Accuracy Determining Anthropometric Norms in Young Adults using Discriminant Functional Analysis

Vasavada D¹, Ojha M^{1*}, Phulari RGS¹, Arora P², Rathod Y¹, Rathod R¹, and Desai H²

¹Department of Oral, Maxillofacial Pathology and Microbiology, Manubhai Patel Dental College and Hospital, India

²Department of Orthodontics and Orthopaedics, Manubhai Patel Dental College and Hospital, India

*Corresponding author: Mehul Ojha, Department of Oral, Maxillofacial Pathology and Microbiology, Manubhai Patel Dental College and Hospital, India, Tel: 9638394210; E-mail: mehulojha7@gmail.com

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Abstract

Scientific standards have been set up for some ethnic and racial gatherings in numerous examinations. Standard for every ethnic gathering are basic for measurable drug. There are contrasts among races and ethnic gatherings and standard have been produced for specific race and gathering. Data on cephalometric standards for a populace has colossal incentive in legal dentistry. Cephalometric guidelines permit recognizable proof of race and sexual orientation of casualties utilizing straightforward estimations. The utilization of morphological highlights of the skull and mandible is a typical approach utilized by anthropologists in sex assurance.

Keywords: Forensic odontology; Anthropology; Cephalometric landmarks; Discriminant functional analysis; Gender determination

Introduction

Anthropology is the study of humans, from past to present and forensic anthropology is the application of this science in a legal setting and frequently used when victim's remains are in the advanced stages of decomposition [1]. A forensic anthropologist usually assist in the identification of deceased individuals whose remains are decomposed, burned, mutilated or otherwise unrecognizable. Using physical markers present on an individual's skeleton, a forensic anthropologist can potentially determine a victim's age, sex, stature, and ancestry [2].

Forensic norms have been set up for various ethnic and racial groups and standard norms for each ethnic group are critical for forensic medicine [3]. There are differences among races and ethnic groups and standard norms have been developed for particular race and group. Studies to identify the differences in facial features of various ethnic groups including Indians, Africans, African-Americans, Brazilians, Japanese, Puerto Ricans, Saudi Arabians, Turkish, Hungarians and Russians have been carried out in the past [4].

Information on cephalometric norms for a population has tremendous value in forensic dentistry. Cephalometric standards allow identification of race and gender of victims using simple measurements [4]. The use of morphological features of the skull and mandible is a common approach used by anthropologists for sex determination [5].

Amongst the very few studies carried out on craniofacial anthropology, Farkas et al. has given an extensive data on Indian adults where 11 measurements were recorded in craniofacial complex [6,7]. The present study was carried out with an objective to establish the craniofacial anthropometric norms of the young Indian adults, to set population-specific standards which can be a useful tool in forensic odontology and to test the validity of sex determination using lateral cephalograms.

Methods

The study group consisted of a sample of 203 young Indian adults (100 males, 103 females) between the age group of 17-25 years who visited department of oral medicine and Radiology-Manubhai Patel dental college, Vadodara. The study was approved by the Institutional ethics committee.

The patients visiting the outpatient department, who had normal occlusion, were considered for the study and lateral cephalometric radiographs were taken with patients consent. The participants were generally healthy and exhibited no craniofacial abnormalities either acquired through any accidents or other forms of trauma, congenital or developmental discrepancies and had no history of plastic or reconstructive surgery.

Lateral cephalograms were taken from X-Mind Pano D+Setelac unit and was obtained in a standard position with the teeth in centric occlusion and lips relaxed. Standardized mandibular orientation and exposure parameters (8 to 20 seconds exposure time, voltage 57-85 kv and current 10 mA) were used. The Onyx Ceph (version 4, 2016) radiographic analysis software was used to trace the lateral cephalometric radiographs with prior calibration done before every tracing.

Eleven measurements were taken with the help of ruler icon and angle icon in onyx tracing software and values were tabulated (Table 1). Showing a lateral cephalogram of the patient (Figure 1), showing all traced cephalometric parameters on the radiograph. Each radiograph was traced and cephalometric landmarks were determined with the help of a good viewer (Figures 2a and 2b).

Figure 1: Showing lateral cephalogram of a patient.

Figure 2b: Each radiograph was traced and cephalometric landmarks were determined.

Figures 2a: Showing all traced cephalometric parameters on the radiograph.

SI No.	Parameters	Landmarks
1	Effective Maxillary length	Co-Point A
2	Mandibular body length	Go-Gn
3	Ramus Height	Co-Go
4	Effective Mandibular length	Co-Gn
5	Lower facial height	ANS-Me
6	SNA angle	S-Sella, N-Nasion and A Point angle
7	SNB angle	S-Sella, N-Nasion and B Point angle
8	ANB angle	The angle between Point A , Nasion and Point B
9	Anterior Cranial Base	N-Se
10	Palatal Mandibular angle	Angle between palatal plane(ANS-PNS) and Mandibular Plane(Go-Gn)
11	Gonial angle	Co-Go-Me. Angle between condylion, gonion and menton.

*Nasion (N), Condylion (Co), Gonion (Go), Gnathion (Gn), Anterior Nasal Spine (ANS), Menton (Me), Sella (Se), Posterior Nasal Spine (PNS)

Table 1: List of 11 Cephalometric Parameters and Landmarks measured in the study.

Statistical Analysis

Data was entered in MS Excel and analyzed using statistical software “R 2.15.2-India”. Descriptive statistics were obtained in form of mean, Std. Deviation and correlation coefficient. Independent t-test was

applied to check mean difference of various parameter values between male and female respondents (Table 2).

Results

SI No.		Sex	N	Mean	Std. Deviation	Mean difference	t-value	p-value
1	Effective Maxillary Length (mm)	Male	100	96.25	4.412	5.404	5.821	0.000
		Female	103	90.85	4.860			
2	Mandibular Body Length (mm)	Male	100	78.45	4.145	6.344	7.849	0.000
		Female	103	72.10	3.935			
3	Ramus Height (mm)	Male	100	62.52	4.078	6.498	6.595	0.000
		Female	103	56.02	5.649			
4	Effective Mandibular Length (mm)	Male	100	119.73	6.155	8.834	7.360	0.000
		Female	103	110.89	5.844			
5	Lower facial height (mm)	Male	100	56.67	5.411	3.788	4.108	0.000
		Female	103	52.88	3.637			
6	SNA (Angle)	Male	100	84.32	2.140	-0.422	-0.838	0.404
		Female	103	84.74	2.847			
7	SNB (Angle)	Male	100	82.99	2.789	1.366	2.515	0.014
		Female	103	81.63	2.642			
8	ANB (Angle)	Male	100	1.37	2.409	-1.788	-4.157	0.000
		Female	103	3.16	1.856			
9	Anterior Cranial Base (mm)	Male	100	73.18	2.137	5.604	8.804	0.000
		Female	103	67.58	3.962			
10	Pal-Man (Angle)	Male	100	16.67	3.080	-0.196	-0.351	0.726
		Female	103	16.87	2.474			
11	Gonial angle	Male	100	117.86	14.746	-6.068	-2.768	0.007
		Female	103	123.93	4.786			
*Independent t-test; *P<0.05 for all measurements								

Table 2: Showing the descriptive statistics for the 11 cephalometric measurements among the male and female groups.

Discriminant Analysis was run to discriminate male and female respondents using selected angles, lengths and gender determination was done using this method. Calculations of 11 cephalometric measurements were performed are given in Table 2. Descriptive statistics including means, standard deviations, and coefficient of variations were calculated for all the variables. The values derived were compared between both the sexes using Independent t test. Significance was set at $p < 0.05$ value. The fitted model is significant with Wilk's lambda of 0.510 and p -value < 0.001 . Standardized canonical discriminant function coefficients are given in Table 3. The functions at group centroids (cut offs) to determine gender is ± 0.970 . Thus if the discriminant function shows value nearer to 0.970, the person can be predicated as a "Male" and if the value is nearer to -0.970, that can be predicated as "Female".

	Function coefficient
Go-Gn (Mandibular Body Length) mm	1.200

Co-Go (Ramus Height) mm	0.903
Co-Gn (Mandibular Length) in mm	-0.807
Lower facial height in mm	-0.068
Pal-Man (Angle)	0.028
Gonial (angle)	-0.202

Table 3: Standardized Canonical Discriminant Function Coefficients of 6 cephalometric parameters measured.

Discussion

To our knowledge, this is the one of the few studies using cephalometric norms in young adult Indian population. The results of this study on a sample of adult Indian population indicate that certain

linear and angular measurements are significantly different between adult males and females in India.

Sex determination is an important tool in forensic odontology especially in mass disaster cases where victims' bodies are mutilated beyond recognition. Identification techniques like facial reconstruction would not be possible unless sex is correctly determined. Various methods of sex determination have been reported like studying the morphology of skull and mandible, cephalometric analysis using dental X-rays, DNA analysis of teeth etc [8].

Sex determination depends on the experience of the investigator; Inexperienced workers are likely to make inaccurate assessment of sex based using visual methods [3]. The technique of discriminant function analysis overcomes some of the problems inherent in subjective methods of sexing skulls, providing a relatively simple, objective means of sexing material with a calculable reliability [3]. Discriminant function for the determination of sex has not been derived specifically for the Indian population.

In the present study, 11 cephalometric measurements were evaluated for gender prediction using discriminant function analysis out of which 6 of the measurement provided accurate sex discrimination in the subjects of known sex. In the present study, men showed significantly larger measurements for 5 linear skeletal parameters namely effective maxillary length (Co-Pt A), Mandibular body length (Go-Gn), ramus height (Co-Go), effective mandibular length (Co-Gn) and lower facial height (ANS-Me) whereas angular measurements namely SNA, ANB and gonial angle were greater in females as compared to males.

Williams and Rogers [8] got 96% success in determining the sex using different features of the skull and the mandible, with constant six traits: mastoid, supraorbital ridge, size and architecture of skull, zygomatic extension, nasal aperture and mandibular gonial angle. This indicates that craniofacial morphology can be used to determine sex of skeletal specimen with a high degree of precision.

According to Vanrell [9], the differential diagnosis of the sex by the analysis of the morphological characteristics of the skull and mandible has 77% success rate, while the analysis on metric traits of the skull in distinguishing the sex exceed 90% accuracy [9]. According to discriminant analysis, that the bi-zygomatic distance presented the greatest sexual dimorphism, corroborating the results of other researchers [10-15].

In establishing the identity of sex from a defleshed skull, lateral cephalograms and posteroanterior view radiographs assume a predominant role, as they provide architectural and morphological details of the skull, thereby revealing additional characteristics and multiple points for comparison [16]. Various workers have claimed that skull radiographs are a reliable method of sex determination with accuracy up to 80%-100% [17].

In the present study, 11 cephalometric measurements were used in discriminant function analysis out of which gender determination was dependent on Go-Gn, Co-Go, Co-Gn and lower facial height. 94% males and 78% females were correctly identified by given function. Hence the accuracy of the given model comes out to be 86% to predict gender of the person.

Hsiao et al. [17] attempted to develop a new method to determine sex from the skull with lateral radiographic cephalometry and discriminant function analysis. With discriminant function created

from 18 cephalometric variables the sex was determined with 100% accuracy in a random sample of 100 Taiwanese adults.

In a study by Patil and Mody [18], with discriminant function derived by using 10 cephalometric variables, in 99% of cases sex could be determined correctly. Veyre-Goulet et al. showed that sex could be determined with 95.6% accuracy in a sample of 114 adult dry skulls of European population using discriminant function derived from the cephalometric measurements [18]. Thus, discriminant function analysis seems suitable, but the most indicative variables differ relative to the ethnic population concerned.

Our results will therefore be useful among both genders in forensic dentistry for identification purposes. In future, this discriminant method should be tested on greater populations with a diverse age group to confirm its reliability. The present study could not determine high degree of accuracy nearing 100% probably due to relatively smaller sample size. There lies a scope for future studies involving larger samples and greater number of cephalometric parameters [19].

Conclusion

From our study we conclude that Cephalometric landmarks are useful aid in forensic dentistry for identification purposes. Very few studies have been administered in other population groups and no study in Indian population group has been conducted using eleven parameters, hence this study can be first of its kind which can give cephalometric norms for Indian population. Correlation between Indian Cephalometric norms and its forensic implications will help in identification of humans in mass disasters.

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