Original Research Article

Determination of Types of Orbit by Orbital Index in Dry Skulls of North India

Prerna Gupta[1] , Sayed Mohd Fareed[2], Areeba Nasar[3], Rahul Singh[4], Abdul Shaheer Umar[5], Kauser Sayedda [6]

[1]Associate Professor, Dept. of Anatomy, Integral Institute of Medical Science & Research, Integral University, Lucknow, U.P, India

[2]Tutor, Dept. of Anatomy, Al-Falla School of Medical Sciences and Research, Dahoj, Faridabad, Haryana, India

[3]Assistant Professor, Dept. of Anatomy, United Institute of Medical Science, Prayagraj, U.P, India

[4]Assistant Professor, Dept. of Anatomy, Integral Institute of Medical Science & Research, Integral University, Lucknow, U.P, India

[5]Undergraduate Biology student, Boston College, Massachusetts, USA

[6]Professor, Deptt. of Pharmacology Integral Institute of Medical Science & Research, Integral University, Lucknow, U.P. India

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Abstract

Introduction: Morphometry of orbit which includes measurement of orbital height and orbital breadth is an important craniofacial parameter. It has been used extensively and successfully in anthropology for identification of human beings in medico-legal cases. The measurement of orbital height and breadth determines the orbital index which is helpful in identifying types of orbit and races. Very few studies have been conducted in North Indian population for determination of Orbital Index, thus the present study was done to further substantiate the available data.**Materials and Methods**: This study was conducted on 50 dried skulls which were obtained from the Department of Anatomy, Integral Institute of Medical Sciences and Research, Lucknow and Career Institute of Medical Sciences and Hospital, Lucknow, after taking Institutional Research and Ethical Committee clearance. Distance between Dacryon and Ectochion were measured for breadth and orbital height to obtain Orbital Index. Measurements were taken with the skull in Frankfurt's plane. **Results and Conclusion:** In the present study the mean Orbital Index (OI) was 85.38 ± 5.11 on right side and 85.90 ± 4.6 on left side. Values are not statistically significantly different ($p>0.05$). The orbit was thus categorized under Mesoseme (OI: 84-89) category. The study also concludes that variation & different categories can be found within the same population.

Key words: orbital index, mesoseme, dry skull, North Indian population

Introduction

Anatomical structural Knowledge, proportion, and mechanical function of the human body and racial dissimilarities in ocular anatomy is important to clinical evaluation and management of patients[1]. Morphometry of orbit which includes measurement of orbital height and orbital breadth is an important cranio facial parameter. It has been used extensively and successfully in anthropology for identification of human beings especially in case of natural disaster and accidents where mutilated or only a part of body is available[2].It can also be used in situations like exploration of mass graves, war victims and homicidal dismemberment of parts of body[3].Morphology of orbit is also useful to distinguish between male and female skulls. Male orbit are square while female orbits are round and large as compared to their male counter parts.[4] The normal value of orbital height and orbital width is useful in diagnosis of craniofacial syndromes, interpretation of fossil records, and classification of skulls in forensic medicine. It is also important in anthropological investigation of unknown individuals for determining gender ethnicity and in exploring the trend of evolutionary and ethnic differences.

**Correspondence*

Dr. Prerna Gupta

Associate Professor, Dept. of Anatomy, Integral Institute of Medical Science & Research, Integral University, Lucknow, U.P, India

Email- id: dr.prerna2009@gmail.com

Prior knowledge of bony orbit has great clinical, surgical and prognostic importance in approach of, oral maxillofacial surgeries, neurosurgery and various surgeries performed on eye[5].It is also helpful in reconstructive surgeries of the face and for assessment of Down syndrome[6].In each orbital cavity the width is usually greater than the height and the relation between the two is given by the orbital index which varies in different races[5,6].Orbital index can be measured both manually and radiologically, but direct measurement of orbital index is easier and more convenient. Hence, in the present study morphometric orbital study was done by vernier caliper to determine orbital values, and thereby calculate orbital index in North Indian population[7].Based on orbital index, orbits are classified in three categories[6]. Megaseme (Large Orbit) where the orbital index is 89 or over . Mesoseme (Medium Orbit) where the Orbital Index is between 84 to 89. Microseme (Small Orbit) where the Orbital Index is 84 or less. This type is characteristic of the black races .The opening is rectangular.The orbital index also determines the shape of the face, being different in various population groups. This proves that the orbit with larger width than height will have smaller orbital indices, while those with larger orbital index will have narrow faces.[8] Orbital index also vary with age, sex, race, region and ethnic evolution. It is necessary to determine their different values in order to help anthropologist, oral and maxillofacial surgeons, forensic expert and anatomist in identifying different types of orbit.[9] Very few studies have been conducted in North Indian population for

determination of Orbital Index, thus the present study was done to further substantiate the available data.

Methods

This study was conducted on 50 dried skulls which were obtained from the Department of Anatomy, Integral Institute of Medical Sciences and Research, Lucknow, Uttar Pradesh and Career Institute of Medical Sciences and Hospital Lucknow, Uttar Pradesh after taking Institutional Research and Ethical Committee clearance. Inclusion criteria were intact, dried adult North Indian skulls with no orbital deformity. The skulls with craniofacial malformation and fracture were excluded from the study.Two points, Dacryon and Ectochion were marked on the skull. Dacryon is a point on the medial border of the orbit where the frontal, lacrimal and maxillary bones meet each other. It is denoted by point "C "in the Fig-1. Ectochion is the intersection of the most anterior surface of the lateral border of the orbit and the line bisecting the orbit along its long axis.[9] It is denoted by point "D" in Fig-1. Point A and B in Fig-1 represent maximum distance from the superior orbital margin to the inferior orbital margin. Instruments used for measurement were Digital Vernier caliper and Marker pen (Fig- 2 & 3). Measurements were taken with the skull in Frankfurt's plane. The measurements of right and left orbit were recorded separately.Orbital height is the maximum distance from the superior orbital margin to the inferior orbital margins lying perpendicular to the orbital breadth. Orbital breadth is the distance measured between dacryon and ectochion. The orbital Index was calculated by the formula given below:

$$\text{Orbital Index} = \frac{\text{Orbital Height}}{\text{Orbital breadth}} \times 100$$

Ethics: The study was approved by Institutional Ethical Committee.

Statistics: Data was collected, tabulated and analyzed statistically using mean, standard deviation and P value was calculated by paired student 't'test using Graph pad prism version 8.

Results

The measurements of right & left orbits were taken individually & analyzed statistically. The parameters of right orbit i.e. orbital height, orbital breadth & orbital index came out to be numerically higher than those of left side's parameters (Table-1) but these were not statistically significantly different (p>0.05).In 24% of right side orbits, orbital index was under 83 or less placing them in microseme category of orbit. Orbital index in 54% of right side orbits ranged from 83-89, therefore, these are placed in mesoseme category. In the rest i.e. 22% of right side orbits, orbital index calculated was 89 & above putting them in megaseme category (Table 4). Similarly in left side orbits, 26% were of microseme category, 56% were placed in mesoseme category & 18% under megaseme category.(Table 5)

Table 1: Measurements of Orbital height and Orbital breadth in right and left side orbit

Parameters	Side	Min-Max	Mean± SD	Level of significance
Orbital Height(mm) (n=50)	Right	28.10-38.54	33.03 ± 2.31	NS
	Left	28.79-37.93	32.71 ± 2.12	
Orbital Breadth(mm) (n=50)	Right	32.77-45.14	38.74 ± 2.56	NS
	Left	32.51-44.21	38.16 ± 2.54	
Orbital Index	Right	72.68-97.84	85.38 ± 5.11	NS
	Left	73.01-96.39	85.90 ± 4.60	

NS-Not significant

Table 2: Comparison of orbital height and breadth between two sides in the present study with that of previous studies.

Author Names		Orbital Height			Orbital Breadth		
		Right (mm)	Left (mm)	Level of significance	Right (mm)	Left (mm)	Level of significance
Kumar et al.,2014		33.47 ± 1.56	33.65 ± 1.53	NS	42.06 ± 1.73	41.87 ± 1.73	NS
Fetouh et al.,2014	M	35.83 ± 1.23	35.27 ± 1.35	S*	43.62 ± 1.3	42.6 ± 0.94	S*
	F	35.53 ± 0.95	34.27 ± 1.12	S*	42.75 ± 1.35	42.0 ± 1.37	S*
Mekala et al., 2015		3.55 ± 0.23	3.53 ± 0.24	NS	4.17 ± 0.02	4.18 ± 0.02	NS
Dhanwate et al., 2016	M	32.64 ± 2.07	32.39 ± 2.18	NS	37.52 ± 1.35	37.08 ± 1.96	S*
	F	32.55 ± 1.91	32.31 ± 1.55	NS	37.23 ± 1.63	36.67 ± 1.57	S*
Agarwal et al.,2017		33.46 ± 3.12	33.79 ±3.46	NS	39.79 ±4.12	39.23 ±3.4	NS
Joshi et al., 2018		32.37 ± 1.8	30.96 ± 0.85	S†	40.31 ± 2.28	40.28 ± 2.02	NS
Present study 2020		33.03 ± 2.31	32.71 ± 2.12	NS	38.74 ± 2.56	38.16 ± 2.54	NS

S-significant, NS-not significant , *p<0.05, † p<0.0001,

Table 3: Comparison of Orbital Indices in different studies in adult dry skulls

Authors	Year	Study Population	Orbital Index	Level of significance	Category (Based on Orbital Index)
Fetouh FA	2014	Egyptian	Male-82.27 Female-83.50	NS	Male-Microseme Female- Mesoseme
Kumar et al	2014	North Indian	Right-79.65 Left-80.49	NS	Microseme
Mekala et al	2015	South Indian	Male-84.62 Female-85.46	NS	Mesoseme

Gopal Krishna et al	2015	Indian	Right-80.69 Left-81.16	NS	Microseme
Dhanwate et al	2016	South Indian	Male-87.47 Female-87.88	NS	Mesoseme
Agarwal et al	2017	Central India	Right-86.19 Left-84.57	NS	Mesoseme
Joshi et al	2018	North India	Male-83.45 Female-77.96	NS	Male-mesoseme Female-microseme
Present Study	**2019**	**North Indian**	**Right-85.38 Left-85.90**	NS	**Mesoseme**

NS-not significant

Table 4: Comparison of right Orbital Index of present study with right Orbital Indices of various studies

Author	Year	Study Population	Category in percent (Based on Right Orbital Index)
Gopalakrishna K	2015	Indian	79.69% Microseme 20.31% Mesoseme
Alam T	2016	North Indian	54% Microseme 14% Mesoseme 32% Megaseme
Agrawal J	2017	Central India	30% Microseme 52% Mesoseme 18% Megaseme
Present study	**2019**	**North Indian**	**24% Microseme 54% Mesoseme 22% Megaseme**

Table-5: Comparison of left Orbital Index of present study with left Orbital Indices of various studies

Author	Year	Study Population	Category in percent (Based on left Orbital Index)
Gopalakrishna et al	2015	Indian	75% Microseme
			25% Megaseme
Alam et al	2016	North Indian	50% Microseme
			24% Mesoseme
			26% Megaseme
Agrawal et al	2017	Central Indian	30% Microseme
			58% Mesoseme
			12% Megaseme
Present study	**2019**	**North Indian**	**26% Microseme**
			56% Mesoseme
			18% Megaseme

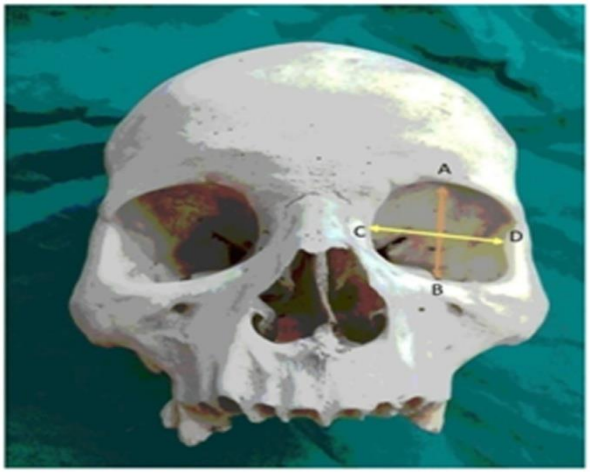

Fig 1: landmarks of Orbit

Fig 2: Measurement of Orbital Breadth

Fig 3: Measurement of Orbital Height

Discussion

Knowledge of orbital parameters & orbital index is important for ophthalmology interventions, maxillofacial & neurosurgeries. Orbital index also plays role in sex determination by forensic experts & it is also important for population differentiation as it determines the shape of face. The orbits with larger breadth will have smaller orbital index (microseme) & orbits with smaller breadth will have larger orbital index (megaseme) inferred from formula of calculating orbital index.In present study, we compared orbital height, orbital breadth and orbital index of both sides. Results from study showed that the right side mean orbital index of North Indian population is 85.38 ± 5.11 and that on left side was 85.90 ± 4.60. This placed orbit of North Indian population group in Mesoseme category. The slight difference between right & left side's orbital index , though not statistically significant, could be because of difference in growth of brain of two sides. Orbital index is more on left side & this should be given due consideration while doing surgical correction of bony orbit.Results of present study are compared with the previous studies. When the height & breadth of two sides are compared, on contrary to the present study, Dhanwate, Duttatray and Gaikwad[9] reported statistically significant difference between orbital breadth of two sides and Joshi et al.,[7] concluded statistically significant difference between orbital height of two sides. Another study explored a significant difference between orbital height & orbital breadth of two sides[10](Table- 2)In agreement with our study, Mekala, Shubha and Rohini[11] and Agarwal et al.,[12] reported that there was no significant difference in orbital height & breadth of the two sides. In a separate study[13], authors did not find any significant difference between right & left side parameters (Table- 3). The differences in orbital parameters of different studies may be attributed to right & left asymmetry. However, no study reported significant difference in orbital index of two sides(Table- 3). Present study places North Indian population orbits in mesoseme category. This coincides with other studies[9,11,12]. (Table-3). Joshi et al.[7] divided male orbits into mesoseme category & females into microseme category. Kumar and Nagar[13] placed orbits in microseme category (Table- 3). The variations may be due to ethnic & racial difference . Present study also further concludes that on right side 56% of orbits were of mesoseme variety, 26% microseme & 18% as megaseme. (Table- 4). On left side , these were 54%, 24% & 22% respectively. (Table- 5)

These findings are in line with study done by Agarwal et al[12] while Alam, Rai and Singh[14] and Gopal Krishna and Shenoy[13] concluded differently. (Table-5). Though these studies were carried out in Indian population only, variations may be due to differences in anatomical characteristics of orbital cavity & bilateral asymmetry.

Conclusion

This study comes up with useful orbital parameters data of North Indian population. Though all types of orbits are found here but majority of orbits are of mesoseme variety. So, we conclude that mesoseme is the orbit type in Norh Indian population. The data collected can be utilized in surgical interventions in Ophthalmology, maxillofacial, oral and neurosurgeries. The study also concludes that variation & different categories can be found within the same population.

Limitations of study

Age & gender wise categorization is not done that would have added more power to the study. Further studies are recommended to explore orbital morphometry in North Indian population

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