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SEX DETERMINATION OF YOUNG ADULTS IN BILASPUR BY DISCRIMINANT FUNCTION ANALYSIS OF LATERAL RADIOGRAPHIC CEPHALOMETRY

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ABSTRACT:

Aim: To test the validity of sex discrimination using lateral cephalometric radiography and discriminant function analysis in young adults and to set certain population- specific standards for the same.

Methods and Materials: Lateral cephalograms of 35 male and 35 female patients visiting the OPD of TIDHRC, Bilaspur were taken in a standard position with teeth in centric occlusion and lips relaxed. Each radiograph was traced and cephalometric landmarks were determined with the help of a good viewer. Calculations of 10 cephalometric measurements were performed. Descriptive statistics including means, standard deviations, and coefficient of variations were calculated for all the variables. The cephalometric data was treated using SSPS.

Results: 4 linear and 2 angular measurements were significantly different between the genders, indicating the presence of sexual dimorphism in the skull. With discriminant function derived by using all the 10 variables simultaneously the sex was determined correctly in 85% of the cases.

Conclusion: From the results of the present study, it may be concluded that sex determination can be done with greater reliability

Keywords: Anthropology, Sex determination, Lateral cephalometry, Discriminant function analysis.

INTRODUCTION:

Human identification is a set of physical characteristics, normal or pathological, functional or psychic, that define an individual. It is a universal process based on scientific principles, involving finger printing primarily, whose objective is identification and registration of individuals for both civil and criminal identification purposes.

Forensic anthropology is the application of the knowledge of physical anthropology for the purpose of forensic medicine.[1] When the scientific method of identification by fingerprint is not possible , than the identification of human remains demands a forensic medicine investigation. The skill process characterizes the medico legal identification and is based on the application of knowledge of forensic anthropology. [2]

One of the most important stage in forensic anthropological examination is determination of sex by skeleton. Sex

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determination is a key factor in determining the biological profile of an individual. Identification techniques such as facial reconstruction would be impossible if sex is not correctly established. So for isolating, interpreting and quantifying the manifestations of sex form an essential part of all skeletal analyses. The studies on sex determination are based on the differences between the sexes that is present in the majority of human bones. [1, 2]

The determination of sex, age and race is almost 100% reliable using the complete skeleton [3-7], 96% reliable while using the pelvis alone [8, 9] 90% reliable when using the skull alone and 97% when using both the pelvis and skull. [8, 9] Skull is the best preserved part of the skeleton after death as it is composed of hard tissue, so it is probably the second best region of the skeleton for determination of the sex. In some cases it is the only available part for forensic examination.. [5-7] When skulls are placed on flat surface, the male skulls rest on the mastoid process, while female skulls rest on the occipital condyles or other portions of the skull. [1] Anthropologists and anatomists developed this branch known as craniometry or cephalometry which with the discovery of X-rays and the increased use of cephalometric radiographs in clinical and research of the growth of skull. [1,2] became ideal for the skull examination as a single radiograph gives details of various anatomical points as well as provide with the architectural and morphological details of skull super structures for comparisons.[10]

In general, while the male skulls are identifiable by being more robust; the female skull is characterized by a weaker development of its superstructures. All bony ridges, crests and processes are smoother and smaller in the female skull as compared to the male skull, especially the nuchal lines, temporal line, external occipital protuberance, mastoid processes, and superciliary arches or ridges. [10, 11]

Discriminant function analysis is a statistical technique that enables the researcher to examine the relationships among two or more groups based on any number of variables simultaneously, and is used to predict group membership from a set of predictors and to classify cases into the values of a categorical dependent, usually a dichotomy. Discriminant function analysis is increasingly utilized for sex diagnosis of skeleton measurements. [2, 12]

Hence, this study is undertaken to evaluate the sex determination technique from the skull using lateral cephalometry and discriminant function analysis, and attempt to develop a technique which can determine the sex from the skull using lateral cephalometric radiograph and discriminant function analysis.

MATERIALS AND METHODS:

The study is carried out in Department of Oral Medicine and Radiology, Triveni Institute of Dental Sciences Hospital &

Research Centre, Bilaspur. 70 young adults were randomly selected within age group 20-40 from the subjects who attended the OPD out of which 35 were males and 35 were females. An informed consent and approval from the institute ethical committee was taken. The patients with a history of trauma or surgery of the skull, developmental disorders, facial asymmetry or any history of prolonged illness, orthodontic or orthognathic treatment were excluded from the study.

Lateral cephalometric radiograph of each subject was taken on the X-ray machine with teeth in centric occlusion and lip relaxed. X-ray films were processed by visual method and good quality radiographs were included in the study. Each radiograph was traced on acetate tracing paper and cephalometric landmarks were determined as shown in fig 1

The commonly used line and plane in lateral cephalometric analysis.6, Nasion to sella (N - S) line and the Frankfurt horizontal (FH) plane was used as reference. 10 measurements (six linear and four angular) as shown in table 1 were measured on each radiograph.

STATISTICAL ANALYSIS

Descriptive statistics such as means, standard deviation, and (CoV) coefficient of variation were calculated for all the variables. These values were compared between both the sexes using Student's t test. $P < 0.05$ value were considered to be significant.

The cephalometric variables data was treated with the (SPSS) discriminant functional analysis. Various combination of variables were analysed to obtain most accurate sex determination. The combination included were all cephalometric variables (linear and angular), only linear variables, only angular variables, only those significant angular variables and only significant linear cephalometric variables were considered.

RESULT:

The cephalometric radiograph of 70 adults from Bilaspur, Chhattisgarh with equal number of males and females was analysed. The subjects were age matched with mean age of males is 27.48 ± 6.8 years as compared to 26.85 ± 7.2 in female's .The descriptive statistics of 10 cephalometric variables which were analysed are given in table no. 2. The mean valves of all the linear cephalometric variables and angular variables except Gonial angle were more in males is more as compared to females. The difference of mean was found to be statistically significant in 4 linear variables and 2 angular variables.

Table 3 shows the percentage of individuals correctly sexed according to discriminant functions. When all the 10 cephalometric variables angular as well as linear were included it correctly classified 82.86% males, 85.71% females and 84.29 % of the total subjects. When all the angular cephalometric variables were used it correctly classified 71.43 % of the sexes, while with all the linear

cephalometric variables 81.43% of the sexes were correctly classified

When only those significant angular cephalometric variables were included, 68.57% of the sexes were classified correctly and when only those with significant linear cephalometric variables were included, 80% of sexes were classified correctly.

DISCUSSION:

Determination of sex based on skeletal features plays a crucial role in legal medicine and forensic anthropology. The identification of sex from adult human remains is highly reliable if the complete skeleton is available for analysis but in many cases, skull is only available for the forensic examination after death and hence determination of sex and stature from skull is of great significance in establishing the identity of a person in a medico legal case. [13]

Two approaches have been adopted by researchers morphological (nonmetrical) and metrical, for the determination of sexual characteristics from bones.3 Morphological attributes are more subjective and sex determination depends on the experience of the investigator, inexperienced workers are likely to make inaccurate assessment of sex based using visual methods. However, when both of the approaches are applied it improves accuracy, as they complement each other.3 Also, the technique of discriminant function analysis solves some of the problems inherent in subjective methods of sexing skulls, providing a relatively simple, objective means of sex determination with a calculable reliability.[14]

In this study 70 subjects from Bilaspur, Chhattisgarh 84% were classified correctly when 10 cephalometric parameters were used. Differences exists in various races as regards of sexual differentiation, what may be true for one population may not be necessarily true for another, so discriminant function technique is therefore applied for determination of sex from skulls. In this study, men showed significantly larger measurements for 4 linear skeletal parameters namely, N-S Nasion Sella , Menton- Gonion(Me-Go), Nasion-Anterior nasal spine(N-ANS) and Condylon-Gnathion(Co- Gn) and 1 angular parameter Point A – Nasion - Point B (ANB) whereas females had larger measurements for 1 angular parameters namely, Gonial angle at $p < 0.05$. However, all other parameter differences were found to be non-significant between the two genders. The studies done on various population for determination of sex from lateral cephalometric radiograph using discriminate analysis is compared in table no 4. [15]

Thus we can state here that skull sex determination methods using lateral cephalographs with discriminant function analysis seem always suitable, but the most accurate variables differ relative to the different population.

CONCLUSION:

Cephalometry has the advantage of being quantified by the effective means of discriminant analysis. We obtained greater reliability of sex determination from skulls with perfect accuracy in this work with radiographic cephalometry and discriminant analysis. In future work, the same research methods would be applied to radiographic cephalometry of the skulls in another test samples to confirm the reliability of the model of sex assignment.

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TABLES:

Table 1 Cephalometric variables used for the analysis

VARIABLES	DESCRIPTION
LINEAR MEASUREMENTS	
a) N-S	Nasion sella, describes the length of the anterior cranial base.
b) Me-Go	Menton-gonion: The extent of the mandibular base
c) N-Sna	Vertical dimension between nasion to anterior nasal spine
d) Sna-Me	Vertical dimension between anterior nasal spine to menton
e) Co-Gn	Describing the total mandibular length: condylon to gnathion.
f) S'-Co'	Dimension measured on Frankfort horizontal plane between the projection of sella and condylon.
ANGULAR MEASUREMENTS	
a) Sella-Nasion-Point A (SNA)	Describes the horizontal position of the maxilla to the cranium
b) Sella-Nasion-Point B (SNB)	Indicates the position of the mandible to the cranial base
c) Point A-Nasion-Point B (ANB)	Magnitude of the horizontal skeletal jaw discrepancy between the maxilla and the mandible.
d) Gonial angle	The angle between the mandibular plane and the mandibular ramus plane.

Table 2 The descriptive statistics of cephalometric variables

Variable	Units	Male		Female		t value	p value
Age	Years	27.48	6.8	26.85	7.2		
N-S	mm	74.33	6.32	71.88	4.47	3.43	< 0.05*
Me-Go	mm	74.68	5.41	71.8	4.7	2.08	< 0.05*
N-Sna	mm	53.84	3.9	50.3	5.5	3.07	< 0.05*
Sna-Me	mm	70.1	6.71	69.25	6.33	0.43	0.65
Co-Gn	mm	119.7	5.98	113.84	5.73	3.06	< 0.05*
S'-Co'	mm	18.6	4.5	15	3.75	1.61	0.09
SNA	deg	81.5	4.18	80.71	3.63	0.91	0.37
SNB	deg	77.44	4.09	76.74	3.74	0.38	0.72
ANB	deg	4.03	1.61	3.55	1.83	2.12	< 0.05*
Gonial angle	deg	119.66	7.17	124.26	10.64	-2.46	< 0.05*

Table 3 Percentage of individuals correctly sexed according to discriminant functions

Sno.	Discriminant function	Correct Classification (%)		
		Male	Female	Total
1	All cephalometric variables (both linear and angular) included	82.86	85.71	84.29
2	All angular cephalometric variables included	68.57	74.29	71.43
3	All linear cephalometric variables included	80.00	82.86	81.43
4	Only significant angular cephalometric variables included	65.71	71.43	68.57
5	Only significant linear cephalometric variables included	77.14	82.86	80.00

Table 4: Comparison of discriminant analysis showing % accuracy in sex determination

Author	No. Of Parameter	Population	% Classified Correctly
Hsiao et al (1996)	18	Taiwanese Population	100%
Franklin et al,(2005)	8	South African	77 To 80%
Patil & mody(2005)	10	Central Indian Population	99%
Hasio et al, 2010	22	Taiwanese Population	95%
Badam et al, 2011	15	Bengaluru	84%
Mahesh kumar et al , 2013	4	Haryanvi Baniyas	77.50%
Mathur et al, 2013	11	Nasik	93%
Present study	10	Bilaspur	85%

FIGURES:

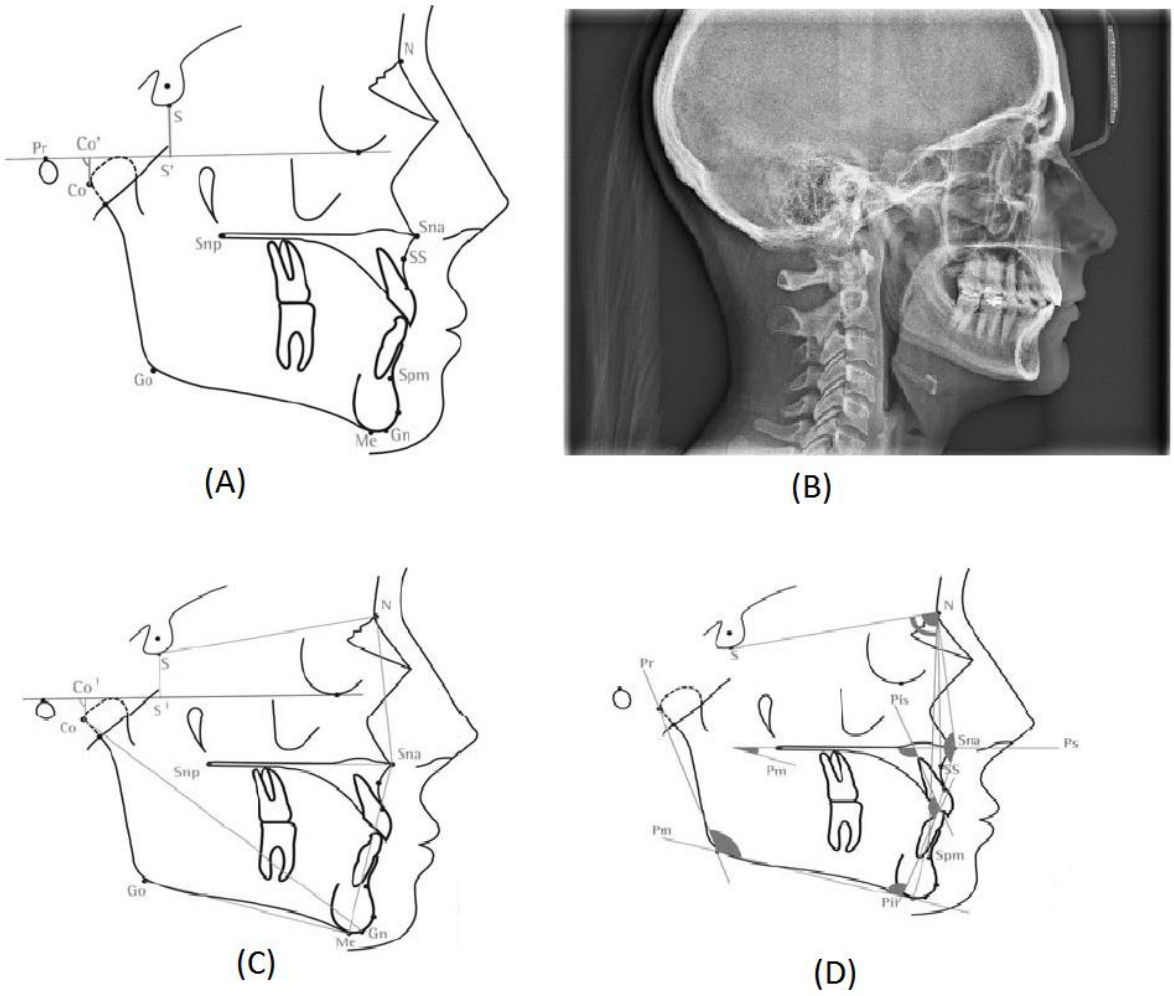

Fig 1 (A) Showing various cephalometric landmarks. (B) Cephalometric radiograph (C) Showing various linear variables (D) Showing various Angular variables