

MORPHOMETRIC STUDY OF THE BONY ORBITSruthi S¹, Biju Urumese Palatty², Geetha S. G³¹14th Year MBBS Student, Amrita School of Medicine, Amrita Vishwa Vidyapeetham, Kochi, Kerala, India.²Associate Professor, Department of Anatomy, Amrita School of Medicine, Amrita Vishwa Vidyapeetham, Kochi, Kerala, India.³Assistant Professor, Department of Anatomy, Amrita School of Medicine, Amrita Vishwa Vidyapeetham, Kochi, Kerala, India.**ABSTRACT****BACKGROUND**

Ocular surgeries and craniofacial surgeries require retrobulbar nerve blocks to produce anaesthesia and akinesia of the eyeball, which involves a risk to the optic nerve.

The aim of this study is to determine the distance of the optic canal from various bony landmarks on the orbital margin of both sides of the skull and correlate these values with the orbital index.

MATERIALS AND METHODS

For the study, 62 human dry skulls of unknown sex were obtained from the bone bank of Anatomy Department, AIMS, Kochi. Using a digital Vernier calliper, the following parameters were measured: orbital height, orbital width, distance of the optic canal from certain landmarks on the orbital margins (Superior, Inferior, Medial and Lateral). The orbital index was calculated.

Statistical Analysis- The observations were analysed using paired t-test ($p < 0.05$ was considered to be significant). The statistical software used was IBM SPSS version 20.0.

Settings and Design- Anatomy Department, AIMS, Kochi. This is a descriptive study.

RESULTS

The mean distance between the optic canal and the landmarks on the superior, inferior and medial margins is significantly different on right and left sides (significance, $p = 0.001$). Whereas, the mean distance of the optic canal from a point on the zygomaticofrontal suture (lateral margin) did not show any significant difference on both sides. The mean values of the orbital index on the left and right sides were 79.48 and 80.40 respectively and not significantly different ($p = 0.517$). 67.7% of the total skulls observed belonged to microseme category (orbital index ≤ 83). The safe distance to the optic nerve from the orbital margins were obtained by reducing 5 mm from the shortest distance on each side.

CONCLUSION

The knowledge of these values is vital in the evaluation, diagnosis, pre-operative and per-operative planning of management for craniofacial syndromes, post-traumatic facial deformities and in the treatment of orbital abnormalities to produce the best aesthetic and functional result. It is also of relevance to anaesthetists in ocular surgeries, while various nerve blocks are being employed.

KEY WORDS

Orbital Index, Optic Canal Orbital Margin, Safe Distance to Optic Nerve.

HOW TO CITE THIS ARTICLE: Sruthi S, Palatty BU, Geetha SG. Morphometric study of the bony orbit. J. Evolution Med. Dent. Sci. 2018;7(26):3028-3031, DOI: 10.14260/jemds/2018/680

BACKGROUND

The bony orbits are skeletal cavities located on either side of the nose. The orbital wall apart from protecting the eye from an injury provides points of attachments for six extraocular muscles. This will help in the accurate positioning of the visual axis and to determine the relationship between the eyes, which in turn is essential for the conjugate movements of the eye and the binocular vision.

The orbital roof is formed by the frontal bone and the lesser wing of the sphenoid.

The optic canal which lies between the roots of the lesser wing is medially bound by the body of the sphenoid. It transmits the optic nerve its meningeal sheath and the ophthalmic artery. Medial wall is formed by lamina papyracea of the ethmoid bone. The orbital floor is mostly made up of the orbital plate of the maxilla, which articulates with the zygomatic bone anterolaterally and the orbital process of the palatine bone posteromedially. The lateral wall is formed by the orbital surface of the greater wing of the sphenoid posteriorly and the frontal process of zygomatic bone anteriorly.

Superior Orbital Fissure (SOF) is the gap between the greater and the lesser wings of the sphenoid bone. The SOF connects the cranial cavity with the orbit and transmits the oculomotor, trochlear and abducens nerves, branches of the ophthalmic nerve and the ophthalmic vein.^[1]

The orbital margin consists of four curved sides. The supraorbital margin is notched or canalised near the medial end for the passage of the supraorbital nerve and artery. The lateral margin is formed by the conjoined processes of the frontal and zygomatic bone. The infraorbital margin is

Financial or Other Competing Interest: None.
Submission 11-05-2018, Peer Review 09-06-2018,
Acceptance 15-06-2018, Published 25-06-2018.

Corresponding Author:

Dr. Geetha S. G,

Assistant Professor,

Department of Anatomy,

Amrita School of Medicine,

Amrita Vishwa Vidyapeetham,

Kochi, Kerala, India.

E-mail: geethajkalister@gmail.com

DOI: 10.14260/jemds/2018/680



formed by the zygomatic bone and the maxilla. The medial margin of the orbit consists of two ridges, which overlap. Inferiorly, the anterior lacrimal crest of the frontal process of maxilla and superiorly the posterior lacrimal crest of the lacrimal bone.

The knowledge of these values is vital in the evaluation, diagnosis, pre-operative and per-operative planning in the management of craniofacial syndromes, post-traumatic facial deformities and orbital abnormalities to produce the best aesthetic and functional result. It is also of relevance to anaesthetists in ocular surgeries, while various nerve blocks are being employed.

Study Design

Descriptive study.

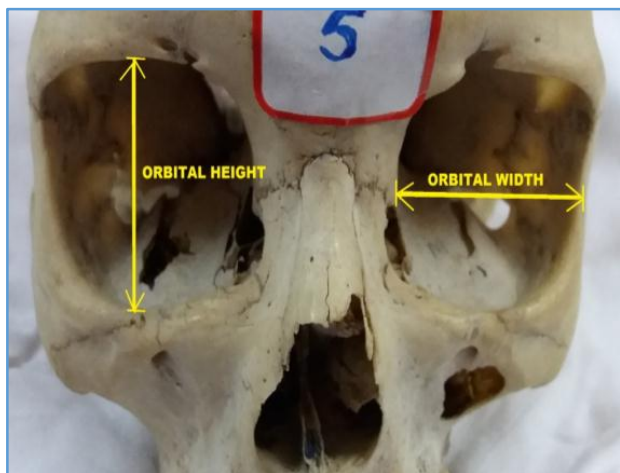
Objective

Aim of the present study was to determine the orbital index and the distance of the optic canal from various landmarks on the orbital margin on both sides of the skull and to correlate the values so obtained with the orbital index. The safe distance to the optic nerve from the orbital margin on both sides of the skull was also measured.

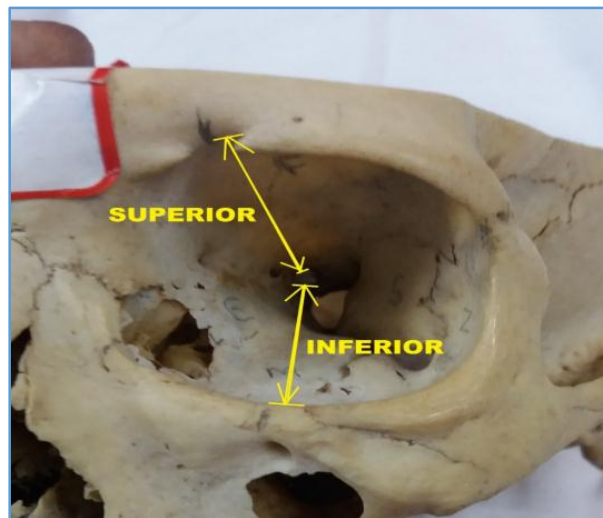
MATERIALS AND METHODS

62 human dry skulls of unknown sex were obtained for the study from the bone bank of Anatomy Department, AIMS, Kochi. The skulls with damaged orbital margins and walls were excluded. Using a digital Vernier calliper, the following measurements were taken-

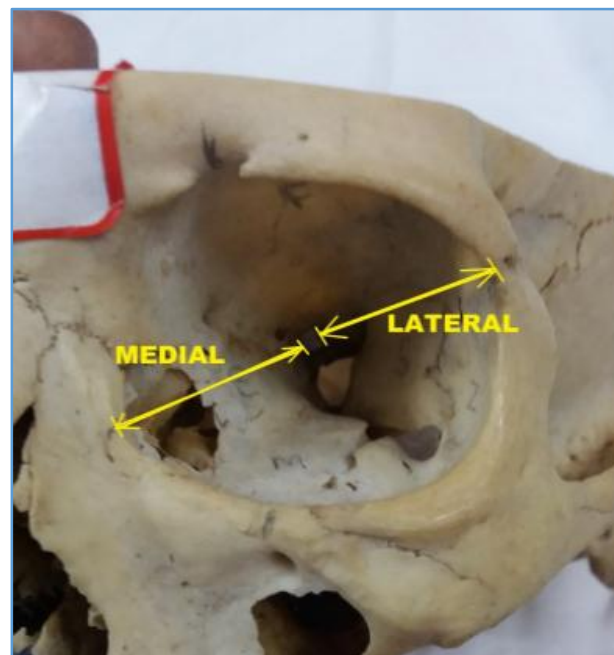
1. Orbital height- the maximum vertical diameter of the orbital margin.
2. Orbital width- the maximum transverse diameter of the orbital margin.



3. Depth of the cavity from all four margins:
 - a. Superior: Distance between superior margin of the optic canal and superior-orbital notch.
 - b. Inferior: Distance between the inferior margin of the optic canal and the inferior orbital margin (just above infraorbital foramen).



- c. Medial: Distance between the medial margin of the optic canal and the anterior lacrimal crest.
- d. Lateral: Distance between the lateral margin of the optic canal and the zygomaticofrontal suture.



4. Orbital index (OI) was calculated as-

$$OI = \left(\frac{\text{Orbital Height}}{\text{Orbital Width}} \right) \times 100$$
5. Safe distance to the optic nerve from each orbital margin was obtained by subtracting 5 mm from the shortest measured distance on both sides of the skull.

The above observations were analysed using paired t-test ($p < 0.05$ was considered to be significant). The statistical software used was IBM SPSS version 20.0

RESULTS

1. Mean orbital height was 33.09 ± 1.89 mm on the right and 33.03 ± 1.94 mm on the left.
2. Mean orbital width was 41.25 ± 2.65 mm on the right and 41.11 ± 2.76 mm on the left.

- Mean orbital index was 80.40 ± 4.97 mm on the right and 79.48 ± 4.97 mm on the left. The difference in the mean orbital index on right and left = 0.9 ± 11.11 mm (Mean \pm SD).
- Mean distances from the optic canal to the superior, inferior, medial and lateral margins were 50.02 ± 4.44 , 51.53 ± 3.13 , 47.70 ± 3.31 and 48.62 ± 3.32 mm respectively on the right side. On the left side were 49.00 ± 4.37 , 50.58 ± 3.18 , 46.68 ± 3.44 and 48.35 ± 3.25 mm respectively. Significant difference (p value 0.01) exists in the mean distances on right and left sides from all the margins except from the lateral margin as shown in Table 1.
- On classifying the skulls according to the Orbital Index (OI), 67.7% were microseme (OI \leq 83), 29% were mesoseme (OI 83 -89), 3.2% were megaseme (OI > 89).
- Safe distance to the optic nerve obtained from superior, inferior, medial and lateral margins on the right side were 26.12, 39.91, 34.96 and 36.98 mm respectively. Whereas on the left side the safe distance from the superior, inferior, medial and lateral orbital margin obtained were 26.13, 38.19, 33.62 and 38.11 mm respectively.

DISCUSSION

A thorough knowledge of the orbit and the important structures in its vicinity such as the optic nerve is vital to surgeons while performing various craniofacial procedures. This study aimed at obtaining a clear understanding of the same.

Although, there are many foreign studies done previously, this is one among the few studies done so far on skulls procured from Southern part of India. Hence, this study has played an important role in opening a new window of knowledge about the orbital morphometry and the associated parameters.

Orbital Margin	Right (mm) (Mean \pm SD)	Left (mm) (Mean \pm SD)	Right-Left P value
Superior margin	50.02 ± 4.44	49.00 ± 4.37	0.01
Inferior margin	51.53 ± 3.13	50.58 ± 3.18	0.01
Medial margin	47.70 ± 3.31	46.68 ± 3.44	0.01
Lateral margin	48.62 ± 3.32	48 ± 3.25	0.34

Table 1

The mean values of the orbital height and width on the right and left sides in the present study were more or less consistent with that of the other Indian studies,^{[2],[3]} but higher than that of a Nigerian study.^[4]

Author	Mean Right Height (mm)	Mean Left Height (mm)	Mean Right Width (mm)	Mean Left Width (mm)	Mean Right Orbital Index	Mean Left Orbital Index
Mekala et al (Indian)	35.5	35.3	41.7	41.8	85.22	84.4
Dr.Gopalakrishnan et al (Indian)	32.75	33.05	40.62	40.75	80.69	81.16
Jaswinder Kaur (Indian)	31.9	32.2	39.7	38.8	80.3	82.98
Ukoha et al (Nigerian)	31.9	31.4	36	34.98	88.61	89.76
Present Study	33.09	33.03	41.25	41.11	80.4	79.48

Table 2

Author	RS	LS	RI	LI	RM	LM	RL	LL
Huanmanop (Thai)	44.5	44.8	46.5	45.9	42.3	42.1	46.6	47.2
Munguti et al (African)	52.9		54.40		-	-	-	-
Karakas et al (Caucasian)	45.3		-		41.7		44.9	
Hwang et al (Korean)	44.9		45.5		40.5		47.4	
Present Study	50.02	49	51.53	50.58	47.7	46.68	48.62	48.35

Table 3. The Mean Values of the distance from the Optic Canal to the Orbital Margin being compared to the other Foreign Studies

The mean values of the distance from the orbital margin to the optic canal obtained in the present study were higher than that obtained in a previous Indian study^[5] by Shilpa et al.

Author	RS	LS	RI	LI	RM	LM	RL	LL
Shilpa et al	45.15	41.07	48.32	48.33	39.69	39.77	41.07	45.61
Present Study	50.02	49	51.53	50.58	47.7	46.68	48.62	48.35

Table 4. The Mean Values of the distance from the Optic Canal to the Orbital Margin being compared to an Indian Study (all values in mm)

Our results were higher than that obtained by studies done on Thai,^[6] Caucasian^[7] and Korean^[8] population, but lesser than that obtained in a study done on African population.^[9]

The skulls were further classified on the basis of the orbital index obtained into megaseme, mesoseme and microseme types. 67.7% of the skulls belonged to the microseme category (orbital index \leq 83). It was seen that two other Indian studies^{[2],[3]} and a Nigerian study^[10] also obtained the same result.

Authors	Population	Mean Orbital Index	Category
Igbigbi et al	Malawian	95.19	Megaseme
Leko Bankole J et al	Nigerian	104.29	Megaseme
Fathy A et al	Egyptian	83.75	Mesoseme
Ebeye OA et al	Nigerian	80.25	Microseme
Jaswinder Kaur	Indian	81.65	Microseme
Mekala et al	Indian	85.8	Mesoseme
Present Study	Indian	79.94	Microseme

Table 5. Comparison of Orbital Index with Previous Studies

The safe distance to the optic nerve from the orbital margins were obtained by reducing 5 mm from the shortest measured distance from the margins to the optic canal on right and left sides.

Orbital Margin	Right Side (mm)	Left Side (mm)
Superior	(31.12 - 5 mm) 26.12	26.13
Inferior	39.91	38.19
Medial	34.96	33.62
Lateral	36.98	38.11

Table 6

The knowledge of these values is vital in the evaluation, diagnosis, pre-operative and per-operative planning of

management for craniofacial syndromes, post-traumatic facial deformities and in the treatment of orbital abnormalities to produce the best aesthetic and functional result.^[2] It is also of relevance to anaesthetists in ocular surgeries, while various nerve blocks are being employed.

Injection at the orbital apex which was advocated in the distant past and is now outmoded, has the potential of frank optic nerve injury.^[11]

As quoted by Kumar et al, risk factors for optic nerve injury include patients with small orbits, placement of a long needle into the apex and the patient looking up and in at the time of the block during the classical retrobulbar block.^[12]

Katsev et al measured the distance from the inferior lateral orbital rim (the traditional insertion point of most sharp needle techniques) to the optic foramen in 120 cadaver orbits and found that in about 20% of the skulls this distance was 45 mm or less. They postulated that a 38 mm needle could injure the optic nerve, while it was encased in the relatively immobile annulus of Zinn in an orbit less than 45 mm. They recommended using shorter needles such as 31 mm or less to eliminate this possibility.^[13]

Pautler et al reported that when the patient is asked to look up and in, this brings the medially positioned optic nerve more lateral and closer to the needle tip.^[14]

CONCLUSION

The knowledge of these values is vital in the evaluation, diagnosis, pre-operative and per-operative planning of management for craniofacial syndromes, post-traumatic facial deformities and in the treatment of orbital abnormalities to produce the best aesthetic and functional result. It is also of relevance to anaesthetists in ocular surgeries, while various nerve blocks are being employed.

REFERENCES

- [1] Standring S. The orbit and the accessory visual apparatus. Gray's anatomy: the anatomical basis of clinical practice. 40th edn. London, UK: Churchill Livingstone 2008: p. 655-66.
- [2] Mekala D, Shubha R, Devi RM. Orbital dimensions and orbital index: a measurement study on south Indian dry skulls. *Int J Anat & Res* 2015;3(3):1387-91.
- [3] Gopalakrishna K, Kashinatha M. The craniometrical study of orbital base of Indian population and its applied importance. *Sch Acad J Biosci* 2015;3(2):618-23.
- [4] Ukoha U, Egwu OA, Okafor IJ, et al. Orbital dimensions of adult male Nigerians: a direct measurement study using dry skulls. *Int J Biol Med Res* 2011;2(3):688-90.
- [5] Gosavi SN, Jadhav SD, Zambare BR. Orbital morphology with reference to bony landmarks. *Rev Arg de Anat Clin* 2014;6(1):20-5.
- [6] Huanmanop T, Agthong S, Chentanez V. Surgical anatomy of fissures and foramina in the orbits of Thai adults. *J Med Asso Thai* 2007;90(11):2383-91.
- [7] Karakas P, Bozkir MG, Oguz O. Morphometric measurements from various reference points in the orbit of male Caucasians. *Surg Radiol Anat* 2003;24(6):358-62.
- [8] Hwang K, Baik SH. Surgical anatomy of the orbit of Korean adults. *J Craniofac Surg* 1999;10(2):129-34.
- [9] Munguti J, Mandela P, Butt F. Referencing orbital measures for surgical and cosmetic procedures. *Ant J of Africa* 2012;1(1):40-5.
- [10] Ebeye OA, Otikpo O. Orbital Index in Urhobos of Nigeria. *IOSR Journal of Dental and Medical Sciences* 2013;8(2):51-3.
- [11] Hamilton RC, Gimbel HV, Strunin L. Regional anaesthesia for 12,000 cataract extraction and intraocular lens implantation procedures. *Can J Anaesth* 1988;35(6):615-23.
- [12] Kumar CM. Orbital regional anesthesia: complications and their prevention. *Indian J Ophthalmol* 2006;54(2):77-84.
- [13] Katsev DA, Drews RC, Rose BT. An anatomical study of retrobulbar needle path length. *Ophthalmology* 1989;96(8):1221-4.
- [14] Pautler SE, Grizzard WS, Thompson LN, et al. Blindness from retrobulbar injection into the optic nerve. *Ophthalmic Surg* 1986;17(6):334-7.