Original Study

GENDER PREDICTION FROM DIGITAL LATERAL CEPHALOGRAM – A PRELIMINARY STUDY

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ABSTRACT

Aim: Determining sex from skull is a challenge to forensic dentist. There are studies conducted to predict gender based on cranial measurements radiographically. Our study attempts to predict gender from facial skeletal variables both linear and angular in digital lateral cephalograms. The aim of the study is to evaluate the role of facial skeletal variables in digital lateral cephalogram to predict sex.

Materials and Method: A total of 24 digital lateral cephalogram images of 12 males and 12 females with age range from 11 to 35 years made using PLANMECA PROMAX CEPHALOSTAT were taken from the archive of our institute for evaluation. In this study six facial skeletal variables were measured using DIMAXIS-3 software and the variables are subjected to discriminant function analysis to predict gender.

Results: In the present study predicted Accuracy for males is75%; for Female 66.7% and the overall 70.83% of the cases are correctly classified by the discriminant Function.

Conclusions: The recommended morphological traits of the skull can be used in combination to assess the sex of unidentified skull in the field of forensic dentistry.

Key Words: Digital lateral cephalogram, linear variables, angular variables, discriminant function analysis.

Introduction

The importance of determining the identity of an individual from his/her skeletal remains arises in natural mass disasters and man-made disasters. Various techniques are employed to identify the individuals from the skeletal remains.[1] Predicting sex is the first step and has been predicted by using cranial measurements.[2,3] Also skulls show population specific differences.[4,5] With this background, an attempt is made to determine the sex of individuals using facial skeletal variables, as no study is conducted using these variables from digital lateral cephalogram in Pondicherry, India population.

Materials and Method

A total of 24 digital lateral cephalogram images of 12 males and 12 females with age range from 11 to 35 years made using PLANMECA PROMAX CEPHALOSTAT were taken after ethical clearance not patient consent as it was a pilot study from the archives of our institute for evaluation. The radiographs with proper angulation, contrast and positioning and images free from any processing and technical errors and artifacts were included. The radiographs revealing bony pathoses and fractures involving craniofacial skeleton images of patients with prior orthodontic/orthognathic treatment were excluded.

The cephalometric bony landmarks were noted and three linear measurements like : [Figure 1]

1. Total facial height (measured from Nasion (N) to Menton (Me)),
2. Mandibular length (measured from Condylion (Co) to Gnathion (Gn)),
3. Maxillary length (measured from Point A to PTM point) and three angular measurements. [Figure 2]
4. Facial angle (angle formed between Frankfurt horizontal plane and the connecting Nasion and Pogonion)
5. Y- axis or growth axis (angle formed between the lines connecting Gnathion and Sella point and Frankfurt horizontal plane and
6. Mandibular plane angle –MPA (angle formed between lower border of mandible and the Frankfurt horizontal plane) were measured using DIMAXIS-3 software. [Figure 3]

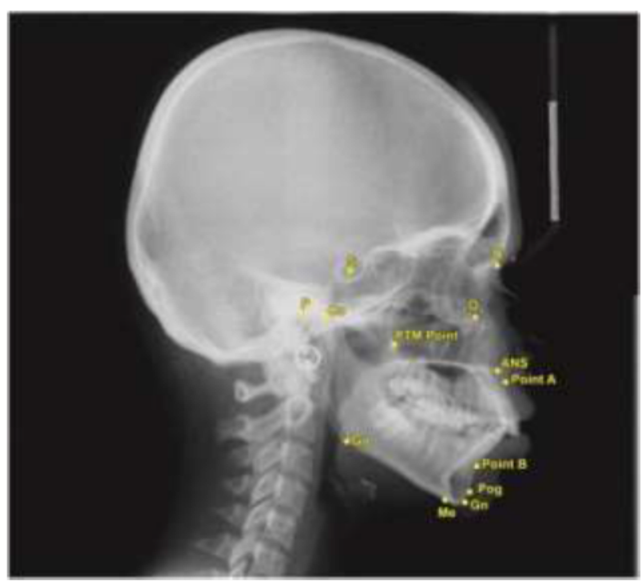

Figure 1: Cephalometric bony landmarks

S- Sella; ANS – Anterior nasal spine; N – Nasion; Point A – Subspinale; P – Porion; Go – Gonion; Co – Condylion; Point B – Submentale; O – Orbitale; Pog – Pogonion; PTM Point – Pterygomaxillare Point; Gn – Gnathion; Me – Menton

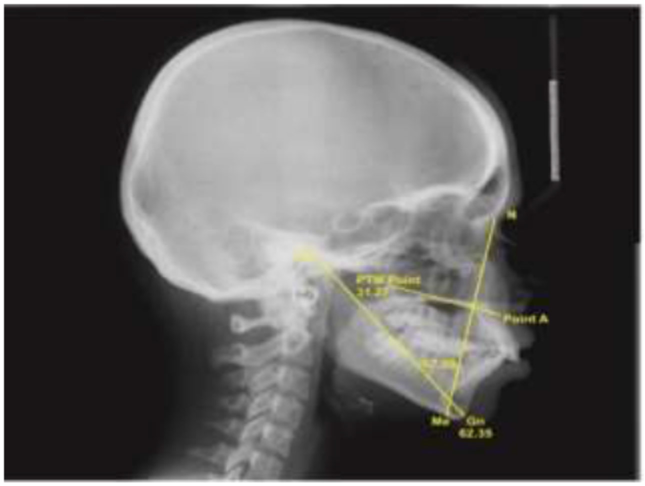

Figure 2: Maxillary length (measured from Point A to PTM point) [Figure 2] and three angular measurements

N – Me = Total Facial Height
PTM point – Point A = Maxillary length
Co- Gn = Mandibular length.

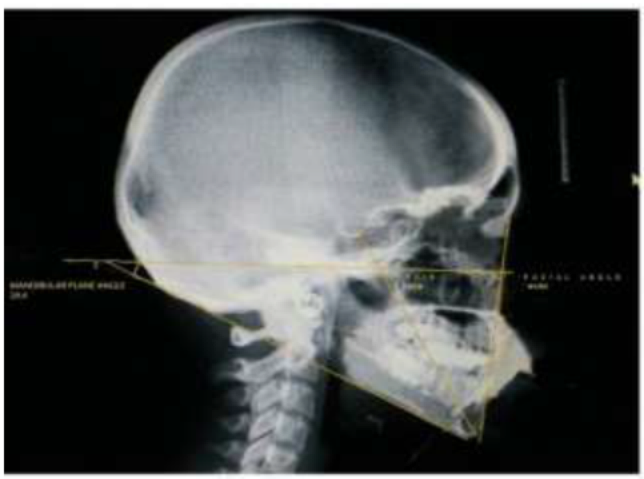

Figure 3: Mandibular plane angle –MPA (angle formed between lower border of mandible and the Frankfurt horizontal plane) were measured using DIMAXIS-3 software.

MPA – Mandibular Plane Angle
FA – Facial Angle
Y – Axis.

Statistics

The computer-aided statistical software 'SPSS version 17' was used for the analysis of the data. Statistical method used for sex determination was discriminant function analysis.

Results

Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on mean ± SD. Significance is assessed at 5% level of significance. T-test has been used to find the significance of study parameters on continuous scale between two groups. [Table 1]

Variable	Male		Female		Diff	t-value	p Value	Discriminant Analysis	
	Mean	SD	Mean	SD				STDC**	%
N-M*	72.22	6.22	67.88	4.71	4.34	1.93	0.0668	0.546	337.57
Co-Gn†	72.52	7.30	67.79	4.45	4.72	1.91	0.0689	0.816	504.36
PTM point-Point A‡	32.90	3.63	32.49	1.72	0.41	0.35	0.7285	-0.502	-310.38
Facial angle§	86.68	3.66	86.63	3.81	0.06	0.04	0.9698	-0.376	-232.52
YAXIS‖	60.45	4.76	59.78	3.79	0.67	0.38	0.7079	-0.284	-175.32
MPA¶	29.33	5.89	27.17	4.23	2.17	1.03	0.3121	-0.038	-23.70
								0.162	100.00

*N-M * Total facial height; Co-Gn† Mandibular length; Y-AXIS|| Growth axis; PTM point – Point A‡ Maxillary length; MPA¶ Mandibular plane angle; Facial angle§ Facial angle; STDC** Standardized Coefficient*

Table 1: Six cephalometric variables were subjected to discriminant function analysis to test their efficacy in differentiating the two sexes.

As shown in Table 1, out of six variables used two were useful in the discrimination of sex (p value close to 5%). It was noted that N-M and Co-Gn emerged as major variables in the determination of sex. The variables Point A-PTM point, Facial angle, Mandibular plane angle and Y-axis were not useful in discrimination of sex among the study subjects. A discriminant function equation was derived using the coefficient of cephalometric variables. [Table 2]

Variables (Parameters)	Function Coefficient
TFH	0.0989
MANDLEN	0.1349
MAXLEN	-0.1768
FACANG	-0.1007
Y AXIS	-0.0659
MPA	-0.0075
Constant	2.2859

Table 2: Discriminant Function Coefficients of Six Parameters of facial skeletal cephalometric measures

Discriminant function equation derived is present below :

***D** ={2.2859+0.0989 (TFH) + 0.1349 (MANDLEN) – 0.1768 (MAXLEN) – 0.1007 (FACANG) + -0.0659 (Y AXIS) – 0.0075 (MPA)}*

Functions at group centroids were 0 to ± 0.4643, with 0 to 0.4643 being for males and 0 to –0.4643 being for females. [Table 3]

Sex	Function
Male	0.4643
Female	-0.4643

Table 3: Functions at Group Centroid – Evaluated Using Unstandardized Discriminant Functions for Male and Female Groups

The reliability of the derived discriminant function was assessed among the study subjects; 75% of the males were recognized as males and 67% of the females were recognized as females, overall 70% of the individuals were classified by discriminant function equation. [Table 4]

		Sex	Predicted Group Membership		
			Male	Female	Total
Original	Count	Male	9	3	12
		Female	4	8	12
	%	Male	75.0	25.0	100.0
		Female	33.3	66.7	100.0

Table 4: Accuracy of Discriminant Function in Sex Determination

Discussion

Sex, age, stature and ethnicity defined the biological profile of an individual.[6] Knowing a person's identity from his/her skeletal remains was important in natural disasters like tsunami, earth quake and man-made disasters like genocide and mass psychotic behaviour like war. Knowing the sex was the first step in the identification process. There were certain morphological skeletal traits that showed sexual dimorphism which helped in identification of which pelvis was the most determinant followed by other traits like long bones and skull.[4] Although they showed gender differences the predictive capacity increased to 100 per cent when taken together and combined with laboratory methods like DNA analysis. These were undertaken in series as a part of two stage strategy.[7] This study intended to identify the sex from an individual's skull remains. Bones especially skull helped in identification of sex, after pelvis, as it resists decomposition.[6] From skull measurements sex equation could be formulated but differs from one population to another due to influences from environmental and epigenetic factors like climate, socioeconomic status, dietary patterns and physical activities. Cephalograms were favoured for craniofacial assessment as they were more objective, standardized and reproducible.[5,8] Various studies had been conducted to determine the role of cephalometric variables in predicting gender. To the best of our knowledge this study was unique wherein we included facial skeletal parameters, both linear and angular, to determine gender based on the premise that the viscerocranial structures show relatively more growth which grow after the completion of neurocranial growth[8] and so may showed gender differences and was the first study conducted using facial skeletal parameters in our population. The variables chosen werre total facial height, maxillary length, mandibular length, facial angle, growth axis and mandibular plane angle. The linear and angular measurements were subjected to statistical analysis using SPSS version 17. It was observed that the total facial height (N – Me) and Mandibular length (Co-Gn) showed gender differences. The standard coefficient for the variable mandibular length had the value 0.816 followed by total facial height and maxillary length with values 0.546 and -0.502 respectively showing discriminatory power. The p values for total facial height and mandibular length werre 0.0668 and 0.0689 respectively. In the present study 70.83% of the cases were correctly classified by the discriminant function. In the study conducted by Mahalakshmi *et al*[2] to predict gender Mastoidale height was best classifier as male and female, with total facial height also showing gender difference.Almas Binnal *et al*[9] conducted a study to determine gender from lateral cephalogram and it was noted that Ma-SN, Ba-ANS, N-M and Ma-FH were the major variables in determination of sex. Zovando MDA *et al*[10] predicted gender from linear measurements from lateral cephalogram found that bizygomatic width and Na-ANS showed gender differences using discriminant function. Osvaldo *et al*[11] used discriminant function analysis to determine gender from cephalometric variables and concluded that bizygomatic width and basion-lambda distance predicted sex. Tin-Hsin Hsiao *et al*[12] determined sex using lateral cephalometric radiography in children and adolescents and concluded that the selected four cephalometric measurements, the GM–BaN variable, an angular measurement of glabella-metopion to basion-nasion, Ba–Br the basi-bregmatic height, MaHt the mastoid height, and Ba–O the foramen magnum length, differed in size between sexes. These were explained by the fact that there werre population specific differences in variables that show gender differences. As the skeletal structure of the human being was influenced by number of environmental factors, specific standards of assessment must be drawn and applied to a particular population under consideration. The derived discriminant function equation might be useful in the identification of sex of human remains in the population. The total facial height and mandibular length were the parameters showing gender differences. In the present study above 70% cases were classified by discriminant function. From this study we conclude that the linear and angular variables used may predict gender in the population studied.

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