Original Article

Morphometric Analysis of the Orbital Aperture in North Indian Population: A Retrospective Digital Forensic Study

Abstract

Introduction: The morphometric variations seen in the orbital aperture play a significant role in forensic anthropology, for determining the personal and gender identification, especially in case of mass disasters. **Aim:** The aim of the present study was to evaluate the orbital aperture dimensions along with interorbital distance as observed on posteroanterior (PA) cephalograms for personal and gender identification. **Materials and Methods:** The present retrospective study was conducted to evaluate the morphometric dimensions of orbital aperture seen on PA cephalogram taken using PLANMECA digital machine and ROMEXIS software. The height and width of the orbits along with the interorbital distance were measured using measuring tools in the accompanying software. Data were analyzed using SPSS software version 21.0. **Results:** All the linear measurements such as orbital height, orbital width, and interorbital distance were significantly greater in males than females in the North Indian population with $P = 0.001$. The present study found 84.8% accuracy after subjecting the obtained value to discriminant function analysis. **Conclusion:** The morphometric analysis of the orbital aperture using postero-anterior cephalogram can be used as an adjuvant for personal and gender identification in forensic anthropology.

Keywords: *Forensic anthropology, gender determination, morphometric analysis, orbital aperture, posteroanterior cephalogram*

Varsha Kanjani, Abha Rani, Deepak Kanjani[1]

Department of Oral Medicine and Radiology, College of Dental Sciences, Davangere, Karnataka, [1]Department of Medicine, Fidusar Government Hospital, Jodhpur, Rajasthan, India

Introduction

In forensic anthropology, the personal and gender identification of human skeletal remains crucial in case of mass disasters, such as earth quacks, cyclones, and fire accidents.[1-3] With a high percentage of 92%, the skull is the second most unique, versatile, and dimorphic anatomical structure after pelvis in a human body.[4,5] In the human skull, there are various unique anatomic structures such as orbital aperture, sella turcica, frontal sinus, nasal septum, and vertical groove patterns can be used as an adjuvant tool for personal and gender identification.[6,7] The orbit and variation in the orbital aperture play a significant role in identifying the dead, decayed, or decomposed human remains.[3,8-10]

Maxillofacial radiology plays a significant role in forensic anthropology in the absence of DNA samples and fingerprints, to identify human remains when the antemortem radiographic records are preserved and compared with postmortem records.[11] Various radiographic techniques are used in literature to measure craniofacial linear dimensions due to superior accuracy and reproducibility. Similarly, morphometric analysis of the orbit and variations in the orbital aperture was determined using dry skull as stated in literature.[12-15] While in the present study, posteroanterior (PA) cephalograms were used for measuring the orbit and variations in its aperture.

The present study was conducted to measure and determine the height and width of the orbit along with interorbital distance in PA cephalogram view and to evaluate the practicality of orbital morphology as an aid in personal and gender determination

Materials and Methods

The present retrospective digital radiographic study was conducted on 250 males and 250 females of Jodhpur city, Rajasthan population, using a single digital PA cephalogram radiographic view at private diagnostic clinic from March 2018 to October 2018. The ideal radiographs with intact orbital integrity along with the age group of 20–50 years were enrolled in the study. Individuals with pathologies,

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Address for correspondence:
Dr. Varsha Kanjani, Department of Oral Medicine and Radiology, College of Dental Sciences, Davangere - 577 004, Karnataka, India.
E-mail: varshakanjani0@gmail.com

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fractures, syndromes, endocrinal, or metabolic disorders were excluded from the study. The radiographs were taken using PLANMECA machine, and parameters were measured using ROMEXIS software.

The selected PA cephalograms were analyzed for maximum height and width of right and left orbits along with interorbital distance, that is, the minimum distance between the medial walls of the orbits using the digitized mouse-driven method. All the selected radiographs were reproduced at the contrast of 107% to avoid magnification errors. The obtained linear measurements from each radiograph were expressed in millimeters (mm) [Figure 1].

Statistical analysis

The obtained linear measurements were tabulated and analyzed using statistical package SPSS software version 21.0 (SPSS Inc., Chicago, IL, USA) using *t*-test and discriminant functional analysis.

Results

On intergroup comparison between males and females, the mean linear dimensions with standard deviation using t-test were statistically significant with $P = 0.001$. The maximum mean left and right height with standard deviation in males was 31.32 ± 1.75 mm and 30.65 ± 1.32 mm while in females was 28.98 ± 1.52 mm and 28.68 ± 1.79 mm, respectively. The maximum mean left and right width with standard deviation in males was 33.48 ± 1.38 mm and 32.61 ± 1.93 mm while in females was 30.94 ± 2.09 mm and 30.31 ± 1.36 mm, respectively [Table 1 and Figure 2].

For gender determination, Wilk's lambda values were used to evaluate parameter practicality stating that value near to "0" evidently discriminate between the genders. Thus, in the present study, the interorbital distance is least and best predictor to differentiate between males and females. The minimum mean interorbital distance between males and females was 25.43 ± 1.32 mm and 22.73 ± 1.62 mm, respectively, with $P < 0.05$.

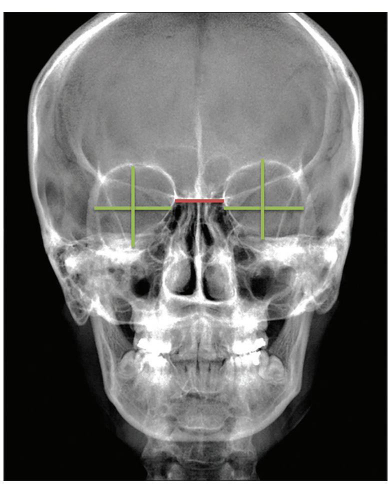

Figure 1: The linear measurements height and width (yellow vertical and horizontal lines) along with interorbital distance (red horizontal lines) on digital posteroanterior radiographic view

Discussion

The human skull plays a significant role in personal and gender identification in forensic anthropology. Anatomical structures, such as sella tursica, frontal sinus, nasal septum, vertical and groove patterns, are unique in the human skull, thereby can be used as a tool in forensics due to long retentive morphological features. The orbit is another similar anatomical structure with morphological variations seen in the orbital aperture which can be used in personal and gender identification in forensic anthropology. A study published in 2010, researchers stated two approaches, that is, metrical and morphological for gender determination using bony characteristics.[16]

In the present study, the linear measurements, that is, the height and width of the orbits along with the interorbital distance was greater in males than females in North Indian population with $P = 0.001$ stating that the PA cephalograms can be used for personal and gender identification. A study published by Cheng *et al.* in 2008 was conducted on Chinese human skulls involving morphologic observations, and metric measurements concluding that orbital dimensions were statistically greater in males than females.[17] Another study published in 2009 by Nitek *et al.* on 100 Polish dry skulls who concluded that orbital aperture dimensions were more in males than females.[18] Another study which is in accordance with the present study was published by Kumar and Gnanagurudasan in 2015 on 50 human skulls stated that morphometric analysis of the bony orbit is of great

Table 1: Descriptive correlation of orbital parameters between males and females

Parameters (mm)	Mean±SD		*P*
	Males	Females	
Left orbital height	31.32±1.75	28.98±1.52	0.001*
Left orbital width	33.48±1.38	30.94±2.09	0.001*
Right orbital height	30.65±1.32	28.68±1.79	0.001*
Right orbital width	32.61±1.93	30.31±1.36	0.001*
Interorbital distance	25.43±1.32	22.73±1.62	0.001*

*Statistically significant at $P<0.005$. SD: Standard deviation

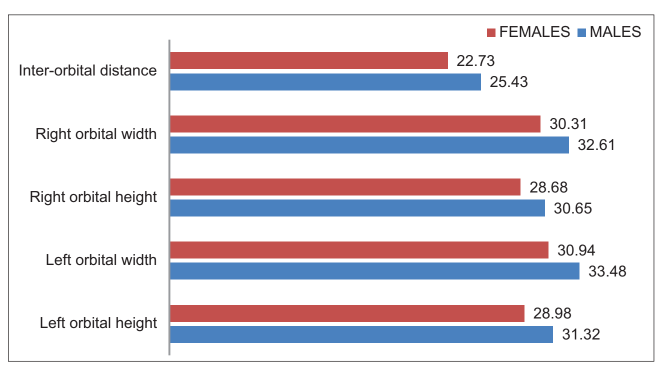

Figure 2: Comparison of mean values between males and females

significance in gender identification.[19] Mekala *et al*. in 2015 measured the orbital dimensions on 200 human skulls using manual vernier caliper on South Indian population concluded that both the orbital height and breadth were significantly greater in males than females.[20]

In an another study conducted by Kaya *et al*., 112 three-dimensional angiography computed tomography skull scans were used to examine the orbital height and width for determining sexual dimorphism on the Turkish population. The above study which is in favor of the present study reported that the linear orbital dimensions were statistically significant but were not reliable parameter for sex determination. Therefore, the present method can be used as an adjuvant for personal and gender determination.[21]

Rossi *et al*. in 2012 evaluated the relationship of the orbital aperture dimensions with gender on 97 Brazilian human skulls using PA Caldwell radiographic view. The authors stated that the orbital measurements parameters such as width, area, and interorbital difference in both the genders were statistically significant. However, the orbital height was not in accordance with the present study as it was not statistically significant as compared to other parameters.[22] Sangvichien *et al.* evaluated sexual dimorphism on 101 Thai human craniums stated significant difference in the orbital width between the genders which is in accordance with the present study while the orbital height dimensions were not significant which is in contrary with the above study.[23] Similarly, another study conducted by Ghorai *et al*. stated that orbital width and interorbital distance were statistically significant between the genders while the orbital height measurements obtained were not significant.[3]

On the contrary, Rajangam *et al.* reported that there is no significant difference in the orbital height, breadth, and orbital index. The study was conducted on 72 human skulls concluded that transverse orbital dimensions could be used as an adjuvant in gender identification. Pommier *et al*. included 48 healthy fetuses and 23 Down syndrome fetuses for fetal age estimation. The orbital and facial computed tomographic scans were taken for all the participants. The authors used the scans for identifying fetal pathologies and thereby helpful in clinical diagnosis and treatment planning.[24,25]

Only few studies are stated in literature PA cephalogram radiographic view for personal and gender identification. In the present study, the small sample size was taken, while in the future, larger sample size should be used recommended along with the use of precise technology, that is, cone-beam computed tomography.

Conclusion

The morphometric analysis of the orbital aperture using single radiograph can be used as an adjuvant for personal and gender identification in forensic anthropology.

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Conflicts of interest

There are no conflicts of interest.

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