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Original Research Article

MORPHOMETRIC STUDY OF THE ORBIT IN HUMAN DRY SKULLS AND HIGH RESOLUTION COMPUTED TOMOGRAPHIC SCANS

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Abstract

Background: The human skull is 92% unique and is more flexible and dimorphic than any other human anatomical feature. Consequently, forensic anthropologists rely heavily on morphometric changes in the orbital aperture to determine personal and gender identity, which is especially important in the aftermath of mass tragedies. The present study aims to evaluate and record the quantitative morphometry of the orbital cavity in people from south India. **Materials and Methods:** A randomised observational study was at PSG Institute of Medical Sciences and Research, Coimbatore. Forty adult dry skulls and sixty patients computed tomographic brain images were analysed for quantitative morphometry of the orbital cavity (30 males and 30 females). Only adults with dry skulls and unaltered orbital cavities were included, and the brain scans had to be rated as "normal" on a computed tomography scanning. **Result:** In the present study, 224 patients, in Wagner's classifications 1 and 2, aged more in both dry skulls and CT scans, there was no statistically significant difference in the morphometric measures of the right and left orbital cavities. However, CT scans revealed that males had larger orbits than females regarding the length of the medial wall, the perimeter of the orbital rim, the size of the orbital foramen, and the volume of the bony orbits. In addition, the CT scans showed dramatic orbital cavity changes as people age. **Conclusion:** Our study concludes that avoiding orbital asymmetry requires precise restoration of orbital volume to its pre-traumatic state during reconstructive procedures.

INTRODUCTION

Both sides of the skull's sagittal plane have orbital cavities, which connect the skull to the facial bone. They have an about equal impact on both areas, given their position. Each orbital cavity houses the eyeball and its accompanying muscles, nerves, arteries, and other parts of the visual system. Several medical specialities, including maxillofacial surgery, ophthalmology, and neurosurgery, are interested in the body.[1] Human adult orbits are pyramidal, with four sides. Its bottom opens into the face and is bounded on all sides by facial bones: the frontal bone to the top, the maxilla and zygoma to the bottom, the frontal, lacrimal, and maxilla to the middle, and the zygoma and frontal to the sides. The optic canal connects the anterior cranial fossa to the middle cranial fossaand its apex is located towards the medial end of the superior orbital fissure.

The bone of the orbit is seen as a pyramid having a top, sides, base, and bottom. The roughly rectangular orbital gate may be spotted near the pyramid's base. It has a 4 cm width and a 3.5 cm height when laid flat. Due to the equator's proximity to the lateral orbital rim because of the globe's lateral movement, the equator receives considerable lateral exposure. The highest point of the orbital pyramid sits 44-50 mm behind the eye.[3] The medial orbital walls are parallel and about 2.5 cm apart; the ethmoid sinuses that divide them are paired. About 30 ml make up's surface, with the globe taking up just about 7 ml. The orbit is spherical because it forms around the eye, and its broadest point is located not at the orbital rim but around 1.5 cm behind it. The breadth of an individual's orbital cavity is often bigger than its height; the ratio between these two dimensions is

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defined by the orbital index, which varies across various ethnic groups. Three types of orbits, defined in terms of the orbital index, have been described.[4]
CT has made incredible strides in studying and treating disorders of the eye and orbit. The utilisation of thin sections enables in-depth analysis thanks to multi-planar scanning and the potential for 3-D reconstruction. For example, suppose we want to be able to forecast and prevent eye injuries.[5] In that case, we need to quantify the anthropometric variance in eye and orbit sizes throughout the average population. Measuring the bony components of the orbit that hold and shield the eye may be done precisely with CT scans. Accurate anthropometric data about the eye and orbit can aid in developing eye protection gear and the simulation of face impacts to better forecast the likelihood of harm.[6]

Aim

The present study aims to evaluate and record the quantitative morphometry of the orbital cavity in people from south India.

MATERIALS AND METHODS

A randomised observational study was done at PSG Institute of Medical Sciences and Research, Coimbatore.
Forty adult dry skulls and sixty patients computed tomographic brain images were analysed for quantitative morphometry of the orbital cavity (30 males and 30 females). Institutional ethical review board permission was obtained before the study was initiated.
Only adults dry skulls with unaltered orbital cavities were included and the brain scans had to be rated as "normal" on a computed tomography scanning (CT). The study did not include CT report with
eye and orbital cavity diseases, intraorbital tumours, thyroid illness, and congenital anomalies such as anophthalmia, microphthalmia, and orbit facial cleft.
There was a total of twelve factors evaluated in both the dry bone and radiographic images. They were orbital breadth, orbital height, orbital index, length of inferior wall, length of superior wall, length of medial wall, inter orbital distance, length of lateral wall, bi orbital distance, orbital foramen area, orbital rim perimeter, and bony orbital volume. Using the software MM basic 3D programme, we measured the bone window in cranial computed tomography scans. This software integrated a three-dimensional image with a two-dimensional axial, coronal, and sagittal perspective on a single display. A three-dimensional picture can be used to designate a location that will then appear in all the three two-dimensional perspectives of the programme.
We used a paired sample T-test to assess the quantitative morphometry of left and right orbital cavities. We used a one-way variance analysis to compare the three groups' quantitative orbital morphometry. The Pearson Correlation Test was used to determine whether there was a connection between the volume of the bony orbits and many other variables.

RESULTS

Table 1: Quantitative orbital morphometry in adult dry Skulls

Parameters	Mean and Standard deviation		
	Right	Left	Average
Orbital Index	80.65±2.60	80.96±2.64	80.80±2.61
Orbital breadth (mm)	40.50±1.55	40.33±1.34	40.41±1.44
Orbital height (mm)	32.65 ± 1.33	32.62 ± 1.47	32.64 ± 1.39
Medial Wall Length (mm)	42.07±1.97	41.90±1.85	41.99±1.90
Lateral Wall Length (mm)	48.15±2.28	48.11±2.38	48.13±2.31
Inferior Wall Length (mm)	47.45±2.33	47.25±2.20	47.35±2.25
Superior Wall Length (mm)	51.97±2.54	52.10±2.49	52.04±2.50
Orbital Foramen Area (cm2)	10.37±0.74	10.32±0.75	10.34±0.74
Orbital Rim Perimeter (mm)	123.98±5.55	124.68±4.92	124.33±5.22
Inter Orbital Distance (mm)			20.98±1.75
Bi Orbital Distance (mm)			94.42±3.66
Bony Orbital Volume (ml)	24.50±2.58	24.40±2.70	24.45±2.62

The mean orbital index for right and left orbital cavities was 80.65 ± 2.60 and 80.96 ± 2.64mm. The mean orbital index for total orbital cavities was 80.80 ± 2.61mm.
The mean orbital breadth for right and left orbital cavities was 40.50 ± 1.55mm and 40.33 ± 1.34mm. The mean orbital breadth for total orbital cavities was 40.41 ± 1.44mm.
In the adult dry skull measurement, the mean orbital height for right and left orbital cavities was 32.65 ± 1.33mm and 32.62 ± 1.47mm. The mean orbital height for total orbital cavities was 32.64 ± 1.39mm [Table 1].
Among the orbital index in the adult dry skull, Microseme OI ≤ 83 on the right side was 31 (77.5%), on the left side was 32 (80%), and in total was 63 (78.75%). Mesoseme OI between 83 to 89 on the right side was 9 (22.5%), on the left side was 8 (20%), and in total was 17 (21.25%). No orbital cavity had an orbital index ≥89 in the adult dry skull.

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Table 2: Classification of the orbital cavity according to orbital index in adult dry skulls and CT images

Category		MICROSEME OI ≤ 83	MESOSEME OI Between 83 To 89	MEGASEME OI ≥ 89
Orbital Index In Adult Dry Skulls	Right Side	31 (77.5%)	9 (22.5%)	Nil
	Left Side	32 (80%)	8 (20%)	Nil
	Total	63 (78.75%)	17 (21.25%)	Nil
Orbital Index In CT Images	Right Side	56 (93.33%)	4 (6.67%)	Nil
	Left Side	54 (90%)	6 (10%)	Nil
	Total	110 (91.67%)	10 (8.33%)	Nil
	Male	51 (85%)	9 (15%)	Nil
	Female	59 (98.33%)	1 (1.67%)	Nil

Among the orbital index in CT images, Microseme OI ≤ 83 on the right side was 56 (93.33%), on the left side was 54 (90%), in total was 110 (91.67%), in males was 51 (85%), and in females was 59 (98.33%). Mesoseme OI between 83 to 89 on the right side was 4 (6.67%), on the left side was 6 (10%), in total was 10 (8.33%), in males was 9 (15%), and in females was 1 (1.67%). No orbital cavity had an orbital index ≥89 in CT images [Table 2].

Table 3: Quantitative orbital morphometry in CT images

Parameters	Mean and Standard deviation				
	Male	Female	Right	Left	Average
Orbital Index	79.98±2.66	79.37±2.37	79.46±2.52	79.89±2.55	79.68±2.53
Orbital breadth (cm)	4.02±0.09	3.96±0.17	3.99±0.16	3.99± 0.12	3.99±0.14
Orbital height (cm)	3.22±0.13	3.15±0.14	3.18±0.13	3.19± 0.14	3.19±0.14
Medial Wall Length (cm)	4.18±0.33	4.01±0.29	4.10±0.32	4.10±0.33	4.10±0.32
Lateral Wall Length (cm)	4.67±0.37	4.49±0.31	4.59±0.35	4.56±0.36	4.58±0.35
Inferior Wall Length (cm)	4.59±0.25	4.49±0.25	4.53±0.27	4.57±0.24	4.55±0.25
Superior Wall Length(cm)	5.10±0.15	5.06±0.18	5.07±0.17	5.09±0.16	5.08±0.16
Orbital Foramen Area (cm2)	10.40±0.74	9.43±0.80	9.92±0.92	9.93±0.90	9.92±0.91
Orbital Rim Perimeter (cm)	11.70±0.36	11.16±0.48	11.44±0.50	11.42±0.50	11.43±0.50
Inter Orbital Distance (cm)	2.59±0.25	2.58±0.24			2.58±0.25
Bi Orbital Distance (cm)	9.33±0.40	8.99±0.42			9.17±0.44
Bony Orbital Volume (cm3)	25.71±2.21	22.56±2.27	24.27±2.79	23.99±2.69	24.13±2.73

The mean orbital index for males was 79.98 ± 2.66cm, and for females was 79.37±2.37cm. The mean orbital index for right and left orbital cavities was 79.46 ± 2.52 and 79.89 ± 2.55cm. The mean orbital index for total orbital cavities was 79.68 ± 2.53cm.

The mean orbital breadth for males was 4.02 ± 0.09cm, and for females was 3.96 ± 0.17cm. The mean orbital breadth for right and left orbital cavities was 3.99 ± 0.16cm and 3.99cm ± 0.12cm. The mean orbital breadth for total orbital cavities was 3.99 ± 0.14cm.

The mean orbital height for males was 3.22 ± 0.13cm, and for females was 3.15 ± 0.14cm. The mean orbital height for right and left orbital cavities was 3.18 ± 0.13cm and 3.19 ± 0.14cm. The mean orbital height for total orbital cavities was 3.19 ± 0.14cm [Table 3].

Table 4: Quantitative morphometry of right and left orbital cavity in male and female (CT images)

Parameters	Side	Mean and Standard deviation	
		Male	Female
Orbital height (cm)	Right	3.21±0.13	3.15±0.13
	Left	3.23±0.13	3.16±0.14
Orbital breadth (cm)	Right	4.02±0.10	3.96±0.19
	Left	4.02± 0.09	3.97±0.14
Orbital Index	Right	79.79±2.64	79.14±2.39
	Left	80.18±2.72	79.61±2.37
Superior Wall Length(cm)	Right	5.10±0.17	5.03±0.17
	Left	5.10±0.13	5.08±0.18
Inferior Wall Length (cm)	Right	4.58±0.25	4.48±0.29
	Left	4.62±0.26	4.51±0.20
Medial Wall Length (cm)	Right	4.19±0.32	4.01±0.31
	Left	4.18±0.35	4.02±0.28
Lateral Wall Length (cm)	Right	4.67±0.35	4.51±0.33
	Left	4.64±0.40	4.48±0.29
Orbital Rim Perimeter (cm)	Right	11.70±0.37	11.17±0.48
	Left	11.69±0.37	11.15±0.48
Orbital Foramen Area (cm^2)	Right	10.41±0.75	9.43±0.82
	Left	10.41±0.74	9.44±0.79
Bony Orbital Volume (cm^3)	Right	25.91±2.20	22.64±2.34
	Left	25.50±2.24	22.49±2.23

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The mean orbital height for males in the right and left orbital cavities was 3.21 ± 0.13cm and 3.23 ± 0.13cm. The mean orbital height for females in the right and left orbital cavities was 3.15 ± 0.13cm and 3.16 ± 0.14cm.
The mean orbital breadth for males in the right and left orbital cavities were 4.02 ± 0.10cm and 4.02 ± 0.09cm. The mean orbital breadth for females in the right and left orbital cavities was 3.96 ± 0.19cm and 3.97 ± 0.14cm.
The mean orbital index for males in the right and left orbital cavities was 79.79 ± 2.64cm and 80.18 ± 2.72cm. The mean orbital index for females in the right and left orbital cavities was 79.14 ± 2.39cm and 79.61 ± 2.37cm [Table 4].

Table 5: Quantitative orbital morphometry for three age groups (CT images)

Parameters	Mean and Standard deviation		
	Group I	Group II	Group III
	25 to 35 years	36 to 50 years	51 to 65 years
Orbital Index	80.52 ± 2.40	80.06 ± 2.20	77.98 ± 2.50
Orbital breadth (cm)	3.99 ± 0.19	3.97 ± 0.12	4.04 ± .09
Orbital height (cm)	3.23 ± 0.15	3.18 ± 0.13	3.15 ± 0.12
Medial Wall Length (cm)	4.08 ± 0.26	4.09 ± 0.35	4.14 ± 0.35
Lateral Wall Length (cm)	4.45 ± 0.23	4.60 ± 0.40	4.68 ± 0.34
Inferior Wall Length (cm)	4.46 ± 0.22	4.59 ± 0.26	4.57 ± 0.27
Superior Wall Length(cm)	5.05 ± 0.15	5.11 ± 0.16	5.04 ± 0.15
Orbital Foramen Area (cm2)	9.62 ± 0.71	9.92 ± 0.92	10.28± 0.99
Orbital Rim Perimeter (cm)	11.27 ± 0.45	11.43 ± 0.49	11.61 ± 0.53
Inter Orbital Distance (cm)	2.60 ± 0.22	2.59 ± 0.28	2.54 ± 0.22
Bony Orbital Volume (cm3)	23.11 ± 2.30	24.14 ± 2.55	25.33 ± 3.09
Bi Orbital Distance (cm)	9.07 ± 0.49	9.12 ± 0.41	9.36 ± 0.39

The mean orbital index for Groups I, II, and III was 80.52 ± 2.40cm, 80.06 ± 2.20cm, and 77.98 ± 2.50cm. The mean orbital breadth for Groups I, II, and III was 3.99 ± 0.19cm, 3.97 ± 0.12cm, and 4.04 ± .09cm. The mean orbital height for Groups I, II, and III was 3.23 ± 0.15cm, 3.18 ± 0.13cm, and 3.15 ± 0.12cm [Table 5].

DISCUSSION

Planning orbital cavity reconstruction operations requires precise quantitative orbital morphometry. Although orbital cavities vary in form between races, ethnicities, and regions, every community must have access to accurate data on the quantitative morphometry of the orbital cavity. In the present study, the mean orbital breadth of the left and right was 40.33 ± 1.34 and 40.50 ± 1.55 mm. The mean orbital height of the left and right was 32.62 ± 1.47 and 32.65 ± 1.33mm.

According to the study by Sangvichien et al., Orbital height averaged 33.44 mm for men and 32.89 mm for women. Males had an average orbital width of 40.10 millimetres, while females averaged 38.09 millimetres.[7]

The study by Ukoha et al. reported the mean orbital height for the left and right sides were31.45±0.71 and 31.90±0.70mm their orbital breadth was 34.98±0.38 and 36.03±0.37mm. Results indicate that the sample is Megaseme, and the study will inform future surgical care of ocular disorders in the context of our ecosystem.[8]

Fathy et al. reported that the mean orbital height in females was 35.12 mm and in males was 35.57 mm. The mean orbital breadth in females was 42.37 mm and in males was 43.25 mm. The mean orbital index in females was 82.5 and in males was 82.27. According to the results that there are considerable disparities between the genders and between the two sides.[9]

Kaur et al. reported that the mean orbital index was 81.65. The mean orbital breadth for the left and right sides was 32.2 ± 1.8 and 31.9 ± 2.2 mm, while their orbital height was 38.8 ± 3.1 and 39.7 ± 2.2mm. The study's findings place the north population in the Microseme group, which will inform future decisions on treating orbital disorders in this context.[10]

According to the study by Agrawal et al., the mean orbital index for the left and right sides was 84.57 ± 5.12 and 86.19 ± 5.12. The mean orbital breadth for the left and right sides was 39.23 ± 34 and 39.79 ± 4.12 mm, while their orbital height was 33.79 ± 3.46 and 33.46 ± 3.12 mm. The orbit characteristics on the left and right sides were not significantly different. Calculated values demonstrate variation in orbital morphology between regions and can aid in diagnosing and treating orbital diseases.[11]

A study by Patil et al. reported that among adult south Indian people, the mean orbital index in females was 82.32 and for males was 81.13. Based on the findings, further regional studies are needed to help globalise values for all races. Studies examining human evolution can benefit from this information since it sheds light on how early humans moved throughout the globe.[12]

A study by Gosavi et al. reported the mean orbital index was 81.88 mm while their mean orbital width was 39.46 ± 2.57 mm, and the mean orbital height was 32.31 ± 2.52 mm. According to the results, orbital morphometry provides valuable preliminary information for ophthalmological, maxillofacial, and reconstructive cosmetic facial procedures.[13]

According to the study by Kumar et al., the mean orbital index for the left and right sides was 80.49 ±4.67 and 79.65 ±4.02mm. The mean orbital width for the left and right sides were 41.87 ±1.73 and 42.06 ±1.68mm, and the mean orbital height for the left and

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right sides was 33.65 ±1.53 and 33.47 ±1.56mm. The information gathered from this study has the potential to be used as a comparative analysis of human orbital anatomy throughout healthy development, accounting for gender and ethnic-related variance.[14] According to Mekala et al., males are noticeably taller and more comprehensive than females. The size of the left and right orbits was not noticeably different from one another. No differences in OI were seen between the sexes or the two teams. The OI classifies the examined population of Indians as Mesoseme.[15] Rao et al. studied the mean orbital index for the left and right sides was 90.69 and 86.13. The mean orbital width for the left and right sides was 36.41 ± 1.78 and 36.5 ± 1.92mm, while their orbital height for the left and right sides was 32.89 ± 2.2 and 32.62 ± 2.03mm. Knowing the index is crucial for a few reasons stemming from the findings, including craniofacial databases, the analysis of fossil records, and the categorisation of criminal cases in forensic sciences.[16]

Compared to the study of Mekala et al.15, the orbital height is lower. Compared to Rao et al.16, our study observed that the orbital width was wider. Due to geographical and ethnic differences, our study's mean fell outside the range of other populations' studies

CONCLUSION

Our study concludes that avoiding orbital asymmetry requires precise restoration of orbital volume to its pre-traumatic state during reconstructive procedures. The spectrum of enophthalmos before and after reconstructive procedures has been studied in detail to predict enophthalmos at an early stage better, and reconstructive surgeries have been planned appropriately. A better outcome can be expected from enophthalmos surgery if it is performed early rather than late in the condition.

REFERENCES

1. Ghorai L, Asha ML, Lekshmy J, Rajarathnam BN, et al. Orbital aperture morphometry in Indian population: A digital radiographic study. J Forensic Dent Sci. 2017; 9:61–4.
2. Saini V, Srivastava R, Rai RK, Shamal SN, et al. Mandibular ramus: An indicator for sex in fragmentary mandible. J Forensic Sci. 2011;56 (Suppl 1): S13–6.
3. Jeremiah Munguti, Pamela Mandela, Fawzia Butt. Referencing orbital measures for surgical and cosmetic procedures. Anat. j. Afr. 2012:1(1):40–45.
4. Sayee Rajangam, Kulkarni RN, Quadrilos Lydia. Orbital dimensions. Indian J. Anat. 2012; 1:5–10.
5. Soman BA, Sujatha GP, Lingappa A. Morphometric evaluation of the frontal sinus in relation to age and gender in subjects residing in Davangere, Karnataka. J Forensic Dent Sci. 2016; 8:57.
6. Lepich T, Dąbek J, Jura-Szołtys E, Witkowska M, et al. Orbital opening shape and its alphanumerical classification. Adv Clin Exp Med. 2015; 24:943–50.
7. Sangvichien S, Boonkaew K, Chuncharunee A, Komoltri C et al. Sex Determination in Thai Skulls Using Craniometry: Multiple Logistic Regression Analysis. Siriraj Med J 2007; 59: 216-221.
8. Ukoha U, Egwu OA, Okafor IJ, Ogugua PC et al. Orbital dimensions of adult male nigerians: a direct measurement study using dry skulls. Int J Biol Med Res. 2011; 2(3): 688-690.
9. Fathy A. Fetouh and Dalia Mandour. Morphometric analysis of the orbit in adult Egyptian skulls and its surgical relevance. Eur. J. Anat. 2014;18(4): 303-315.
10. Kaur J, Yadav S, Sing Z. Orbital dimensions – A direct measurement study using dry skulls. J. Acad. ind. res. 2012;1(6): 293-295.
11. Agrawal J, Gautam D, Soutkke V, Mourya PK. Morphometry of orbit from the adult dry skull of the central Indian population. Int J Anat Res 2017;5(4.3):4756-59.
12. Patil GV. Study of the orbital index in dry human skulls of South Indian origin. J Anat Soc India. 2015(64): S15.
13. Gosavi S, Jadhav SD, Zambre BR. A study of orbital morphometry in Indian dry skulls. Asian J. Biomed. Pharm. Sci. 2014;4(29):23.
14. Kumar A, Nagar M. Morphometry of the orbital region: "Beauty is bought by judgment of the eyes.". Int J Anat Res. 2014;2(3):566-70.
15. Mekala D, Shubha R, Rohini Devi M. Orbital dimensions and orbital index: A measurement study on south Indian dry skulls. Int J Anat Res. 2015;3(3):1387–1391.
16. Rao N, Pramila Padmini M. A study of Orbital Index in dry skulls of North Coastal Andhra Pradesh. Int. J. Appl. Basic med. 2015;5(2):1-3.

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