DETERMINATION OF THE GENDER FROM THE LENGTH OF SKULL SUTURES

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Abstract

Background: Determination of the identity of an unknown dead body is one of the most important medico-legal roles of forensic medicine. The present study aimed to determine the gender of the deceased body using the length of the skull sutures.

Material and Methods: A cross-sectional study was conducted in the department of forensic medicine, Gandhi Medical College, Bhopal between the periods of January 2016-June 2017. A total of 500 dead bodies were examined for this study. We utilized the discriminant function analysis to predict a relationship between the gender and the independent variables viz. skull sutures.

Results: Maximum numbers of the case belonged to 20-29 years age group and the least were in >70 age group. The minimum age of any case was 20 years and the maximum age was 89 years, mean of age was 38.07 (standard deviation 13.61) and the median age was 35. There was a total of 307 males and 193 females. In the present study, the length of the Coronal suture is the most predictive parameter out of three in determining the gender of the deceased person with a value of 0.946. A total of 66.6% of original grouped cases [263 among 307 males (85.7%) and 70 females from 193 (36.3%)] were correctly classified using discriminant function analysis score.

Conclusion: The correct gender from the skull of the body was identified in about two-third of the cases.

Introduction

Identity means the qualities and characteristics of a person that makes them different from others. Identification of a dead individual can be established utilizing various parameters such as clothes, birthmarks, scar, tattoo marks, malformations, age, sex, race, stature, fingerprints, DNA fingerprinting etc.¹ Age, sex, and stature are the main parameters which lend a hand in establishing the identity of a dead individual. Sex estimation can be done by examining the sexual characteristics like gonads, build, breasts, pubic hair, body hair, etc.¹ However, the task of identifying a dead body becomes challenging when the body has decomposed, is mutilated, or burnt. The highest accuracy regarding the identification of gender, height and age of an individual can be obtained from the complete skeleton.^{2,3} However, not all cases of forensic anthropology have a complete skeleton. Previous research indicates that sex determination using the anatomical and morphological characteristics of the complete human pelvis has the highest accuracy.³ However, the pelvis is shattered or is incomplete in many cases. In comparison, the skull is composed of hard tissue, it is easily preserved, and in most cases, we could only get the skull completely. So, sex identification through the skull becomes the core content of forensic anthropology, and it also is the first step in

craniofacial reconstruction.^{4,5} In the forensic anthropology, sex identification from an unknown skeleton is important for more than one reasons.^{6,7} The determination of sex is essential since the other parameters like age, race, and stature depend on the sex of deceased.⁷ The common investigations of sex classification include morphology discriminant method and measurement discriminant method.⁸ The present study is an attempt to analyse these parameters with the help of skull sutures in Central India region, aiding in the identification of the gender of a deceased person.

Materials and Methods:

Study Design: This was a cross-sectional study. **Study Setting:** The present study was conducted in the Department of Forensic Medicine and Toxicology, Gandhi Medical College, Bhopal, Madhya Pradesh. **Study Duration:** The total duration of the study was eighteen months (January' 2016- June' 2017). **Study Subject:** The study was undertaken on dead bodies coming for medico-legal examination to the Department of Forensic medicine, Gandhi Medical College, Bhopal.

Inclusion Criteria

1. The cases whose correct gender was known before the medicolegal postmortem examination.

2. The age of the person at the time of death was ≥ 20 years.

Exclusion Criteria

1. Unidentified bodies, where exact gender cannot be confirmed.
2. Cases with a severe head injury (based on history and external examination), which may hamper the examination of suture closure.
3. Cases with any congenital or hereditary bony deformity based on history or external examination.

Sample Size: We collected data from 500 dead bodies.

Data Collection:

The body was placed in a supine position on the autopsy table, with the neck and feet in a neutral position. The whole thickness of the scalp was incised with the help of a scalpel between the mastoid process over the vertex in the coronal plane.⁹⁻¹¹ The anterior and posterior halves of the scalp were separated from the skull and then reflected forward and backwards. An incision was made and then the soft tissues adherent to the periosteum along the coronal, sagittal, lambdoid sutures were scraped manually until the suture line over the vertex, the pterion on side, bregma, lambda and asterion on both sides were visible.⁹⁻¹¹ The length of coronal, sagittal, lambdoid sutures was measured using a non-extensible thread and Vernier calliper graduated in millimetres.

The following measurements were taken:

1. **Length of coronal suture:** One end of the inelastic thread was placed over the right pterion then along the coronal suture thread extended up to left pterion. Then these two points were marked, a thread was then fixed on wooden cardboard with the help of pins and distance between the two pins was calculated with the help of Vernier calliper.⁹⁻¹¹
2. **Length of sagittal suture:** One end of the inelastic thread was placed over the bregma and passed along the sagittal plane to the lambda and two points were marked, further process same as above.⁹⁻¹¹
3. **Length of lambdoid suture:** Distance from one asterion to another along the lambdoid suture.⁹⁻¹¹

Data Analysis:

Descriptive analyses were conducted to study the distribution of dependent variables among study participants. A P -value < 0.05 was considered statistically significant. Sex was determined from the length of Sagittal, Coronal and Lambdoid sutures by using discriminant function analysis. Discriminant function analysis: It is a statistical analysis to predict a categorical dependent

variable by one or more continuous or binary independent variables (predictor variables).¹² The following discriminant function is obtained from the discriminant coefficient:

$$Di = 0.119 (SS) + 0.081 (CS) + 0.050 (LS) - 42.842^{12}$$

In the present study dependent variable was gender, and the independent variables were the length of coronal, sagittal and lambdoid sutures. The data was analyzed using SPSS version 20.0. Appropriate statistical tests were applied for comparative data analysis.

Ethical Clearance: The present study was approved in the year 2016 by the ethical board on human research of the Gandhi Medical College, Bhopal.

Results:

The present study was conducted on the 500 dead bodies brought to the department of forensic medicine, Gandhi Medical College, Bhopal for autopsy between the period of January 2016 to June 2017. Maximum numbers of the case belonged to 20-29 years age group and the least were in >70 age group. The minimum age of any case was 20 years and the maximum age was 89 years, mean of age was 38.07(standard deviation 13.61) and the median age was 35 years. There were 307 males and 193 females in total. Table 1 presents the results of our analysis. The Eigen value was estimated to be 0.119 with 100 % variance, which indicates that the dependent variable (gender) is a good parameter for the present analysis. Discriminant function was calculated in the present study using Wilk's Lambda and observed value equalled 0.893, chi-square (χ^2) equal to 55.976, degree of freedom= 3 and P -value of 0.000. Because P value was less than 0.05, we could say that length of sagittal, coronal and lambdoid sutures is a good indicator for sexual dimorphism. The structural matrix analysis shows the correlations of each variable with each discriminant function. Higher the value more is the correlation. In the present study, the highest correlation has been observed with Coronal sutures and least with Lambdoid sutures. In the present study, the length of the Coronal suture is the most predictive parameter out of three in determining the gender of the deceased person with a value of 0.946.

Table 1: The results of the discriminant function analysis.

Eigenvalues		% of variance	Cumulative %	Canonical correlation	
0.119		100	100	0.327	
Wilk's Lambda		Chi square	df	Sig.	
0.893		55.976	3	0.00	
Sutures	Wilk's Lambda	F	Df1	Df2	Sig
Sagittal	0.953	24.376	1	498	0.00
Coronal	0.946	28.527	1	498	0.00
Lambdoid	0.977	11.941	1	498	0.001

From table 2, it can be noted that **66.6 %** of original grouped cases [263 among 307 males (85.7%) and 70 females from 193 (36.3%)] were correctly classified by this DF score. It implies that criteria's length of Coronal, Sagittal and Lambdoid sutures can be used with **66.6 %** accuracy for sex determination.

Table 2: Classification results

	Sex	Predicted group Membership	
		Male	Female
Original count	Male	263	44
	Female	123	70
%	Male	85.7 1	14.3
	Female	63.7	36.3
Total		66.6%	

Discussion:

Establishing the correct identity of an individual from skeletal remains is a major challenge in every country. Identification of an individual can be done employing various parameters such as clothes, birthmarks, scar, tattoo marks, malformations, assessment of age and sex, determination of race and stature, anthropometric measurements, fingerprints, DNA fingerprinting etc.^{1,2} When the available data establish a positive identity and a person is known by his/her name with complete address, it is known as complete identification.¹ However, when only some data are available which do not establish the positive identity of a person, known as partial identification.² Sex estimation can be done by examining the genitals only when the body is intact. But when a mutilated, dismembered or skeletonized body is recovered, these external parameters become a challenge to interpret.²

In our study of 500 dead bodies, maximum numbers of the case belonged to 20-29 years age and the least were in >70 age group. The minimum age of any case was 20 years and the maximum age was 89 years, mean of age was 38.07(standard deviation 13.61) and the median age was 35. In the present study, sex was determined from the length of coronal, sagittal and lambdoid suture using discriminant function analysis. For estimating gender, discriminant function analysis¹² done on the three variables (length of coronal, sagittal and lambdoid suture) and the derived equation is:

$$Di = (0.119 \times SS) + (0.081 \times CS) + (0.050 \times LS) - 42.842^{12}$$

Each subject's discriminant score would be computed by entering his or her variable values in the equation. If the observed value is ≥ 0.273 , it can be depicted that the examined skull belongs to a male. If the observed value is ≤ -0.435 , then the examined skull belongs to a female. In our study coronal, sagittal and lambdoid suture showed a positive correlation with the sex of the individual and were statistically significant ($p < 0.05$), thus these sutures can be used in determining the sex of an individual and accuracy

derived was 66.6%. Various scientists estimated the sex determination based on their selected parameters of the skull, and the accuracy derived (Table 3).

Table 3: Comparison with the results of similar studies¹³⁻¹⁸

S No	Name of scientist	Accuracy (%)
	Sahoo et al (2001)	83.2
	Patil et al (2005)	99
	Rogers (2005)	89.1
	Walker (2008)	90
	Veyre-Goulet et al (2008)	95.6
	Ramsthaler et al (2010)	90.8
	Present study	66.6

Sexual dimorphism is a vital component of the morphological variation among biological populations. The index of sexual dimorphism in the present study was shown to be higher than that of the Sri Lankans (8.46%) and Caucasians: (7.95%) and lower than the Koreans: 10.3%; Turkmenians: 13.61%; Native Fars: 11.22%; and Turkey population: 10.06%.¹⁴ The sexual differences in cranial dimensions emphasize the significance of applying the anatomical variation data to an individual subject in a given population.

In the present study, the difference between each group is 10 years, it should be reduced and sutures like basilar, metopic, lateral, palatal etc. should be included to find better results. The number of cases and gender distribution, age group wise is not uniform. Hence, this (sampling error) has to be taken into consideration in future studies.

References:

1. Reddy NK, Murty OP. The essentials of forensic medicine and toxicology. Jaypee Brothers Medical Publishers; 2014.
2. Buchner A. The identification of human remains. *International dental journal*. 1985;Dec:35(4):307-11.
3. Steyn M, Iscan MY. Metric sex determination from the pelvis in modern Greeks. *Forensic Sci Int*. 2008; 179:86.e81-6.
4. Buikstra JE, Ubelaker DH. Standards for data collection from human skeletal remains. Fayetteville: Arkansas Archaeological Survey. 1994; 44:185-202.
5. Chandrashekhra P. Skull suture—Forensic Science as is what is: The Forensic Science Society of India. Madras 1985. 1985; 166.
6. Camargo JR, Daruge E, Prado FB, Caria PH, Alves MC, Silva RF, Daruge Jr E. The frontal sinus morphology in radiographs of Brazilian subjects: its forensic importance. *Journal of Morphological Sciences*. 2017 Jan 16;24(4).
7. Dong-Sheng C, Yu-Wen L, Cheng T, Run-Ji G, Yong-Chuan M, Jian-Hai F, Wei-Dong W, Jiang Z. A study on the standard for forensic

- anthropologic identification of skull-image superimposition. *Journal of Forensic Science*. 1989 Nov 1;34(6):1343-56.
8. Dayal MR, Spocter MA, Bidmos MA. An assessment of sex using the skull of black South Africans by discriminant function analysis. *HOMO*. 2008; 59:209–21.
 9. Rahilly OR, Muller F, Carpenter S, Swenson R (1983) *Basic Human Anatomy*. (1stedn) London: WB Saunders, United Kingdom.
 10. Krogman WM (1962) *The Human Skeleton in Forensic Science*. (1stedn), Springfield USA: Charles C. Thomas.
 11. Quigley C. *Skulls and skeletons: Human bone collections and accumulations*. McFarland; 2001.
 12. Poulsen J, French A. *Discriminant function analysis*. San Francisco State University: San Francisco, CA. 2008 Oct 23.
 13. Sahoo PC, Mishra SS, De A. Determination of sex from parietal bone for a given height. *Journal of Forensic Medicine and Toxicology*. 2000; 17(2):5-9.
 14. Patil KR, Mody RN. Determination of sex by discriminant function analysis and stature by regression analysis: a lateral cephalometric study. *Forensic science international*. 2005 Jan 29; 147(2):175-80.
 15. Walker PL. Sexing skulls using discriminant function analysis of visually assessed traits. *American Journal of Physical Anthropology*. 2008 May 1; 136(1):39-50.
 16. Rogers TL. Determining the sex of human remains through cranial morphology. *Journal of Forensic Science*. 2005 Apr 6; 50(3):1-8.
 17. Ramsthaler F, Kettner M, Gehl A, Verhoff MA. Digital forensic osteology: morphological sexing of skeletal remains using volume-rendered cranial CT scans. *Forensic science international*. 2010 Feb 25; 195(1):148-52.
 18. Veyre-Goulet SA, Mercier C, Robin O, Guerin C. Recent human sexual dimorphism study using cephalometric plots on lateral telerradiography and discriminant function analysis. *Journal of forensic sciences*. 2008 Jul 1; 53(4):786-9.