Original Article

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Orbital Index in Human Dry Skulls of East Indian Origin: A Cross-sectional Study

Anatomy Section

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ABSTRACT

Introduction: Orbital index demonstrates the proportion of the orbital length to the orbital width and varies with race, geographic region, and ethnicity.

Aim: To evaluate the normal reference orbital parameters for the adult Bihar population of east Indian region.

Materials and Methods: A cross-sectional study was conducted at Mata Gujri Memorial Medical College, Kishanganj, Bihar, India for a period of one month from September 2022 to October 2022. A total of 41 dry adult skulls irrespective of sex were included. The digital Vernier caliper was used to measure the maximum orbital height and width. The orbital index was determined by using the formula maximum orbital length (height)/maximum orbital width×100. Based on the average orbital index as standard, three categories of orbits have been described-Megaseme (large): the orbital index is 89 or over, Mesoseme (intermediate): the orbital index varies between 89 to 83, and Microseme (small): the orbital index is 83 or less. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 20.0. Orbital index between the right-side and left-side were compared using an unpaired two-tailed t-test at a 95% confidence limit.

Results: Mean orbital length of right orbit of the dry skulls was 33.14±1.95 mm and left orbit was 33.44±1.92 mm. The mean orbital width of right orbit was 39.43±2.47 and left orbit was 39.13±2.49 mm. The mean orbital index was found to be 84.26±5.59 mm and 85.62±5.17 mm on the right and left orbit respectively (p-value=0.244). According to the orbital index the studied group of east Indian population comes under the mesoseme category.

Conclusion: The study provides useful baseline orbital morphometric data of east Indian population which are very important during forensic research.

Keywords: Anatomy, Craniofacial skeletal structures, Orbit

INTRODUCTION

The orbits are bilateral and almost symmetrical bony cavities in the head and are situated on either side of the mid-sagittal plane of the skull between the cranium and the facial bones [1]. The orbital cavity is a roughly quadrilateral pyramidal space with four walls: a roof, medial wall, floor, and lateral wall. The base of the pyramid is the orbital entrance. The cavity is essentially intended to serve as a socket for the eyeball and also contains associated muscles, vessels, nerves, lacrimal apparatus, tendons, and adipose tissue [1,2]. Among the modern human groups, the orbital characteristics may vary considerably [3].

The bony orbit which forms the subject of interest of this study is important not only for anatomists but also for ophthalmologists, oral and maxillofacial surgeon, neurosurgeon, anthropologists and forensic specialists [1]. The main goal of oculo plastic surgery for repair of orbital fractures is to re-establish the stereo structure of the orbit and to maintain the proper symmetric relationship between the two orbits. Orbital dimensions and orbital index study will also provide parameters for the preoperative surgical planning and prediction of the postoperative result [4].

During forensic investigation, the determination of origin and identity of the skeletal parts collected from a crime spot is an important and very delicate procedure. Several craniofacial measurements and indices can be helpful for these investigations [5]. The method of evaluating the parameters needed for the measurement of indices depends upon the sample types. The dry bone collection with all the available information about the skeletons has been the best source of sample for the research work [6]. However advanced radiological imaging such as Computed Tomography (CT), Magnetic Resonance Imaging (MRI) is also the alternative choice where skull collection is not available [5,7,8].

Various craniofacial indices have been used in the determination of human origin and identity. Among the different parameters calculated during the craniofacial morphometric investigation is the orbital index. This index is vital as it determines the shape of the face in various population groups. It varies with race, geographic regions, within the same race and stages in evolution. The direct measurement on dry skulls is a natural method in evaluating the orbital cavities [6].

The information of this index is appreciated in numerous fields such as in explanation of fossil records, skull classification in forensic science, and in exploring the trends in evolutionary and cultural differences. Additionally, familiar ranges of this index in diverse nationalistic groups will help in skull identification, mainly among different races where forensic data is not accessible. In addition, a prior information of the orbital dimensions is very vital for a better surgical approach and outcome [4,5].

Thus, knowledge of orbital morphometry is very useful for better surgical interventions. However, there is no study in the literature pertaining to the morphometry of orbit in the Bihar population of the East Indian region. Hence, this study of morphometry of the orbit in adult skulls becomes essential to develop a database to determine the normal range of the orbital values and orbital index in the East Indian population.

MATERIALS AND METHODS

A cross-sectional study was conducted at the Anatomy Department of the Mata Gujri Memorial Medical College, Kisangani, Bihar, India from September 2022 to October 2022. Approval was granted by the Institutional Ethics Committee (IEC)- MGM/PRI-785/22. All the samples (n=41) that were used for the study were procured from cadavers obtained from the districts of east Bihar.

Inclusion criteria: Adult normal skulls with an age range from 40 years to 80 years, irrespective of sex with non pathological bones were included in this study.

Exclusion criteria: Skulls of articulated skeletons which were procured from other states were not included in the study. Skulls that were sectioned at various planes in which the bony orbit was damaged and pathological bones for this particular study suggest skull bones having gross malformations and osteoporotic changes which might have damaged the bony orbit leading to difficulty in the estimation of orbital measurements were also excluded from the study.

Study Procedure

The direct measurements of both right and left bony orbits were taken with the help of a digital Vernier caliper calibrated in millimeters. The caliper with 0.1 mm accuracy was used to measure length and width of the orbits. Standard procedures were used for all measurements. All measurements were estimated twice and average data was recorded.

Measurement of Orbital Parameters [9]

Orbital width: It was measured from the point of junction of maxillary bone, lacrimal bone, and frontal bone (Dacryon) to the most lateral point (farthest point) of the lateral wall of the orbit.

Orbital length: Maximum height from the upper to the lower orbital bones perpendicular to the width of the orbit [Table/Fig-1].

[Table/Fig-1a]: Orbital length of the skull.
[Table/Fig-1b]: Orbital width of the skull.

Orbital Index: It was calculated by the following formula-

Orbital Index=Length of the orbit/width of the orbit x100.

Based on the average orbital index as a standard there are one of the three predetermined categories [l,2]:

- Megaseme (large) the orbital index is 89 or over. This type is found in yellow races except for Eskimos where the orbital opening is round.
- Mesoseme (intermediate) the orbital index varies between 89 and 83. This type is seen in white races.
- Microseme (small) the orbital index is 83 or less. This type is found in the black races where the orbital opening is rectangular.

STATISTICAL ANALYSIS

The statistical analysis was done using SPSS version 20.0. Student t-test was used to verify the statistical significance of all parameters of the orbits with respect to side (right and left-side). The results were considered significant when p-value is <0.05.

RESULTS

The mean orbital length was found to be 33.14±1.95 mm and 33.44±1.92 mm whereas the mean orbital width was 39.43±2.47 mm and 39.13±2.49 mm on the right and left-sides respectively [Table/Fig-2]. The mean orbital index was 84.26±5.59 mm and 85.62±5.17 mm on right and left-side respectively (p-value-0.244).

Measurements	Minimum (mm)	Maximum (mm)	Mean±SD (mm)	p-value
Orbital length				
Right	28.7	37.2	33.14±1.95	0.479
Left	29.9	37.1	33.44±1.92	
Orbital width				
Right	35.5	44.9	39.43±2.47	0.587
Left	35.6	45.1	39.13±2.49	

[Table/Fig-2]: Normative measurements of the orbital dimension.
*Standard deviation
The results were considered significant when p-value is <0.05.

DISCUSSION

The normative measurements of orbital dimensions are important in anatomy, ophthalmology, maxillofacial surgery, and neurosurgery [10]. In forensic medicine, the orbital index has been used to determine the sex of an individual and is also applicable in skull classification [11]. The various reports of morphometric measurements of orbit show variation in the results based on race, region and ethnicity [12].

The differential growth of the two sides of the brain may be responsible for the slight difference in the orbital index observed between the right and left orbit [12,13]. Many factors have been involved in the transformation of the fetal skeleton into the adult form. While in the uterus, the basic structure is genetically determined and is modified postnatally by environmental factors such as climate, activity pattern, and masticatory functions [14]. Differences in orbital index between the different population groups could be due to genetic and environmental factors.

Results of the orbital indices from various states of South India such as Mekala D et al., (Tamil Nadu), Divya C et al., and Sanjaykumar BR (Karnataka), Nagaraj S et al., (Telengana), Shaikh M (Kerala), belong to the same mesoseme category [4,13,15-17]. Narasinga RB et al., evaluated the orbital index in dry skulls of north coastal Andhra Pradesh of South East India found that right orbital index was mesoseme variety while left orbital Index was a megaseme category [Table/Fig-3] [4,9,12,13,15-24].

	Author	Year of study	State	Orbital index (mm)	Category
1.	Mekala D et al., [4]	2015	Tamil Nadu, India	85.8	Mesoseme
2.	Kumar A and Nagar M [9]	2014	Delhi, North India	Right 79.65±4.02 Left 80.49±4.67	Microseme Microseme
3.	Kaur J et al., [12]	2012	Punjab, Northwest India	81.65	Microseme
4.	Divya C et al., [13]	2018	Karnataka, South India	Right 84.49 Left 85.48	Mesoseme Mesoseme
5.	Sanjay kumar BR et al., [15]	2019	Karnataka, Southwest India	Right 83.07 Left 84.22	Mesoseme Mesoseme
6.	Nagaraj S et al., [16]	2017	Telangana, South India	87.39	Mesoseme
7.	Shaikh M [17]	2021	Kerala, Southwest India	Right 83.07 Left 83.9	Mesoseme Mesoseme
8.	Narasinga RB et al., [18]	2015	Andhra Pradesh, Southeast India	Right 86.13 Left 90.69	Mesoseme Megaseme
9.	Agrawal J et al., [19]	2017	Chhattisgarh, Central India	Right 86.19±5.12 Left 84.57±5.12	Mesoseme Mesoseme
10.	Gosavi SN et al., [20]	2014	Maharashtra, Western India	81.88	Microseme
11.	Shukla A et al., [21]	2020	Maharashtra, Western India	Right 80.9 Left 80.2	Microseme Microseme
12	Howale DS et al., [22]	2012	Maharashtra, Western India	86.4	Mesoseme

13	Amjad F et al., [23]	2019	Maharashtra, Western India	Right 86.63 Left 85.99	Mesoseme Mesoseme
14	Joshi R et al., [24]	2018	Uttar Pradesh, North India	Right 80.75±5.60 Left 80.67±5.31	Microseme Microseme
15	Present Study	2023	Bihar, East India	Right 84.26±5.59 Left 85.62±5.17	Mesoseme Mesoseme

[Table/Fig-3]: Comparison of orbital indices of previous studies from other states and zones of India with the present study [4,9,12,13,15-24].

Normative data of orbital indices are important measurements in the diagnosis of craniofacial syndromes and post-traumatic deformities. Prior knowledge of the normal values for a particular region is essential to treat abnormalities and to make the best aesthetic and functional outcome. For these purposes, standards based on local data are preferable, because these standards reflect the various pattern of craniofacial growth resulting from racial, ethnic, social, behavioural, and dietary habits [13].

During review of literature, it was found that there was a lack of recent studies on orbital index among East Indian population, and as a result it was difficult to compare our study results with other similar studies in same region. Further studies shall be necessary to evaluate and replicate the results. Multi-institutional studies involving a more diverse population belonging to East India might overcome the limitations.

Limitation(s)

The study samples that we used were collected through our institutional hospital and the local authorities, and due to legal boundaries, all of them were from the region of east Bihar. Therefore the sample overwhelmingly represents the local population and the results of the study may not accurately reflect all of the population of east India. A male-female comparison could not be done. A broader scope study including a more suitable number of skulls of both sexes could be able to further assess this aspect.

CONCLUSION(S)

The study conducted on the orbital index of east Indian adult dry skull provides useful morphometric data of the orbit, for medical and surgical management in ophthalmology, oral and facial surgery, plastic surgery and neurosurgery. The data is also helpful in the design of eye protective equipment. The value of this index is important in different aspects such as in forensic medicine for the classification of skull, fossil records interpretation. It is essential for anthropological research of unknown individuals for gender determination, ethnicity and also in investigating the trends in evolutionary and ethnic differences.

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