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Original Article

MORPHOMETRY OF THE ORBITAL REGION: "BEAUTY IS BOUGHT BY JUDGMENT OF THE EYES."

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ABSTRACT

Objective: This study aimed to assess the orbital index which varies with race, regions, within the same race and periods in evolution. The knowledge of this index is therefore important in various aspects such as in interpretation of fossil records, skull classification in forensic medicine and in exploring the trends in evolutionary and ethnic differences. The documented ranges of this index in different nationalistic groups will assist in skull identification.

Method: Sixty eight skulls were obtained from the Anatomy Department of University College of Medical Sciences and Guru Teg Bahadur Hospital, Delhi for the present study. To prevent interobserver and intraobserver error two individuals measured the parameters independently with predetermined procedures. Vernier calipers accurate to 0.1mm and a 30mm ruler were used to measure the width and height of the orbits and a tapeline was used to measure the length and width of the skull.

Result: The mean orbital height was found to be 33.47 ±1.56mm and 33.65 ±1.53mm whereas the mean orbital width was 42.06 ±1.68mm and 41.87 ±1.73mm on the right and left sides respectively. The mean orbital index was 79.65 ±4.02mm and 80.49 ±4.67mm on right and left sides respectively. The mean width of the skull was 128.71±5.94mm whereas the mean height of skull was 130.96 ± 4.07mm. Data obtained was statistically analyzed.

Conclusion: Comparison of results from previous studies makes it evident that there is a large variation of the anatomical characteristics of the orbital cavity, not only due to the diversity of the used parameters, but also due to ethnic differences, the different measurement method and sample size. Data collected in the present investigation could serve as data base for the quantitative description of human orbital morphology during normal growth and development considering sex and ethnic related variation.

KEYWORDS: Orbital index, Skull, Vernier calipers, Orbital cavity, Ethnic differences.

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INTRODUCTION

Recent studies report that morphometry is a fast and efficient method for the evaluation of morphological characteristics such as ethnicity, gender, age, genetic factors, dietary habits and regional variations which can alter the shape and size of bone structures. These aspects are significantly important in determining the anthropometric changes between different populations and genders [1]. Anthropometric studies are integral part of craniofacial surgery and syndesmology [2]. For these reasons standards based on ethnic or radical data are described because these standards reflect the potentially different patterns of craniofacial growth resulting from racial, ethnic, and sexual differences [3].

As a result, racial and ethnic perspective have been totally incorporated into the study of anthropometry because Tanner stated that body physique is determined by numerous genes and environmental factors even though the relative contribution of these factors are not precisely known [4]. Weiss et al described the CT as the best way of assessing the orbital cavity because of the complexity in the anatomy of ocular and ethmoidal regions. But considering the expensiveness of CT and its inaccessibility, it is far beyond the reach of most people in the developing world [5].

However, some critical issues in the use of X- rays have been reported by numerous authors. Thus, this anthropometric study employs the use of direct measurement on dry skulls as it will present a different and a more natural perspective in assessing the orbital cavities. Also, this study will provide a deeper insight in the morphological disposition of anatomic relationships of the orbit and also a guiding principle for surgeons who are involved in the reconstructive management of fractures due to traumas and different orbital pathologies. Surgical practice begins with a detailed knowledge of anatomy.

While the anatomy of the orbit has not changed over time, advances in surgical procedures have challenged surgeons to apply a detailed understanding of the anatomic relationships of the orbit. The orbital cavities are situated on either side of the sagittal plane of the skull between the cranium and the skeleton of the face. It is essentially intended as a socket for the eye-ball and contains associated muscles, nerves, vessels and in essence lodges the visual apparatus.

Wilton Krogman developed a different way of assessing orbits. He took a qualitative approach and concluded that northern and southern Europeans had angular orbits, while central Europeans' and Asians' orbits were more rounded. African orbits were deemed more rectangular. Krogman also assessed the differences between the sexes and stated that female orbits were ''rounded, higher, relatively larger, with sharp margins,'' while male orbits were ''squared, lower, relatively smaller, with rounded margins'' [6].

These methods, or close variations of them, also continue to be seen in textbooks and research manuals [7]. Most recently, Komar and Buikstra report that male orbits are ''squared, low'' and with ''rounded margins,'' while female orbits are ''rounded, high'' and with ''sharp margins'' [8].

In the present study, the differences between the sexes assessed and stated that Male skulls typically have more prominent supraorbital ridges, a more prominent glabella, and temporal lines. Female skulls generally have rounder orbits, and narrower jaws. Male skulls on average have larger, broader palates, squarer orbits, and larger mastoid processes, larger sinuses, and larger occipital condyles, rougher muscle attachments than those of females.

Orbital cavities are of immense clinical and surgical interest in ophthalmology, oral and maxillofacial surgery and neurosurgery. In particular the orbital index is important as it varies in the different races of mankind and determines the shape of the face in different population groups. The index varies with race, regions, within the same race and periods in evolution. The documented ranges of this index in different nationalistic groups will assist in skull identification (Table 1). The knowledge of the dimensions of the orbital cavity in relation to the skull craniometry is also important in various aspects such as in interpretation of fossil records, skull classification in forensic medicine, in exploring the trends in evolutionary and ethnic differences.

A sound knowledge of the characteristics of the orbital cavity can provide a safer performance of clinical procedures, such as surgeries in the anterior and superior wall of the maxilla. This study was undertaken to establish a baseline data on the regional anatomy of the orbital cavity's morphometrical parameters.

MATERIALS AND METHODS

For this study sixty eight skulls were obtained from the Anatomy Department of Delhi University Medical Colleges for the present study.

The direct measurements of both the right and left orbits were taken with the help of Vernier taken directly using a manual Vernier Caliper calibrated in millimeters. Vernier calipers accurate to 0.1mm were used to measure the width and height of the orbits. Spreading calipers was used to measure the length and width of the skull. Two individuals measured the parameters independently with predetermined procedures to prevent inter-observer and intra-observer error. Data was tabulated and statistically analyzed.

Table 1: Orbital index of the orbital cavity.

Side	Orbital Index Mean±SD (mm)	p-value (one way ANOVA)	Significance (paired ‘t ’ test)
Left	80.49±4.67	>0.001	Non-Significant
Right	79.65±4.02		

Orbital parameters measured: (fig. 1)

ORBITAL HEIGHT: Maximum height from the upper to the lower orbital borders perpendicular to the horizontal axis of the orbit [9].

ORBITAL WIDTH: Width was measured from the point of intersection of the anterior lacrimal crest with the frontolacrimal suture (Maxillofrontale) to the most lateral point of the lateral wall of the orbit (Ectoconchion) [9].

Orbital Index

The orbital index was calculated by the following formula:

$$\text{Orbital index} = \frac{\text{Height of orbit}}{\text{Width of orbit}} \times 100$$

All measurements were recorded and expressed as means ± SD [10].

Fig. 1: Orbital Length of Skull.

ORBITAL HEIGHT **ORBITAL WIDTH**

Fig. 2: Cranial Length of Skull.

CRANIAL HEIGHT **CRANIAL WIDTH**

The Orbital index which determines the shape of the face differs in different population groups. This means that the orbits with larger widths than height will have smaller orbital indices while those with larger orbital indices will have narrow faces (Table 2).

Table 2: Orbital index in different population groups.

Countries	Region	Orbital Index	Cateogry
Japan	Minatogawa	65.2-66.7	Microseme
	Kanto	79.26-80.33	Microseme
	Kinki	79.26-80.33	Microseme
China	Peking province	80.68	Microseme
	Fushun	83.57	Mesoseme
	Hokien	90.39	Megaseme
Malawian		94.35	Megaseme
Indonesia	Flores	106.63	Megaseme
	Batak	99.26	Megaseme
	Klaten	102.73	Megaseme
Nigeria		93.7	Megaseme
Present Study	North Indian	79.65-80.49	Microseme

ORBITAL INDEX IS CLASSIFIED INTO THREE CATEGORIES [11]

Megaseme (large): The orbital index is 89 or over. This type is characteristics of the yellow races, except the Esquimaux (Eskimos) where the orbital opening is round.

Mesoseme (intermediate): The orbital index is range between 89 and 83. This type is found in the white races.

Microseme (small): The Orbital index is 83 or less. This type is characteristics of the black races where the orbital opening is rectangular.

Cranial Parameters measured: (fig. 2)

CRANIAL HEIGHT:

Distance from the midpoint of the anterior border of the foramen magnum (basion) to the intersection of the coronal and sagittal sutures (bregma).

CRANIAL WIDTH:

Greatest width between the parietal eminences (Euryon*).

*Euyron: The lateral most point placed on the greatest transverse diameter of the head.

RESULTS

The mean orbital height was found to be 33.47 ±1.56mm and 33.65 ±1.53mm whereas the mean orbital width was 42.06 ±1.68mm and 41.87 ±1.73mm on the right and left sides respectively (Table 3). The mean orbital index was 79.65 ±4.02mm and 80.49 ±4.67mm on right and left sides respectively based on this the orbital category of the North Indians is Microseme (Table 1).The mean cranial width of the skull was 128.71±5.94mm whereas the mean cranial height of skull was 130.96 ± 4.07mm. on the right and left sides respectively (Table 4).

Table 4: Parameters of the cranium.

Parameters	Min. (mm)	Max. (mm)	Mean Mean±SD (mm)
Height	116	139	130.96±4.07
Width	117	143	128.71±5.94

Table 5: Regression analysis between heights of cranium and orbit.

Regressor	Dependent	Correlation	Regressor equation	Significance
Orbital height	Cranial height	0.249	Cranial height = 1.43 orbital height	Significant
Orbital width	Cranial width	0.553	Cranial width = 1.16 Orbital width	Significant

Regression through origin shows the cranial height is 1.43 times of the orbit and the cranial width is 1.16 times of the orbital width (Table 5). No statistically significant difference was found in the height, width and orbital index between the right and left orbits. Therefore no bilateral asymmetry was observed.

Comparison of results from previous studies makes it evident that there is a large variation of the anatomical characteristics of the orbital cavity, not only due to the diversity of the used parameters, but also due to ethnic differences, the different measurement method and sample size (Table 2).

Some studies demonstrate that the expression of inter-population variability in the orbital mor-

	Side	Min. (mm)	Max. (mm)	Mean ± SD (mm)	p-value (one way ANOVA)	Significance (paired ‘t ’ test)
Orbital Height	Left	29.9	37.1	33.56±1.54	> 0.001	Non-Significant
	Right	30.9	37.1	33.47±1.56		
Orbital Width	Left	37.4	45.3	41.88±1.73	> 0.001	Non-Significant
	Right	38.3	45.9	42.06±1.69		

Table 3: Height and width of orbital cavity.

-phomerty has both environmental and genetic components that need to be accounted for in population-level research.

CONCLUSION

Data collected in the present investigation could serve as data base for the quantitative description of human orbital morphology during normal growth and development considering sex and ethnic related variation. The findings of the present study allow for quantification of the orbital features of North Indian adults and provide parameters for preoperative planning and prediction of postoperative outcome.

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Conflicts of Interests: None

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