporated as “a secondary confirmation, with caution” in male gender but never in female gender.<sup>4</sup> Acsádi – Nemeskéri study on suture closure for estimation of age is widely known in all corners of forensic research. They studied 352 crania (208 males plus 144 females) and did not observe any gender variation neither endocranially

nor ectocranially.<sup>5</sup> In the late 20<sup>th</sup> Century W. Perizonius (1984) had similar observations for determining gender based on observations of cranial suture closure<sup>6</sup>.

Later in the same year Baker arrived at a total different observation stating that for estimation of age first the gender should be determined. He observed male cranium showing early closure as compared to that of females of same age in a sample of Los Angeles. He said ectocranial cranial closure could partially be used for females but not for males (the opposite to the suggestions of Brook) for determination of gender.<sup>4</sup>

Using the same method Meindl and Lovejoy observed differences to be insignificant for gender determination for suture closure pattern. They applied an entirely new standards and credited that gender determination is invaluable. The most recent studies are again in favor of gender prediction from cranial suture closure conflicting with Meindl and Lovejoy observations.<sup>7</sup> Classical observation regarding sexual dimorphism was seen, Key et al. Females were found exhibiting strong correlation with age<sup>8</sup>.

Besides the closure pattern other morphological features of the sutures were observed by Hauser et al including the size, shape, secondary extensions and protrusions in a population of 35 males and equal no of females in coronal, sagittal and lambdoid sutures. The insignificant gender variations were observed<sup>9</sup>.

Among all the sutures, sagittal suture was found unclosed even at the age of 65 in female gender by Hershkovitz et al. thereby establishing the fact that a close association between the gender and time span pattern of suture closure<sup>10</sup>. A better association of males with lateral – anterior sutures and females with skull sutures was found

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correlated significantly. A clear evidence of early closure of coronal suture in males as compared to female exist.<sup>11</sup>

**MATERIALS AND METHODS**

The study was carried out among the cases 90 dead bodies sample with equal proportions of both the genders with an age bracket of more than 20 years and less than 70 years. All the cases were brought for postmortem examination in the department of Forensic Medicine and Toxicology, King Edward Medical University Lahore. The cases included in the study were brought during the period of nine months i.e. from January 2016 to September 2016 and the data was collected as per proforma after following

the standardized autopsy protocol. The scalp was removed with sickle shaped incision extending from one mastoid to the other. The scalp flaps were reflected anteriorly and posteriorly to the extents until the entire length of the sagittal sutures was made clearly visible to the naked eye. All the tissue including periosteum were carefully removed. The sagittal sutures were studied *in-situ* and suture fusion was observed macroscopically both ectocranially and endocranially.

For better, complete and convenient understanding of the suture closure from the sagittal suture was divided into four equal parts S1, S2, S3, and S4 from front (bregma) to backwards (lambda) shown in the table 01 Fig. 01 below.<sup>12</sup>

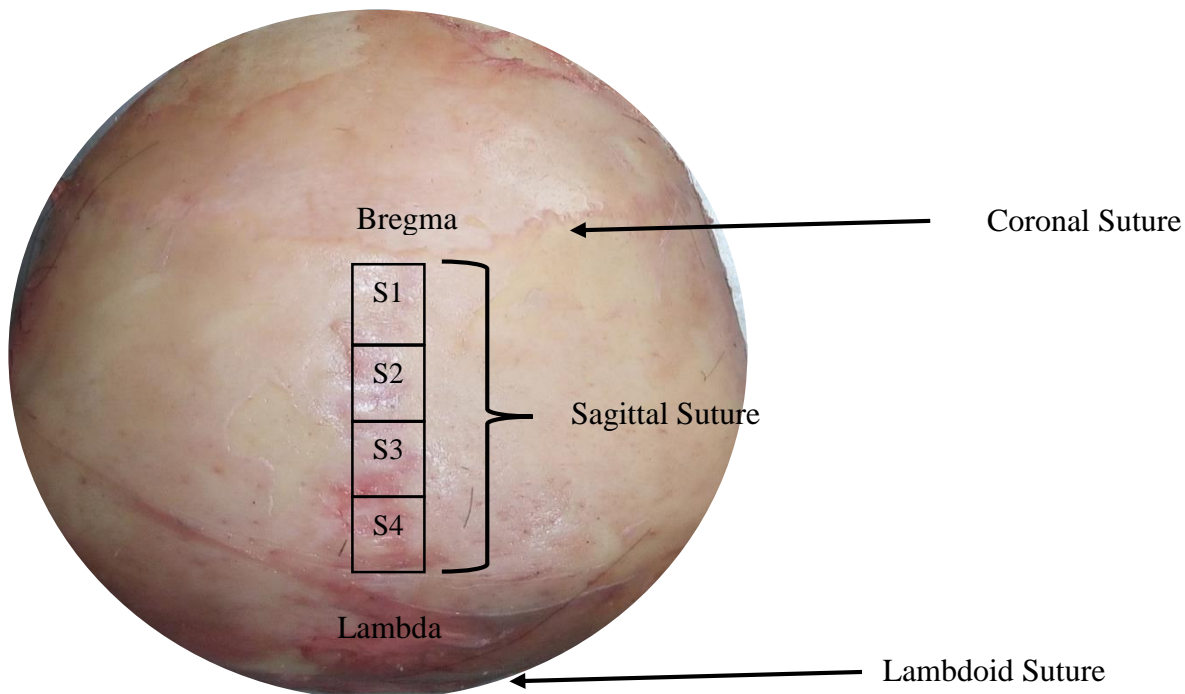


Fig. 1: Description of Sagittal Suture and its Subsections (Ectocranial Surface)

Table 1: Subdivisions of sagittal suture

Suture	Sutural Subdivisions	Units
Sagittal	Bregmatica (S1), Vault Vertica (S2), Obelica(S3), Lambdica (S4)	4

After collection of data ectocranially the skull cap containing the sagittal cranial suture was removed with bone saw. The removed calvarium was carefully cleaned from tissue tags and due attention was given to the visibility of the suture. The calvarium was then air dried and research data from endocranial surface was collected. Every time the observations were recorded and photographed.

The degree of fusion of all the four parts sagittal suture closure was recorded both ectocranially (outer table) and endocranially (inner table) separately following 0 – 4 scales as five grades of Acsádi-Nemeskéri Scale as follows **Acsádi-Nemeskéri Scale (for suture closure):**

- 0 – Open with no closure at all
- 1 – Incipient closure with less than half closed

- 2 – Closure in process with half of the suture closed
- 3 – Advanced closure with more than half of the suture closed
- 4 – Closed completely

**Statistical analysis:** The grade of the fusion of each segment of suture was analysed in terms of the standard deviation and the statistical mean. The mean score were compared in both the genders of male and female ectocranially and endocranially with student t – test. The mean of the sutures closure was estimated and compared. The correlation coefficients and gender comparison of degree of closure for each segment of the sagittal suture was studied. Statistically the less than 0.05 of p – value was taken as significant and the analysis was made in the data pack of SPSS software version 11.0.

**Gender versus age distribution:** The age bracket of all the subjects under study was fixed as 21 years as minimum and 70 years as maximum as shown in the table 02 below. Hence a class of 10 years was made to stratify

the data. The maximum number of cases were observed in the 21 – 30 years age bracket having 32 cases total with 10 males and 22 females (35% as valid percentage). The 31 – 40 years age bracket contained 15 subjects with 08 males and 07 females (16.5% as valid percentage). Similarly the age bracket of 18 subjects with 10 males and 08 females having 20% as valid percentage. The subjects within age bracket of 51 – 60 years contained 14 subjects with 08 males and 06 females with a valid percentage of 15.5%. the last age bracket of 61 – 70 years contributed 09 males and just 02 females producing a valid percentage of 12% of the entire sample.

Table 2: The age groups versus gender distribution (n=90)

Age Group (years)	Male	Female	Total	Valid %age
21-30	10	22	32	35.5%
31- 40	08	07	15	16.7%
41-50	10	08	18	20%
51- 60	08	06	14	15.6%
61 - 70	09	02	11	12.2%

## RESULTS

The process of ossification and degree of the suture closure was critically compared in both the genders to assess the sexual dimorphism in the sagittal suture. The outcome from the student t-test was found to be significant with p – value less than 0.05 estimated from the differences between the mean of the closure status both from male and female cases. The results were the same as depicted in Acsádi-Nemeskéri (1970) study. In order to assess the relation of degree of suture closure and possible age at that point of closure different tools of statistics including spearman rank correlation coefficients, the students' t-test for quality of means and Levene's test of quality of variance (as shown in table 03 below) and SPSS Software version 11.0 were used.

To demonstrate the sexual dimorphism following main aspects were considered significantly.

1. The time scale pattern of ectocranial or endocranial suture fusion in males and females
2. The sex specific pattern of ectocranial or outer table suture fusion/obliteration

Table 3: Levene's test

Independent Samples Test		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Diff.	Std. Error Diff.	95% Interval Difference	Confidence of the
								Lower	Upper	
Mean of the Ectocranial Suture	Eq. Variance assumed	.329	.568	3.278	88	.001	.81556	.24879	.32114	1.30997
	Eq. Variance not assumed			3.278	87.831	.001	.81556	.24879	.32112	1.30999
Mean of the Endocranial Suture	Eq. Variance assumed	.001	.972	3.312	88	.001	.73778	.22274	.29513	1.18042
	Eq. Variance not assumed			3.312	87.929	.001	.73778	.22274	.29513	1.18043

Table 4: Gender based commencement of sagittal suture closure

Ectocranial Closure				
Gender	n	Mean Score	P value	Significance
Male	45	2.86	< 0.05	Significant
Female	45	2.06		
Endocranial Closure				
Gender	n	Mean Score	P value	Significance
Male	45	3.10	< 0.05	Significant
Female	45	2.37		

3. Endocranial or inner table suture fusion/obliteration pattern for the same sex

Significant early commencement of suture closure was observed with a p-value of < 0.05 showing fusion of almost all the parts of the sagittal suture in males as compared to the same age of females. Besides that outer table/ectocranial fusion was observed to commence latter than inner table/endocranial fusion of the same suture in the same sex but earlier in males than in females.

**Gender Based Comparison for Commencement of Sagittal Suture Closure:** With a prime objective to assess sexual dimorphism, in the first instance, it was analyzed as a whole for all the three sutures altogether. It was documented with a much fair degree of significance that suture closure/fusion takes place earlier in males as compared to the same age group of females with a p-value of 0.001 both ectocranially and endocranially. It was also established that suture closure starts from inner table first and then moves to outer table or from endocranial closure to ectocranial closure pattern ensues.

Sexual dimorphism was assessed in the sagittal suture of the cranium and documented with earlier commencement of closure in males than in females as shown in table 04 below. It was also confirmed that closure starts endocranially to ectocranially.

The table 4 shows the ectocranial and endocranial commencement of the sagittal suture closure in males and females separately.

The table shows the early commencement of sagittal suture closure in males as compared to that of the female both ectocranially and endocranially. The maximum closure stage is the stage with score of 4 where the closure is complete. As shown in the table above the ectocranial is more marked in males with mean score of 2.86 (close to 4, the stage of complete closure) as compared to mean score of 2.06 for females with a significant p-value of less than 0.05. Similarly the endocranial closure score is more than 3 which is closest to 4 showing that closure started endocranially first and that in males (3.10 close to final stage of complete closure as 4) more than females (2.37 lesser than males). The p-value is significant being <0.05.

## DISCUSSION

Significant early closure of the sagittal suture in males was observed compared to the female of same age bracket showing hence establishing significant sexual dimorphism. The same was documented in many other scientists including Parson and Box (1905) who categorically

mentioned that cranial suture closure always is later in females than in male<sup>13</sup>.

Though there is a still scientific data available for not favoring the exact sexual dimorphism from the cranial sutures until unless other parameters are incorporated in it but still it can be established with certain degree of accuracy. Moondra states that closure of sagittal and coronal suture are clearly in advance in males than in females<sup>11</sup>.

Our study clearly showed that all the three main sutures closure commences earlier in males than in females. The same also has been documented by Khandare SV (2015) that suture closure take earlier in place in males as compared to females there confirmation of sexual dimorphism in cranial suture closure<sup>14</sup>.

## CONCLUSION

In our study a firm scientific opinion has been established that the sagittal suture closure of the cranial vault has a pattern of fusion in terms of time scale closure clearly helps in sex determination while commencing earlier in males than in females. Though no scientific evidence has been found to justify the pattern but it is assumed that the dipole in between the two table is factor that has a role to play in this sexual dimorphism. Despite this fact that suture closure be able for sexual dimorphism it is highly recommended where possible to incorporate other indicators for determination of sex. However if left with skeletal material cranial suture closure helps in determination of sex while conducting autopsy with quiet a certain degree of confidence.

**Conflict of interest:** Nil

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