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Determination of Sex From The Length of Sagittal, Coronal and Lambdoid Sutures in Cadavers: Delhi Study

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ABSTRACT

Background: Identification of human remains is a major challenge in every country. There are numerous techniques of identification, some of them being reconstructive and other being comparative techniques.

Materials and Methods: The body was placed in supine position on the flat hard surfaced autopsy table, with the knee and hip joints extended, and the neck and feet in a neutral position. The cadaver length (stature) was measured from the vertex of the head to the base of the heel using measurements available on the autopsy table. Present study was undertaken to estimate sex from the length of Sagittal suture, Coronal suture and Lambdoid suture in cadavers. Gender was determined from the length of Sagittal, Coronal and Lambdoid sutures by discriminant function analysis.

Results: 62% of the original grouped cases were correctly classified. In the present study sex was determined from the length of coronal, sagittal and Lambdoid suture using discriminant function analysis. According to our study coronal and Lambdoid suture showed positive correlation and were statistically significant, thus can be used in determining sex.

Conclusion: Sex estimation remains an important step in developing a biological profile for human skeletal remains as methods of establishing stature and age-at-death are frequently sex dependent.

Keywords: Coronal Suture, Sagittal Suture, Lambdoid Suture, Discriminant Function Analysis.

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INTRODUCTION

Identification of human remains is a major challenge in every country. There are numerous techniques of identification, some of them being reconstructive and other being comparative techniques.[1] Identification of an individual must be classified as certain, probable, possible or excluded.[2] Identification of victims from dismembered human remains has always been a challenge for forensic scientists.[3] In certain medico legal cases where only head and face are available it becomes difficult for a forensic specialist to identify the deceased. In such cases, skeletal examination may help in identification, since bones resists decomposition for a long time. Determination of sex from skeletal remains is important for identification of an individual in medico legal cases.[4] The assessment of this demographic characteristic is more reliable if a complete pelvis and skull are available for analysis; however, this is often not the case in forensic and bio archaeological investigations, making it necessary to be able to predict sex from a variety of skeletal elements.[5]

Determination of sex by examination of the skeletal remains is based upon the morphological and morph-metrical features present in the pelvis, skull, sternum and long bones.[6] Discriminant function analysis has been applied for identification in forensic medicine and the result of various methods have shown accuracy ranging from 82%-94%.[7] In discriminant function analysis, reliable equations have been developed for different bones or bone fragments which are used in anthropological research.[8] Studies on the determination of gender from skull is scanty in Indian

population. Considering its importance, we planned to study on determination of sex from skull using length of coronal suture, sagittal suture and lambdoid suture.

OBJECTIVES
To determine sex from the length of Sagittal, Coronal and Lambdoid sutures in cadavers.

MATERIALS AND METHODS
Place of Study: Department of Forensic Medicine UCMS and Guru Teg Bahadur hospital Delhi 95.

Inclusion Criteria
Cases brought for medicolegal autopsy to the Mortuary of Department of Forensic Medicine UCMS and GTB Hospital Delhi were studied for taking various measurements. Initial 150 cases were selected randomly on the basis of that all the cases coming on Monday and Thursday were taken till the desired sample size was achieved.

Exclusion Criteria
1. Cases with head injury on the basis of history and external examination.
2. Cases with any congenital or hereditary bony deformity on the basis of history and external examination.
3. Cases with bone diseases on the basis of history and external examination.

Study Design: Cross sectional observational study

Materials
1. The following instruments and documents were used for the study:
a) Autopsy table and instruments.
b) Inquest papers and other related documents.
c) Flexible Measuring tape
d) Non extensible thread
e) Vernier callipers
f) Standard Autopsy suit and gloves
2. Universal precautions were taken while performing autopsies.
3. Informed consent was taken from relatives.

METHODS
The body was placed in supine position on the flat hard surfaced autopsy table, with the knee and hip joints extended, and the neck and feet in a neutral position. The cadaver length (stature) was measured from the vertex of the head to the base of the heel using measurements available on the autopsy table. The whole thickness of the scalp was incised between the mastoid process over the vertex in the coronal plane. The anterior and posterior halves of the scalp were separated from the skull and then reflected forward and backward. The anterior flap was reflected to a level of 2 cm above the supraorbital ridge. The posterior flap was reflected down to a level just above the occipital protuberance. The temporalis muscle was incised along the superior temporal line on both sides. 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 both sides, bregma, lambda and mastoid angles on both sides were clearly visible. The length of coronal, sagittal, lambdoid sutures was measured using a non-extensible thread and vernier callipers graduated in millimeters.[1] The following measurements were taken:

I. **Length of Coronal Suture**: one end of the inelastic thread was placed over the right pterion at the junction of the sphenoparietal with the sphenofrontal sutures along the coronal plane to the pterion at the junction of the sphenoparietal with the sphenofrontal sutures on left side and two points were marked, the thread was then placed on vernier callipers and the reading was taken.[4]

II. **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, the thread was then placed on vernier callipers and the reading was taken.[4]

III. **Length of Lambdoid Suture**: one end of inelastic thread was placed over the right mastoid angle of the parietal bone along the occipitomastoid suture between the occipital and temporal bones to the mastoid angle over left side and two points were marked, the thread was then placed on vernier callipers and the reading was taken.[9]

A predesigned proforma was used to enter the various data for parameters being studied. Three measurements in millimeters were taken for each parameter to improve the accuracy of reading and the mean of all the three readings were taken. All the measurements were taken and cross checked to minimize measurements error.

Statistical Methods: Sex was determined from the length of Sagittal, Coronal and Lambdoid sutures by using discriminant function analysis.

RESULTS AND DISCUSSION
The study was conducted in the department of Forensic medicine UCMS and GTB hospital from the period of 1st November 2011 to 30th February 2013. 81 males and 69 females were studied. Present study was undertaken to estimate sex from the length of Sagittal suture, Coronal suture and Lambdoid suture in cadavers. Data collected were subjected to statistical analysis. Gender was determined from the length of Sagittal, Coronal and Lambdoid sutures by discriminant function analysis.

DISCRIMINANT FUNCTION ANALYSIS
Stepwise method was used
Selection of factors for discriminant function analysis was done and Multivariate analysis was carried in SPSS 17.0
1. Eigen values
2. Wilk's Lambda

Table 1: Showing Eigen values

Eigen values	% of variance	Cumulative %	Canonical corelation
0.102	100	100	0.304

The ultimate goal of positive identification can be done by antemortem and post-mortem comparison and craniofacial reconstruction techniques may only be a lead towards a proposal for identification.

Various methods were used to establish the identity of unknown human remains. In the present study, gender has been estimated from coronal, sagittal and Lambdoid suture. In table 1 the eigen values, percentage variance, cumulative and canonical correlation were found to be 0.102, 100,100 and 0.304 respectively.

Table 2: Showing Wilk's Lambda

Wilk's Lambda	Chi square	df	Sig.
0.907	14.300	2	0.001

In table 2; the sex discrimination analysis was done by wilkslamba method, The results revealed that wilkslamba value was estimated to be 0.907.

Table 3: Structural matrix

Variables	Function
Coronal suture	0.777
Lambdoid suture	0.625
Sagittal suture	0.137
Age	0.064

Table 3 depicted function analysis of various variables i.e coronal, lambdoid and sagittal sutures. The significance values of coronal, lambdoid, sagittal sutures and age were obtained to be 0.777,0.625,0.137 and 0.064 respectively. In table 4 tests of equality of group means were done. The wilks lambda values of age, coronal, sagittal and lambdoid suture were attained to be 0.992, 0.942,1.000 and 0.962 respectively.

Table 4: Tests of Equality of Group Means

	Wilk's Lambda	F	df 1	df 2	sig
Age	.992	1.186	1	148	0.278
Coronal suture	.942	9.138	1	148	0.003
Sagittal suture	1.000	.066	1	148	0.797
Lambdoid suture	.962	5.916	1	148	0.016

Table 5: Classification Function Coefficients

	Sex	
	Male	Female
Coronal suture	1.375	1.336
Lambdoid suture	1.107	1.075
(Constant)	-255.900	-241.711

As shown in table no. 5 Classification Function coefficients of Coronal suture in males is 1.375 and for females is 1.336. Classification Function coefficients of Lambdoid suture for males is 1.107 and for females is 1.075. The constant for males is -255.900 and the constant for females is -241.711.

Method of Classification of Cases

The estimate of the classification function for females and males were based on Fisher's linear discriminant function.

$1.336 \times$ Coronal suture $+1.075 \times$ Lambdoid suture $- 241.711$ (Female)

$1.375 \times$ Coronal suture $+1.107 \times$ Lambdoid suture $- 255.900$ (male)

Fisher's Linear Discriminant Function (Z)

When there were only two groups as in this case, the difference between the two groups gives the Fisher's Linear Function

$Z = 0.061 \times$ Coronal Suture Length $+0.049 \times$ Lambdoid suture $- 22.299$

Probability of classification of cases into Male and Female category: It can be found out using this formula:

$$1 / [1+ e^{-(0.061 \times \text{coronal suture length} + 0.049 \times \text{Lambdoid suture} - 22.29)}]$$

Table 6: Classification results

Original count	Sex	Predicted group Membership		Total
		Male	Female	
	Male	46	35	81
	Female	22	47	69
%	Male	56.8	43.2	100
	Female	31.9	68.1	100
	Total	62 %		

As shown in table no. 6, 62% of the original grouped cases were correctly classified. In the present study sex was determined from the length of coronal, sagittal and Lambdoid suture using discriminant function analysis. According to our study coronal and Lambdoid suture showed positive correlation and were statistically significant, thus can be used in determining sex. Present study is significant because it predicts sex by 62% accuracy taking only two parameters into account. Our results were in line with various previous studies. According to one study, Keen[10] (1950) documented an accuracy of 85% based on selected cranial traits and dimensions of Cape coloured skull from South Africa which is greater than the present study. Hanihara[11] (1959) reported an accuracy of 83%-89% in sexing Japanese skull which is greater than the present study. Giles and Elliot[12] (1962) determined sex from the skulls of American Blacks and Whites using discriminant function analysis and reported an accuracy of 83%-89%. Krogman[13] (1986) determined sex from skull alone 92% and from pelvis and skull bone with 98% accuracy. Sahoo[14] et al determined sex from the coronal suture using discriminant function analysis and reported an accuracy of 83.2% which is greater than our study.

CONCLUSION

Sex estimation remains an important step in developing a biological profile for human skeletal remains as methods of establishing stature and age-at-death are frequently sex dependent. Our study mainly determined that gender differentiation using discriminant function analysis resulted to be noteworthy method for coronal suture and Lambdoid suture.

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