Original Article

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Morphometric Analysis of Orbit: A Study on Dry Indian Human Skulls

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Abstract

Background and Aims: The morphometric study of the orbit is a common practice among anatomists, anthropologists, surgeons and forensic experts as it derives its importance with surgical procedures indicated for trauma, decompression, tumours and metastases. Surgically orbital morphometric study provides parameters for preoperative planning and prediction of postoperative outcome. Racial and ethnic differences noted on the basis of Orbital Index (OI) amongst different population formulates database for respective studies. *Materials and Methods*: 54 dry Indian human skulls of known sexes studied for orbital length , breadth and biorbital & inerorbital length. Orbital index calculated and compared for ethnic , racial differences. *Results*: no significant difference in orbital height and breadth noted on right and left side. Orbital index was found more in females. *Conclusion*: Present studies assess the clinical and surgical significance of the orbit to establish a morphometric analysis with interrelated structures, thus enhancing anatomic and anthropological knowledge regarding Indian orbits. Parameters of the study formulates guidelines for operative procedures.

Keywords: Orbital Index; Race and Ethnicity; Morphometric Classification.

Introduction

The orbit is a pyramid shaped cavity with its apex directed posteriorly and the base anteriorly located at the viscerocranium [1]. The roof of the orbit is composed largely of the orbital plate of the frontal bone anteriorly and of the lesser wing of the sphenoid with a minor part in the posterior part. The triangular shape of the roof narrows toward the orbital apex. The floor of the orbit is shorter in its anteroposterior extent than the three other orbital walls and terminates in the Inferior Orbital Fissure in front of the orbital apex that consequently turns into a triangular frontal cross section [2]. For its most part, the floor consists of the orbital plate of the maxilla supplemented by the tiny orbital plate of the palatine bone posteriorly and by the inferior orbital process of the zygoma anterolaterally. The medial orbital wall is formed, again in the anterior posterior direction, by the frontonasal maxillary process, the lacrimal bone, the lamina papyracea of the ethmoid bone, which is quadrangular in shape, and the anterolateral surface of the sphenoid body.[3] The lateral orbital wall consists of the lateral orbital process of the zygoma constituting the anterior part and the greater wing of the sphenoid posteriorly.

The orbit contain the eye and associated muscles, the lacrimal glands, the ophthalmic artery and veins, the ophthalmic nerve, the optic (II), oculomotor (III), trochlear (IV), and the abducens (VI) nerves. The orbital characters vary amongst different races and ethnic groups, also, it is known to possess sexual dimorphism, and it is anthropologically relevant in race definition [4].

Thus seven osseous components of the orbit can be conceptualized into a simple geometrical layout of a four-sided pyramid with the anterior aditus as a base and the posterior cone as apex. All neurovascular structures pass through bony openings in the sphenoid bone before diversification in the mid and anterior orbit. A set of landmarks such as the optic

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and maxillary strut comes into new focus. Within the topographical surfaces of the internal orbit the lazy S-shaped floor and the posteromedial bulge are principal determinants for the ocular globe position. The inferomedial orbital strut represents a discernible sagittal buttress. The periorbita and orbital soft tissue contents—extraocular muscles, septae, neurovasculature—are detailed and put into context with periorbital dissection [2].

Surgically Orbital morphometric study will also provide parameters for preoperative planning and prediction of postoperative outcome. Among modern human groups there is considerable variability in the characteristics of the orbit [4]. The orbital index (OI), the proportion of the orbit height to its breadth multiplied by 100 is determined by the shape of the face and varies with race, regions within the same race and periods in evolution [5,6].

Taking the orbital index(OI) as the standard, three classes of orbit are recognised

1. Megaseme (Large) with OI 89 or over found in Yellow races
2. Mesoseme (Intermediate) with OI 83-89 found in European (87), English
3. Microseme (Small) with OI 83 or less found in Black

Understanding the structural disposition of the human body is aided by the advances in medical imaging techniques such as radiography, MRI, CT scan etc. But direct measurement on dry skulls is a more natural perspective in assessing the orbital cavities [7].

Thus a prior knowledge of the orbital morphometry is very essential for better surgical approach and outcome. Not many studies have been done pertaining to morphometry of orbit in Indian population. Hence, this study of morphometry of orbit in skulls becomes essential to develop a database to determine normal range of orbital values and orbital index Indian population [8].

Aim and Objective

1. To measure and compare orbital length and breadth bilaterally.
2. To calculate orbital index(OI) and compare it with available studies.

Materials and Methods

54 skulls of known sexes (35 male and 19 female) were studied at the Department of Anatomy, Govt Medical College, Aurangabad, Maharashtra, India . The orbital height was measured as the distance between the midpoint of the upper and lower margins of the orbital cavity and orbital breadth was measured as the distance between the midpoint of the medial and lateral margin of the orbit by using manual Vernier calliper.

Orbital index (OI) was calculated by using the following formula,

OI = orbital height / orbital breadth x 100

Similarly interorbital bredth is measured as distance between medial walls of two orbits and biorbital breadth is measured as distance between lateral walls of both orbits.

Illustration 2: Showing Measurement of Orbital Breadth

The data obtained were tabulated and analysed statistically by computing descriptive statistics like mean, standard deviation and range.

Results

In all the studied skulls orbital height was found more on left than right but difference was insignificant. No significant gender difference was noted in orbital height. Orbital breadth was comparable on either side with no gender difference. Interorbital breadth was found more in females whereas biorbital breadth was lesser ($p<0.001$). Orbital index was comparable in both sides but in females it was significantly more than males ($p<0.001$).

Table 1:

	Orbital Height		Orbital Breadth		Interorbital	Biorbital	Orbital Index	
	Right	Left	Right	Left	Breadth	Breadth	Right	Left
A	31.90±2.04	32.30±2.20	39.10±2.15	39.17±2.03	22.27±2.72	95.27±3.87	81.77±6.49	82.60±6.11
M	31.72±1.97	32.15±2.20	39.53±2.02	39.45±1.85	21.96±2.93	95.69±3.33	80.38±5.81	81.56±5.69
F	32.24±2.19	32.58±2.20	38.29±2.20	38.69±2.28	22.85±2.20	94.46±4.72	84.40±7.03	84.58±6.54

A-ALL
M- MALE
F- FEMALE

Illustration 1: Showing Measurement of Orbital Height

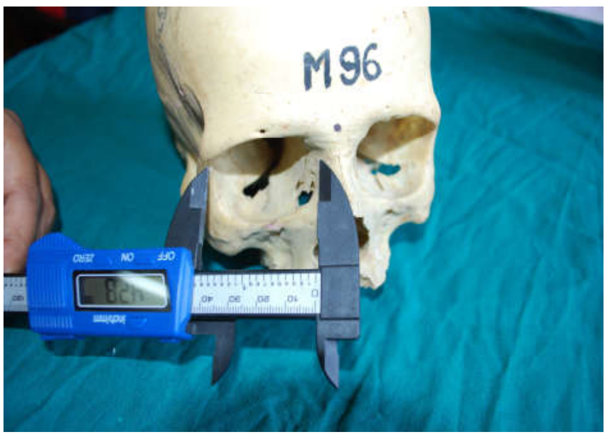

Illustration 2: Showing Measurement of Orbital Breadth

Illustration 3: Showing Measurement of Biorbital length

Illustration 4: Showing Measurement of Interorbital length

Discussion

The morphometric study of the human skull is a common practice among anatomists, anthropologists, surgeons and forensic experts, as it is a structure of great interest since it possesses sexual dimorphic characters and ethnic differences. Furthermore, the cranium seems to be less affected by factors such as nutrition and they are more genetically driven [19]. The skull alone can provide 90% of accuracy regarding the gender aspect. Similarly orbital morphology derives its importance with surgical procedures indicated for trauma, decompression, tumors and metastases. It involves complicated inter-relations of neurovascular structures which often presents with profound clinical symptoms even in early involvement in above mentioned entities [10]. The formation of the orbit is set within 2 months of embryogenesis. Cells from the neural crest migrate over the face over 2 different routes: the frontonasal anlage migrates to the prosencephalon, approaching the orbit from above, and the maxillary waves curves around and forms the orbit from below. The frontonasal process originates the lacrimal and ethmoid bones, while the maxillary process forms the floor and lateral walls of the orbit. All bones of the orbit ossify and fuse between the sixth and seventh months of gestation. It is worth mentioning that the development of the eyes is vital to the formation of the bony orbit and its surrounding soft tissue contents. The lesser wing of the sphenoid ossificates through endochondral ossification, and all of the other orbital bones and the greater wing of the sphenoid arises from intramembranous ossification [11.

Regarding the morphometric aspects of the orbit, we found relatively few studies that used the same anatomical points that ours did to measure the bony orbit. Ji et al observed the orbit measures through a CT-scan in Chinese subjects, and their results revealed that the mean Right Orbital Height (ROH) was 33.28±1.58 mm, and the mean Right Orbital Breadth(ROB) was 38±94 mm, also, their research revealed that there wasn't a statistically significant difference of the Orbital height between male and female patients [12].

Ukoha et al. (2011) found that the Right Orbital Breadth was 36.03±0.37 mm and the ROH was 31.90±0.70 mm, stating that there were no statistically significance difference between the right and left sides [13].

Fetouh and Mandour (2014) stated that in a male Egyptian population, the mean ROH was 35.83±1.23 mm, the mean ROB was 43.62±1.13 mm, and the mean

OI was 82.20±2.97 mm, and in females, the mean ROH was 35.53±0.95 mm, the mean ROB was 42.75±1.35 mm, and the OI was 84.13±3.76 mm [14].

Elzaki et al. (2015) found that the ROB was 34.10±1.76 mm and the ROH was 37.90±2.57 mm, they also found that the OB was slightly higher in man than in woman, but the OH was similar. Many results showed that the males orbit area was significantly larger than in females although there is some divergence whether the symmetry of the orbit: some authors agree that there is a significant difference between right orbit and left orbit while other authors found no statistically significant difference between [15]

Lal N et al in their study of Sri-lankan orbits could note that, the left and right orbital heights and breadths in males and females were not significantly different, suggesting left and right symmetry. However, when these parameters were used to derive OI, differences between the left and right sides in males and females became apparent. This indicates that individually, the differences found between the left and right side orbital height and width were not large enough to be detected by their statistical tests. But insignificant height difference detected in present study may answer their query in orbital index differences. Left-right asymmetry in orbital height or breadth was previously reported in Egyptian and Nigerian populations; morphological asymmetry is not unique to this region and was identified in other studies as well [16].

Additionally present study records Interorbital breadth , which was found more in females whereas biorbital breadth was found lesser as compared to males. These notifications could not be sited in literature and unique for this study. They definitely have aesthetic implications in plastic surgery.

The importance of orbital index lies in its use for the interpretation of fossil records, skull classification in forensic medicine and the explanation of trends in evolutionary and ethnic differences. Normal values of orbital indices are vital measurements in the evaluation, and diagnosis of craniofacial syndromes and post traumatic deformities, and knowledge of the normal values for a particular region or population can be used to treat abnormalities to produce the best aesthetics and functional result. Variation of OI between and within the population could be due to genetic and environmental factors and also different patterns of craniofacial growth mainly resulting from racial and ethnic differences [2,5].

OI has been studied by several authors. It has been reported that the racial and ethnic differences occur in OI amongst different population. The present study involves comparison of the OI of the Indian population with available data from

other populations of the world. In the present study there was statistically significant difference observed in the OI, between the genders. As female OI was more than male. This finding is similar to that of study by Lal et al. hence in present study, as per standard classification the mean OI male orbits can be classified as microseme (OI<83) and female as mesoseme (OI=83–89), which is an unusual finding given many Asian populations are said to have megaseme (OI>89) [2,5,16].

On comparison with other Indian authors present study differs. Jaswinder Kaur et al studied on Indian population, the OI values are lower compared to our results [17]. Deepak S Howale et al studied Indian population and have reported a slightly higher mean OI (86.4) compared to our results. They followed different classification to categorize the skulls according to OI [18].

Conclusion

Even though morphometric studies of the orbit are relatively frequent, factors such as different ethnic classification, different methods of taking the measurements, different methods of statistical analysis can make the comparison difficult or impossible. We assessed the clinical and surgical significance of the orbit, furthermore, we were able to establish a morphometric parameter with interrelated structures, thus enhancing anatomic and anthropological knowledge regarding Indian skulls, as different Indian authors' had varied findings on this issue. Furthermore, our data presented a base in which the investigation of the quantitative morphology of the orbit development can be reoffered.

Since the orbit is an anatomic area used to determine the sex and the ethnicity, its importance in various ocular surgeries leave this study utmost important landmark for surgeons.

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