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A MORPHOMETRIC ANALYSIS OF ORBIT IN DRY ADULT HUMAN SKULLS AND ITS CLINICAL IMPORTANCE

Mr. Gajendra Kumar Sah[1] and Dr. Hari Narayan Yadav[2*]

[1]Tutor, Department of Anatomy, Rama Medical College Hospital & Research Centre, Pilkhuwa, Hapur, Uttar Pradesh.
[2*]Associate Professor, Department of Anatomy, Krishna Mohan Medical College & Hospital, Mathura, Uttar Pradesh.

***Corresponding Author:** Dr. Hari Narayan Yadav
*Associate Professor, Department of Anatomy, Krishna Mohan Medical College & Hospital, Mathura, Uttar Pradesh, India.Email: harinarayanyadav278@gmail.com

ABSTRACT:

Background: The bony orbits are skeletal cavities located on either side of the nose. They house the eyes, the paired peripheral organs of vision. The orbit also contains extraocular muscles, the optic, oculomotor, trochlear, and abducent nerves and branches of the ophthalmic and maxillary divisions of the trigeminal nerve; the ciliary parasympathetic ganglion; the ophthalmic vessels; and the nasolacrimal apparatus.

Aim & Objectives: The aim of this study is a morphometric study of the orbit in dry human adult skulls of the North Indian population. The objective is to study the various parameters of orbit in human dried skulls and compare them with other studies. The following parameters are measured: 1. Orbital height (OH) 2. Orbital breadth (OB) 3. Orbital index (OI) 4. Interorbital distance (IOD) 5. Biorbital distance (BOD).

Materials and Methods: 50 adult dry skulls (100 orbits) with 0.01mm accuracy on both the right and left sides were measured using digital verniercalipers. The skulls were obtained from the bone bank of the department of anatomy at Rama Medical College, Hospital, and Research Centre, Pilkhuwa, Hapur, and K. M. Medical College & Hospital, Mathura.Orbital height (OH) and orbital breadth (OB) of both sides were measured, and orbital index (OI) was calculated by applying the formula OI = OH/OB x 100. All the data obtained were statistically analyzed and tabulated. The quantitative morphometry of right and left orbital cavities was compared by an independent sample't' test.

Results: The mean orbital heights for the right and left sides were 34.67 ± 2.50 mm and 34.40 ± 2.32 mm, while their breadth was 39.75 ± 3.43 mm and 39.31 ± 3.26 mm, respectively. The mean orbital index calculated was 86.45 ± 9.67 mm on the right and 87.56 ± 7.45 mm on the left side. There was no significant difference between the right and left sides of the orbital parameters. The mean biorbital distance and interorbital distance were 98.23 ± 6.84 mm and 20.86 ± 2.42 mm, respectively. The majority of orbits measured were of the mesoseme category.

Conclusion:

Regional studies on the orbital index will provide useful data for clinical and surgical treatment for patients in ophthalmology, oral and maxillofacial surgery, and neurosurgery.

Keywords: Dry, eyes, human, Orbit, population, study, skulls.

INTRODUCTION

The bony orbits are skeletal cavities located on either side of the nose. They house the eyes, the paired peripheral organs of vision. The walls of each orbit protect the eyes from injury, provide points of attachment for six extra ocular muscles that allow the accurate positioning of the visual axis, and determine the spatial relationship between the two eyes, which is essential for both binocular vision and conjugate eye movements. Each cavity approximates a quadrilateral pyramid with a base at the orbital openings, narrowing to its apex along a postero-medially directed axis. Each orbit has a roof, floor, medial, and lateral walls. The eyeball thus occupies only one-fifth of the volume of the orbit; the remainder of the cavity is filled with vessels and nerves that are contained within and supported by orbital fat connective tissue. In brief, the orbit also contains extraocular muscles, the optic, oculomotor, trochlear, and abducent nerves and branches of the ophthalmic and maxillary divisions of the trigeminal nerve; the ciliary parasympathetic ganglion; the ophthalmic vessels; and the nasolacrimal apparatus. [1]

Each orbit can be compared to a tiny jewel box that has very precious contents, all carefully wrapped in fat tissue. They can also be compared to a main room, to which access is gathered through a pre-chamber, the cavernous sinus. [2] The orbits are hollow bony cavities in the facial skeleton. The orbits contain and protect the eyeballs and accessory visual structures. [3] In the adult human, the volume of the orbit is 30 to 32 ml, of which the eye occupies only 1/5th of the space. [4] The orbit is aligned so that the medial walls are parallel and the lateral walls are perpendicular to each other.[5]

Orbits are the most conspicuous feature of the facial skeleton. [6] Due to the fact that it is made up of many bones and that it has fissures, foramina, and canals, the orbit is said to have a very complex structure. [7] The stereostructure of the orbit is affected by several orbital diseases. [8] The orbit is an essential anatomic landmark as it comprises the crossroads of the central nervous system and connections with the nose, paranasal sinuses, and face, as well as the structures related to the function of the eyeball. [9]

The skull remains the most preferred bone for identification and sexual dimorphism because it is least perishable and resists fire, explosions, and mutilations. The sex of an individual can be identified accurately in 90% of cases using the skull alone and in 98% of cases using the pelvis and skull together. [10] Among other parts, orbits also show sexual dimorphism; male orbits are square and relatively smaller, while the orbits of female skulls are usually rounder and relatively larger. [11, 12] Patniak (2001) [13] statedthat in each orbital cavity, the width is usually greater than the height; the relation between the two is given by the orbital index, which varies in different races. The orbital index is the ratio of orbital height to orbital breadth multiplied by 100. i.e., orbital index (OI) = (Orbital Height/Orbital Breadth) X 100. Taking the orbital index as the standard, three classes of orbit have been described:

1. **Megaseme (large):** The orbital index is 89 or over. This type is seen in the yellow race. The orbital opening is round. [14]
2. **Mesoseme (intermediate):** The orbital index ranges between 89 and 83. This type is seen in the white races. [15]
3. **Microseme (small**): Orbital index is 83 or less. This type is characteristic of the black races, where the orbital opening is rectangular. [14]

Previous studies stated that the Indian population comes under the microseme [16] and mesoseme [17, 18] categories.

Aim & Objectives:

The aim of this study is a morphometric study of the orbit in dry human adult skulls of the North Indian population. The objective is to study the following parameters of orbit in human dried skulls and compare them with other studies: 1. Orbital height (OH) 2. Orbital breadth (OB) 3. Orbital index (OI) 4. Interorbital distance (IOD) 5. Biorbital distance (BOD).

MATERIAL AND METHODS

The observational study was carried out on 50 adult dry human skulls (i.e., 100 orbits) of unknown sex from a bone bank at the Department of Anatomy of Rama Medical College, Hospital and Research Centre, Pilkhuwa, Hapur, and K. M. Medical College & Hospital, Mathura. The dimensions of orbital cavities were measured by using a digital vernier caliper with 0.01mm accuracy on both the right and left sides. Fetal skulls and skulls fractured at the areas of the orbit were excluded from the study. **Statistical Analysis:** the data was entered in Microsoft Excel. The mean and standard deviation of all parameters were analyzed using SPSS version 21. The level of significance ($p<0.05$) for the statistical analysis was set at 5%. A student's t-test was used to compare the morphometric dimensions of the right and left orbital cavities, and a p-value was calculated.

The following dimensions were measured:

Orbital height (OH) [Table/Fig. 1]: The distance between the midpoints of the upper and lower margins of the orbital cavity.

Orbital breadth (OB) [Table/Fig. 2]: The distance between the midpoint of the medial and lateral margins of the orbit.

Orbital Index (OI): Calculated as: (orbital height/orbital breadth) ×100.

Biorbital distance (BOD) [Table/Fig. 3]: The distance between the left and right ectoconchion (intersection of the most anterior surface of the lateral wall of the orbit and a line bisecting the orbit along its long axis).

Interorbital distance (IOD) [Table/Fig. 4]: The distance between the left and right dacryon (the point on the medial wall of the orbit at which the frontal, lacrimal, and maxilla bones intersect).

[Table/Fig- 1]:Measuring orbital height of the skull.

[Table/Fig- 2]:Measuring orbital breadth of the skull.

[Table/Fig- 3]:Measuring the biorbital distance of the skull.

[Table/Fig- 4]:Measuring interorbital distance of the skull.

RESULTS

Results were obtained after the direct measurement in hundred orbital cavities of fifty human adult dry skulls by using digital vernier caliper. The quantitative morphometry of right and left orbital cavities were studied individually and analysed statistically**.**

[Table/Fig- 5]:Showing Mean and Sd Of Orbital Dimensions.

S.No.	Parameters		Range	Mean ± S.D.	p- value
1.	Orbital Height(OH)	Right Side	30.79 - 40.26	34.67± 2.50	
		Left Side	30.25 - 39.13	34.40 ± 2.32	0.572
2.	Orbital Breadth (OB)	Right Side	31.78 - 49.18	39.75± 3.43	
		Left Side	31.21 - 47.34	39.31± 3.26	0.509
3.	Orbital Index(OI)	Right Side	99.07 - 99.38	86.45± 9.67	
		Left Side	69.65 - 97.98	87.56± 7.45	0.523

The mean orbital height for the right and left side were 34.67 ± 2.50 mm and 34.40 ± 2.32 mm while their breadth were 39.75 ± 3.43 and 39.31 ± 3.26 mm respectively. The mean orbital index calculated was 86.45 ± 9.67 on right and 87.56 ± 7.45 on left side. There was no significant difference between right and left side of the orbital parameters.

[Table/Fig- 6]:Showing Mean and Sd of BOD And IOD.

Parameters	Range	Mean ± S.D.
Biorbital Distance (BOD)	83.08 – 110.23	98.23 ± 6.84
Interorbital Distance(IOD)	16.50- 26.84	20.86 ± 2.42

The mean Biorbital Distance (BOD) was 98.23 ± 6.84 and Interorbital Distance(IOD) was 20.86 ± 2.42.

Table/Fig- 7]:Category of Orbit in Right and Left Side.

Category	Right	Left
Microseme (<83)	24%	26%
Mesoseme (83-89)	40%	38%
Megaseme (>89)	36%	36%

It has been observed that the majority of orbits belonged to mesoseme category whether right (40%) or left (38%). Orbital dimension of a particular person depend predominantly on genetic constitution, influence by environmental and nutritional habits.

DISCUSSION

[Table/Fig- 8]:Comparison of Orbital Dimensions with earlier research.

PARAMETERS (mm)	Weavers et al(2010) [19]	Jaswinder Kaur et al(2012) [20]	Howale et al(2012) [21]	Ebeye and Otikpo (2013) [22]	Gosavi et al(2014) [23]	Nagaraj et al(2017) [24]	Jagriti et al(2017) [25]	Mugunti et al(2012) [26]	Present study (2024)
ORBITAL HEIGHT (OH)	**32.09**	**32.05**	**31.10**	**32.46**	**32.31**	**32.42**	**33.46**	_	**34.54**
ORBITAL BREADTH (OB)	**37.01**	**39.25**	**36.20**	**41.53**	**39.46**	**36.01**	**39.79**	_	**39.53**
ORBITAL INDEX (OI)	**86.70**	**81.65**	**86.40**	**78.36**	**81.88**	**87.39**	**86.19**	_	**87.00**
INTERORBITAL DISTANCE (IOD)	_	_	_	_	**19.49**	_	_	**18.91**	**20.85**
BIORBITAL DISTANCE (BOD)	_	_	_	_	**95.65**	_	_	**99.49**	**98.23**

In the present study, we found that mean OH of the orbit was higher than that of other studies [19-25]. The findings indicate that mean OB of orbit in the current study was 39.58 mm which was consistent with findings of other study [20, 23, 25] but contrarily the study done by Ebeye and Otikpo was found 41.53 mm which was higher than the present study. The findings revealed that mean OB of orbit in the current study was greater than the values reported by other researchers [19, 21, 24]. Mean Orbital index (OI) of the orbit reported by Nagaraj et al (87.39) was nearly similar to the present study but the values reported by other researchers [19- 23, 25] was lesser than our study. In the present study, we observed mean IOD of orbit was 20.85 mm which was greater than other studies [23 & 26]. The findings revealed that mean BOD of orbit found by Mugunti et al(99.49 mm) which was higher than the current study but it was greater in our study than Gosavi et al.

[Table/Fig- 9]:Comparison of Orbital Index with some of the previous studies.

S.N.	Authors	Number of skulls	Race/Regions	Mean O.I.	Category
1.	Ukoha et.al.(2011)[27]	70	Nigerians	89.21	Megaseme
2.	Jaswinder Kour et al. (2012) [20]	30	North Indian	81.65	Microseme
3.	Howale et al (2012) [21]	75	Maharashtra	86.40	Megaseme
4.	Mugunti et al.(2013) [26]	150	Black Kenyan	83.03	Mesoseme
5.	Gosavi et al.(2014)[23]	64	Maharashtra	81.88	Microseme
6.	Giris V. Patil et al. (2014)[28]	200	South Indian	81.23	Microseme
7.	Kumar et al (2014)[29]	68	Indian	80.07	Microseme
8.	Fetouh and Mandour et al.(2014)[30]	52	Egyptian	82.89	Microseme
9.	Mekala D et al.(2015)[31]	200	South Indian	85.04	Mesoseme
10.	Maharana and Agrawal et al (2015)[32]	100	North Indian	81.66	Microseme
11.	Narasinga and Pramila et al.(2015)[33]	50	South Indian	88.41	Mesoseme
12.	Navneet et al.(2016)[34]	50	Srilankan	81.29	Microseme
13.	Nagaraj S. et al.(2017)[24]	100	Telangana	87.39	Mesoseme
14.	Present study(2024)	50	North Indian	87.00	Mesoseme

The findings revealed that the majority of the orbits belonged to mesoseme category in the present study, which was consistent with the findings of other study [24, 26, 31 & 33]. Microseme category of orbits observed by other researchers [20, 23, 28, 29, 30, 34], whereas the study done by Ukoha et.al. & Howale et al found the megaseme category of orbits. The Orbital index which determines the shape of the face differs in different population groups. This means that the orbit with larger breadth than height will have smaller orbital indices while those with larger orbital index will have narrow faces.

CONCLUSION

Regional studies on the orbital index will provide useful data for clinical and surgical treatment for patients in ophthalmology, oral and maxillofacial surgery, and neurosurgery. The orbital measurements are helpful not only for surgical accuracy but also for the preparation of an ocular prosthesis. It helps the physical anthropologists to know the migration pattern of the early civilization. A detailed knowledge of anatomy and its variations will help the surgeons avoid surgical complications. Thus, the study done on North Indian adult dry skulls may be useful for forensic medicine experts. It would also be of clinical value in assessing patients with orbital deformities, pathologies, and various craniofacial deformities.

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