Research Paper

Orbital Fissures in South Indian Skulls: A Cross-Sectional Study Using Morphological and Morphometric Analysis

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ABSTRACT

Background: The middle cerebral fossa is accessible from several foramina in orbit. They are referred to as Warwick's foramen, orbito-meningeal foramen, and metopic canal in addition to superior orbital fissure, inferior orbital fissure, and optic canal. Anatomists, ophthalmologists, and maxillofacial surgeons might benefit from the morphometric assessment of orbital fissures in order to prevent damage to the neurovascular bundles that travel through these fissures. To study the dimensions and variations in shape of superior orbital fissure (SOF) and inferior orbital fissure (IOF).

Methods: The Department of Anatomy at the Akash Institute of Medical Sciences in Bangalore, Karnataka, India, carried out a cross-sectional study between February 2023 and March 2024. Sixty-six dry human skulls were measured for superior and inferior orbital fissure diameters using a needle divider and manual Vernier callipers. The SOF and IOF morphologies were examined and categorized into various kinds for every orbit. The length and width of the SOF and IOF were among the parameters assessed bilaterally. Nine distinct morphological kinds of SOF and six morphological types of IOF were identified. Applications included descriptive statistics and the Pearson correlation coefficient.

Results: The most prevalent SOF shape in the current present study was Type VI. The most common IOF shapes were Type I-right and Type II bilaterally, which appeared in 19 orbits out of 66 skulls (28.8%), with 30 orbits on the left (45.5%) and 27 orbits on the right (40.9%).The mean length of SOF was 13.80 mm on the right side and 13.91 mm on the left side. The mean breadth of SOF was 5.90 mm on the right side and 5.84 mm on the left side. The mean length of IOF was 22.21 mm on the right side and 20.98 mm on the left side. The mean breadth of IOF was 6.31 mm on the right side and 6.18 mm on the left side.

Conclusion: The morphometry of orbital fissures would facilitate a smooth surgical approach and the design of eye protective equipment.

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Introduction

The human orbit is complex anatomically [1]. The orbit is a bony pyramid with four walls: the base, the roof, the medial and lateral walls, and the floor. The orbital base/margin is typically rectangular [2]. It is 4 cm wide and 3.5 cm high, and it is turned. The superior orbital fissure (SOF), a space between the lesser and larger wings of the sphenoid bone, is where branches of the ophthalmic nerve, the oculomotor, trochlear, and abducens nerves, as well as the ophthalmic veins, are transferred and the body of the sphenoid bone encloses the medial margin [3].

The inferior and lateral orbital walls are divided by the inferior orbital fissure (IOF), also known as the spheno-maxillary fissure. It is restricted in the superolateral part by the zygomatic bone and the great wing of the sphenoid, and in the inferior-medial region by the maxillary bone and the orbital process of the palatine bone. This fissure is traversed by the inferior ophthalmic vein, the infraorbital and zygomatic branches of the maxillary nerve (V2), and the orbital postganglionic parasympathetic branches of the pterygopalatine ganglion [4].

Improving the detection of several clinical illnesses and their implications requires an understanding of the microanatomy of SOF and IOF. Variations in the morphology and morphometry of SOF and IOF following a range of surgical procedures can be very helpful to both neurosurgeons and ophthalmologists. These measurements might be very important to the surgeons for both preoperative planning and avoiding problems during surgery. This information may also be useful to manufacturers of orbital wall prosthesis in identifying the exact measurements that correspond to the local orbital morphology [4, 5]. In order to safeguard the neurovascular bundles that go through the fissure, surgeons approaching this anatomical region must be aware of the variations in the morphology and morphometry of SOF and IOF. The results of cadaveric research should be further correlated using studies based on computed tomography images. The objectives of the current study were to classify the variations in shape between inferior orbital fissures (IOF) and superior orbital fissures (SOF) and to examine the diameters of each.

Materials and Methods

From February 2023 to March 2024, this cross-sectional study was conducted in the anatomy department of the Akash Institute of Medical Sciences in Bangalore, Karnataka, India. The Institutional Ethics Committee granted a waiver because the study used adult human dry skulls from the department's osteology collection and did not involve any patients or animals.

Eighty-four dried human skulls were studied. They were divided into 60 male and 24 female skulls based on morphology [6]. Of them, 66 skulls were suitable for analysis.

Inclusion criteria was the dry human skulls with superior and inferior orbital fissures and exclusion criteria was damaged skulls.

Prior to making any observations, the skulls were properly positioned and stabilized. The measurements were taken with Vernier Callipers (precision 0.02 mm). A single observer took the measurements twice, and the average of the two measurements was used to get the final results.

For each orbit, the SOF and IOF morphology was analyzed and divided into several types. The length and width of the SOF and IOF were two of the bilaterally measured characteristics. The superior orbital fissure's length between the superolateral and superomedial ends was measured, and its width was determined at the lower segment (Figure 1).

Figure 1. Closer view of right orbit showing the dimensions of superior orbital fissure and inferior orbital fissure as measured using vernier calipers.
1. SOF length; 2. IOF length; 3. SOF breadth; 4. IOF breadth

The inferior orbital fissure's length was measured between its inferolateral and inferomedial ends, and its width was measured at the lower segment (Figure 1). The Sharma PK et al. SOF type classification was applied in the current investigation [7]. Nine different SOF morphological types were found (Figure 2).

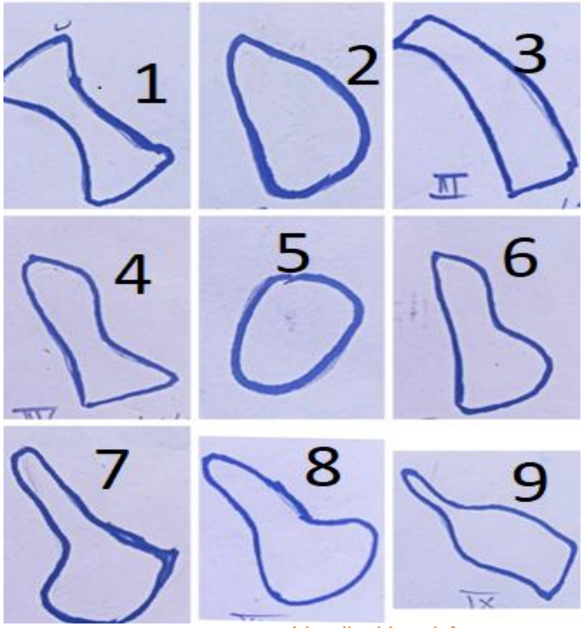

Figure 2. Schematic diagram showing different shapes of SOF (superior orbital fissure).

The IOF form of each orbit was examined and classified using the criteria given by Ozer et al. [8]. There are six distinct IOF morphological categories (Figure 3).

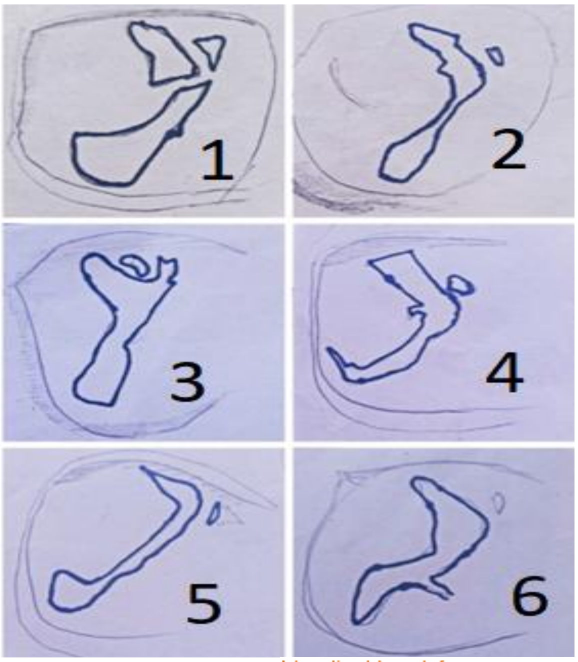

Figure 3. Schematic diagram showing different shapes of IOF (inferior orbital fissure).
IOF classified as types [8]: 1. IOF has a narrow posteromedial part and a wider anterolateral part. 2. IOF is very narrow along its entire length. 3. IOF has a rectangular shape. 4. IOF resembles the letter "V", with a longer posterior segment and shorter anterior segment. 5. IOF has a very narrow posteromedial segment and a wider anterolateral part. 6. IOF presented a wider area at each end of the fissure and a narrower segment in the middle.

Results

Statistical analysis: Version 25 of the Statistical Package for Social Sciences (SPSS) program was used. The average length of SOF was 13.91 mm on the left side and 13.80 mm on the right. The average width of SOF was 5.84 mm on the left and 5.90 mm on the right. (Table 1). The average IOF length was 20.98 mm on the left side and 22.21 mm on the right. The average IOF width was 6.18 mm on the left side and 6.31 mm on the right (Table 2).

Type VI was the most prevalent shape of SOF on both the left and right sides (Table 3). Type I-right and Type II on both the left and right sides were the most prevalent forms of IOF (Table 4).

According to the observed values, SOF length left and right, IOF length left and right, and IOF breadth left and right all have very strong correlations (very strong/excellent correlation = 0.90-1), while SOF breadth left and right have a strong correlation (strong correlation = 0.70-0.89) at 0.842. This correlation coefficient has a two-tailed p-value of 0.000, which means that the correlation is statistically significant at the 0.01 level.

Discussion

The SOF is an important point of entrance from the cranial cavity into the orbit [5]. It is the area between the wings of the lesser and greater sphenoid bones [1]. It is a complex and functionally important region of the middle cranial fossa because it carries the III, IV, and VI cranial nerves and arteries.

We can better identify the underlying cause of clinical problems and advise surgical therapies in variant instances thanks to the variety of SOF kinds. The morphological type of SOF determines the position of soft tissue structures and whether or not there is a noticeable constriction of SOF [9].

Nine morphological forms of the SOF were identified by Reymond J et al. There were two primary types among them: type "a," which had a distinct constriction inside the fissure, and type "b," which did not. The length of the "a" and "b" fissures differed as well, with type "b" cracks being noticeably shorter [10].

In their study, Govsa F et al. discovered that type VI was the most prevalent kind of SOF (35.4%) [11]. The dimensions of SOF and IOF in the current study did not coincide with the findings of Govsa F et al. since the current investigation was done on dry human skulls, whereas the latter was done on cadavers regarding soft tissue tissues around the SOF.

Table 1. Shows the descriptive statistics of the measurements of SOF.

Superior orbital fissure	Mean (in mm)	Maximum (in mm)	Minimum (in mm)	Standard Error
Left-Length	13.91	22.38	8.36	0.38
Left-Breadth	5.84	10.54	2.84	0.18
Right-Length	13.80	22.42	8.78	0.39
Right-Breadth	5.90	12.14	3.12	0.21

Table 2. Shows the descriptive statistics of the measurements of IOF.

Inferior orbital fissure	Mean (in mm)	Maximum (in mm)	Minimum (in mm)	Standard Error
Left-Length	20.98	28.88	16.08	0.36
Left-Breadth	6.18	12.36	1.02	0.32
Right-Length	22.21	30.16	16.92	0.38
Right-Breadth	6.31	13.32	1.84	0.32

Table 3. Shows the descriptive statistics of the measurements of IOF.

Morphological types of SOF	Left	Right
I	1.6 (1.52%)	1.6 (1.52%)
II	1.6 (1.52%)	4.6 (6.06%)
III	6.6 (9.09%)	5.6 (7.57%)
IV	2.6 (3.03%)	2.6 (3.04%)
V	0.6	0.6
VI	30.6 (45.45%)	27.6 (40.90%)
VII	21.6 (31.81%)	19.6 (28.78%)
VII	4.6 (6.06%)	6.6 (9.09%)
IX	1.6 (1.52%)	2.6 (3.04%)

Table 4. Shows the frequency and percentage of incidence of types of IOF.

Morphological types of IOF	Left (%)	Right (%)
I	18.6 (27.27)	19.6 (28.78)
II	19.6 (28.78)	19.6 (28.78)
III	4.6 (6.06)	3.6 (4.54)
IV	5.6 (7.57)	5.6 (7.57)
V	18.6 (27.27)	18.6 (27.27)
VI	2.6 (3.04)	2.6 (3.04)
Pearson correlation		
Between SOF length left and right		0.916
Between SOF breadth left and right		0.842
Between IOF length left and right		0.933
Between IOF breadth left and right		0.917

Desai SD and Sreepadma S noted that the fissure had a typical form and that the SOF measures were 0.9 cm vertically and 0.6 cm transversely on the right side and 0.9 cm vertically and 1.4 cm transversely on the left [12]. The mean length of the right SOF was 1.39±0.21 cm and the left side was 1.4±0.24 cm in the study by Shukla A et al. [13].

According to Rasheed A et al., all skulls had a mean transverse diameter of 2.42+0.45 mm for the right supraorbital foramen and 2.13+0.39 mm for the left. All skulls had a mean vertical diameter of 3.64+0.687 mm for the right-side supraorbital foramen and 3.489+.651 mm for the left side. The mean transverse diameter of the left and right infraorbital foramens was 3.112+.823 mm and 2.858+.633 mm, respectively. IOF's mean vertical diameter was 4.199+.732 mm on the right side and 4.229+.887 mm on the left [14].

According to Parimala Sirikonda et al., Type VI was the most prevalent shape of SOF on both the left and right sides. According to the current study, Type VI was observed in 27 orbits out of 72 skulls (38.5%) on the right side and in 31 orbits on the left. The second most common type was Type VIII in Right SOF and Type III in Left SOF. On the right side of one head, the SOF was narrowed. The average superomedial edge height was 9.72±0.71 mm on the left and 10.07±0.85 mm on the right. The average superolateral edge height was 3.65±0.87 mm on the left and 3.76±0.75 mm on the right. The average separation between the superomedial and superolateral borders was 19.52±0.65 mm on the right and 19.01±0.65 mm on the left [5].

During procedures involving the orbit's lateral wall, which can result in serious consequences such diplopia, anophthalmia, orbital hemorrhage, or ocular dysfunction, the morphology and size of the IOF are crucial [15].

In their study, Coroleucă R et al. found that the morphology of the IOF tended to be right/left symmetrical (in most cases), with type 1 being the most prevalent morphology, followed by type 5. The IOF was 33.5 mm long on average. The IOF's average length was 33.4 mm in the right orbit and 33.6 mm in the left [4].

In their study, De Battista et al. found that the IOF length varied from 25 to 35 mm (mean 29 mm). The anterolateral, middle, and posteromedial segments' respective average lengths and widths were 6.46/5, 4.95/3.2, and 17.6/2.4 mm [16]. Because Coroleucă R et al. and De Bastista et al. [4, 16, 17] used laser on dry skulls and cadaveric transnasal endoscopy, while the current investigation was conducted on dry human skulls, our results did not correlate with their results. Surgeons can avoid damaging the vasculonervous bundles that flow through the fissure by being aware of the variations in the morphology and morphometry of SOF and IOF.

As the study was done on dried human skulls, it differs from investigations that used computerised tomography scans on live patients, laser-treated dry skulls, and cadaveric endoscopy.

Conclusion

Understanding these values is essential for managing craniofacial syndromes, post-traumatic facial deformities, and orbital anomalies in order to get the best possible functional and cosmetic outcome. When different nerve blocks are used during ocular procedures, it is also important for anesthetists. In order to safeguard the vasculonervous bundles that go through the fissure, surgeons must be aware of the variations in the morphology and morphometry of the IOF. By doing this, damage to the arteries and nerves during orbital decompression or during procedures at the base of the skull with access from this region will be avoided.

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Conflicts of Interest

The authors report there are no competing interests to declare.

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