*Original Article*

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# Estimation of Stature from the Length of Cranial Sutures By Regression Analysis: A Cadaveric Study in South India

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**Abstract**

*Introduction:* Skull is more represented and reported to forensic experts for the identification of a person. Stature is an important biological profile to help to confirm the absolute identification of a person. The judicial authority still consider stature estimation to confirm the identity. Even though many studies are available from the long bones, the challenge arises when long bones are not available and the formulae derived from these were limited applicable to fragmentary skeletal remain. Hence, we have undertaken the study, for the estimation of stature from the length of cranial sutures.

*Methodology:* The study conducted at the tertiary health care institute in South India. This is a prospective observational study and includes 210 cases out of 229 autopsy cases conducted from December 2016 to December 2018. Out of 210 cases males were 160 (76.19%) and females were 50 (23.81%).

*Result:* The age of cases was ranging from 21 years to 60 years and their mean stature was 162.953 cm. The correlation coefficient (Pearson's correlation, *R*) of total samples for coronal suture length (CSL) and sagittal suture length (SSL) were 0.326 and 0.308 respectively with the stature of deceased (STAD). The results showed, the cranial sutures are weakly correlated with stature in males and the linear regression equation could not be derived for males. The coronal suture showed the moderate correlation with stature in females ($R = 0.300$) and the regression equation derived. The coronal and sagittal sutures showed a moderate correlation with stature in total samples and regression equations derived.

*Conclusion:* The formulae derived are limited to the South Indian population and applicable only when the sex is not identifiable or other long bones are not available. This study was helpful when the skull, head, and vault with cranial suture were available as a fragmentary bone.

**Keywords:** Coronal suture; Cranial suture; Linear regression; Sagittal suture; Stature.

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## Introduction

Skull is one of the most indestructible and noticeable humans remain to persist during the processes of postmortem taphonomic. The skull can be recovered and reported to the forensic expert for the identity of the deceased. But still, there is difficulty in collecting the information from human remains for identification process due to certain reason like decomposition, mutilation and missing of certain parts of bones.[1–4] Age sex, race, and stature are the important biological profile that can be estimated from the skull.[5]

Stature is one of the foremost presumptive findings of identification that leads to other methods to confirm identity.[6] Few studies reported the stature from cranial measurements.[7,8] Krogman and Iscan performed the radiological study in a view of identification of mass disaster victims by observing the cranial capacity, sinus pattern, and shape of sphenoid including sella turcica.[9] Patil and Mody derived a formula for stature from the various skull measurements. They observed the various lengths of a skull by using a radiograph through a lateral cephalometric view. The authors concluded that measurements of a skull were a good reliable indicator for the estimation of stature.[10]

Kalia et al. had done the study by using a lateral cephalometric view of radiographs for estimating the stature from the mesiodistal crown width of the six maxillary anterior teeth. The author concluded that the study was more helpful for estimating the stature.[11] Introna et al. performed a study of estimation of stature from maximum anterior-posterior and lateral diameter of the skull in age between 17 and 27 years old male.[12] Even though many methods to confirm identity like facial reconstruction, superimposition techniques.[13]

The estimation of stature from cranial sutures is quick and easy at the scene of the crime; as compared with other methods.[14] Such studies are very rarely reported in the literature. Skull or head is recovered without the body. Stature estimation is important for identification. This study is helpful for the estimation of stature from cranial suture length. The main objective of the study was to estimate stature from cranial suture length and their correlation. We had derived the linear regression formula, particularly from the South Indian population.

## Materials and Methods

The present study conducted at the tertiary health care institute, in South India. This is a prospective, observational study conducted at the mortuary of our institute during the period from December 2016 to December 2018. Ethical clearance has been taken from the Institutional Ethics Committee (JIP/IEC/2016/1035) before the onset of the study. The study sample includes a total of 210 medicolegal autopsy cases, out of 229 cases. Nineteen cases excluded due to the presence of diastatic fractures and craniotomy. Among these 160 males and 50 females of South Indian origin, aged between 21 to 60 years.

Consent obtained from the legally accepted representative of the deceased in their own language. Cadaver is kept in supine with knee and hip joints extended, and neck and feet in a neutral position. The body length of the cadaver is measured from the vertex to heel with a measuring tape to the nearest 0.1 cm in the supine position. The scalp incised in full-thickness by placing a bi-mastoid incision using a Bard-Parkers knife. The anterior flap reflected till 2 cm above supraorbital ridges, and the posterior flap reflected up tothe external occipital protuberance. The temporalis muscle on both sides is excised out. The length of coronal suture is measured with a measuring tape from left pterion to right pterion. The length of sagittal suture is measured from Bregma to the lambda with a measuring tape. All lengths measured in centimeters to the nearest 0.1 cm. Measurements noted in anonymous data collection proforma by one author to minimize the error. The data computed using the Statistical Package for Social Sciences version 19.0. The correlation between stature and the length of the coronal and sagittal suture carried out by using Pearson's correlation analysis and its significance tested by Pearson's chi-squared test ($\chi^2$). The linear regression equation derived for the estimation of stature from the length of the coronal and sagittal suture.

## Results

The total of 210 cases were analyzed of that 160 (76.19%) were males and 50 (23.81%) were females. The results of statistical descriptive for all cases were given in (Table 1) as per age-wise, the stature of deceased (STAD), coronal suture length (CSL), and sagittal suture length (SSL).

**Table 1:** The Statistical descriptive results for all cases

| Variables | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|
| Age (years) | 21.0 | 60.0 | 39.48 | 13.175 |
| STAD (cm) | 140.8 | 190.2 | 162.953 | 8.2997 |
| CSL (cm) | 20.1 | 28.6 | 23.713 | 1.5572 |
| SSL (cm) | 9.2 | 16.8 | 12.027 | 1.2748 |

A significant and positive correlation noted between STAD and CSL in females ($p < 0.05$) (Fig. 1). CSL showed less correlation with stature in males. The SSL showed less correlation with stature in both sexes. A significant and moderate positive correlation noted between STAD and CSL, SSL in total samples ($p < 0.05$) (Table 2, Fig. 2 & Fig. 3).

**Table 2:** Correlation of cranial sutures with STAD

| Variables | Males | | Females | | Total samples | |
|---|---|---|---|---|---|---|
| | *R*-value | *p*-value | *R*-value | *p*-value | *R*-value | *p*-value |
| CSL | 0.244 | <0.05 | 0.300 | <.005 | 0.326 | <0.05 |
| **SSL** | 0.243 | <0.05 | 0.244 | <0.05 | 0.308 | <0.05 |

*R* is correlation coefficient (Pearson Correlation)

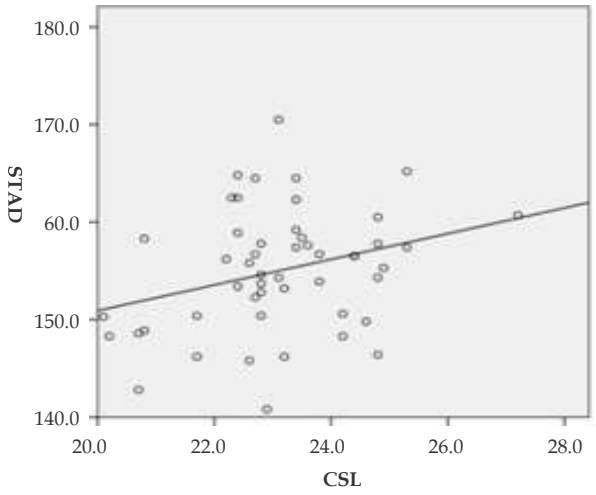


**Fig. 1:** The relationship between STAD and CSL in females.

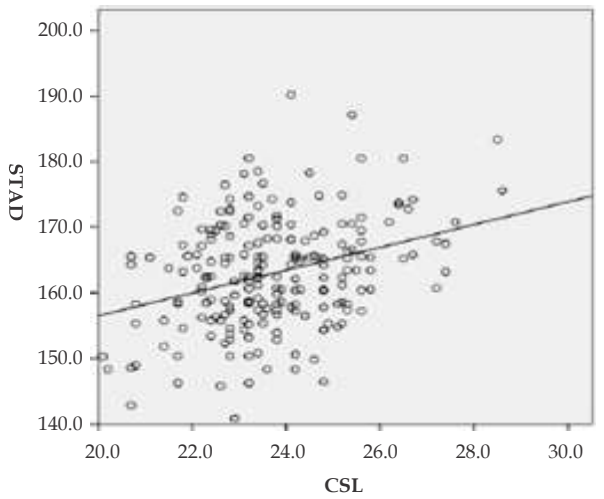


**Fig. 2:** The relationship between STAD and CSL in total samples.

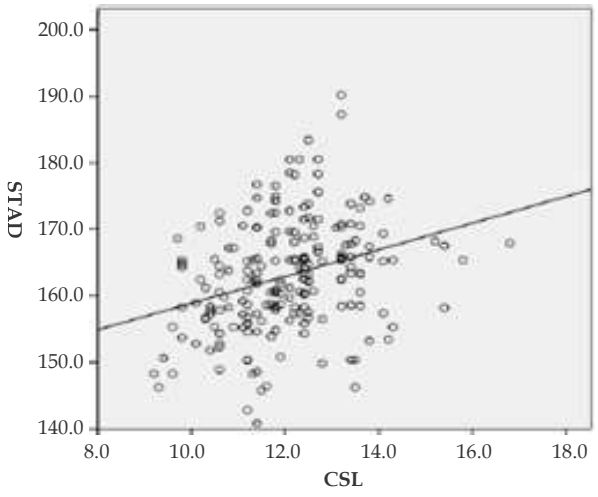


**Fig. 3:** The relationship between STAD and SSL in total samples.

The linear regression equations derived from CSL for the estimation of stature in Females. The linear regression equations from CSL and SSL in total samples are given in (Table 3). The linear regression equations from CSL and SSL for estimation of stature in males could not be derived due to the results were not statistically significant. The linear regression equations from SSL for estimation of stature in females could not be derived due to the results were not statistically significant.

**Table 3:** Linear regression equations for estimation of stature from cranial sutures measurements

| Sample and variable | Linear Regression Equation | SE | $R^2$ |
|---|---|---|---|
| Female | | | |
| $X_1$: CSL | $S = 124.614 + 1.315(X_1)$ | 6.0271 | 0.09 |
| Total samples | | | |
| $X_2$: CSL | $S = 121.719 + 1.739\ (X_{2)}$ | 8.302 | 0.106 |
| $X_3$: SSL | $S = 138.805 + 2.008\ (X_3)$ | 5.194 | 0.095 |

Linear regression equation ($S = \alpha + \beta X$)

"S" is stature, "$\alpha$" is constant according to variables,

"$\beta$" is regression coefficient of variables, "$X$" is variables.

SE-standard error,

$R^2$- coefficient of determination.

The linear regression equations measured in centimeter

## Discussion

Skeletal remains are more often reported to a forensic expert to find the identification of the person.[15] In cases of identification, stature usually estimated by using the regression equation from a length of bones. The main drawback of this method is very difficult and limited applicability to fragmentary skeletal remains.[16] The forensic expert also faces a challenge when long bones are not available and stature estimation from other than long bones should be considered. Amongst the skeletal remain, the skull is most commonly noticeable and reported for personal identity.[17] The judicial authority needs to confirm the identity of a person, they are still considered stature estimation even though the more specific method is available for personal identification. Hence, we undertaken the study, for the estimation of stature from the length of cranial sutures.

In the present study, there is more correlation coefficient between the stature and coronal sutures in females than males. In females, there is significant and more correlation coefficient between the stature and coronal suture length than sagittal suture length. In the present study, there is less correlation coefficient with STAD and cranial sutures in males. Rao et al. studied that, there is more correlation coefficient between the stature and coronal suture length in South Indian male population.[7] The analysis of total samples in our study showed that there is a positive and significant correlation coefficient between the STAD with CSL and SSL. Kolencherry et al. revealed that there is less correlation coefficient of stature with coronal suture ($R = 0.015$) and sagittal suture ($R = 0.045$) in the Central European population.[8]

Rao et al. study, derived the linear regression equation for stature estimation from the length of coronal suture in South Indian male population.[7]In this study, the linear regression equation for stature estimation from the length of cranial sutures could not be derived due to less correlation coefficient with stature in males. In females, the linear regression equation derived for stature estimation from the length of the coronal suture. But the linear regression equation could not be derived from the length of sagittal suture due to less correlation coefficient with stature in the female. On analysis of total samples, the linear regression equation derived for stature estimation from the length of the coronal suture and sagittal suture.

## Conclusion

The present study showed a moderate correlation coefficient with stature and cranial sutures in total samples and high standard errors for stature estimation as compared to previous studies. The formulae derived are limited to the South Indian population and applicable only when the sex is not identifiable or other long bones are not available. This study is helpful when the skull, head, and vault are available with cranial suture as a fragmentary bone. In the males we cannot derive regression formula due to fewer samples. In future similar studies should be carried out on larger samples in other groups of the population to confirm these findings.

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## References

1. Puschel K, Koops E. Dismemberment and mutilation. Arch Kriminol. Puschel K, Koops E Dismemberment and mutilation. Arch

Kriminol 1987;180:88–100.

2. O'Connor WG. Briefly unidentified: A study of peculiar source of identification. J Forensic Sci 1999;44:713–15.
3. Benecke M, Rodriguez Y, Rowinski M Luis Alfredo Garavito Cubillos: criminal and legal aspects of serial homicide with over 200 victims. Arch Kriminol 2002;210:83–94.
4. Tsokos M, Turk EE, Madea B, et al. Pathologic features of suicidal deaths caused by explosives. Am J Forensic Med Pathol 2003;24:55–6.
5. De Mendonca MC. Estimation of height from the length of long bones in a Portuguese adult population. Am J PhysAnthropol 2000;112: 39–48.
6. Krishan K, Kumar R. Determination of stature from cephalo-facial dimensions in a North Indian population. Leg Med 2007;9:128–33.
7. Rao PJ, Sowmya J, Yoganarasimha K, et al. Estimation of stature from cranial sutures in a south Indian male population. Int J Leg Med 2009;123(3):271–6.
8. Kolencherry TV, Birngruber CG, Ramsthaler F, et al. Stature estimation from sagittal and coronal suture lengths for central European individuals. Arch Kriminol 2016;23(5-6): 204–11.
9. Krogman WM, Iscan MY. Calculation of stature. In: Human skeleton in forensic medicine 1986;302–51.
10. Patil KR, Mody RN. Determination of sex by discriminant function analysis and stature by regression analysis: A lateral cephalometric study. Forensic Sci Int 2005;147:175–80.
11. Kalia S, Shetty SK, Patil K, et al. Stature estimation using odontometry and skull anthropometry. Indian J Dent Res 2008;19: 150–4.
12. Introna F Jr, Di Vella G, Petrachi S. Determination of height in life using multiple regression of skull parameters. Boll Soc Ital Biol Sper 1993;69:153–60.
13. Aggrawal A. Identification. In: Textbook of forensic medicine and toxicology. 1st ed. New Delhi: Avichal publishing company 2014; 109–11.
14. Rosing FW, Graw M, Marre B, et al. Recommendations for the forensic diagnosis of sex and age from skeletons. Homo 2007;58(1):75–89.
15. Kanchan T, Krishan K. Anthropometry of hand in sex determination of dismembered remains-a review of literature. J Forensic Legal Med 2011;18(1):14–7.
16. Holland TD. Estimation of adult stature from fragmentary tibias. J Forensic Sci 1992;37: 1223–9.
17. Jasuja OP, Harbhajan S, Anupama K. Estimation of stature from stride length while walking fast. Forensic Sci Int 1997;86:181–6.