Anthropometric analysis of the infraorbital foramen in a South Indian population

Boopathi S, Chakravarthy Marx S, Dhalapathy S, Anupa S

ABSTRACT

Introduction: The aim of this study was to document the morphological and topographical anatomy of the infraorbital foramen (IOF) in relation to the infraorbital rim (IOR), which is necessary in clinical situations that require regional nerve blocks.

Methods: A total of 80 dry South Indian adult human skulls of unknown age and gender were studied. In each skull, the IOF on both sides was measured using a metal casing digital vernier caliper, with the IOR as the reference point. The IOF's location and its transverse and vertical diameters were measured. The shape, size, orientation and accessory foramens of the IOF were also documented.

Results: The majority of IOF among the skulls were oval-shaped on both the right (55 percent) and left (51.25 percent) sides. The majority were directed inferomedially on both the right (55 percent) and left (52.50 percent) sides. The overall combined distance between the IOR and IOF was 4.1 to 11.5 (6.57 +/− 1.28) mm. The overall combined vertical diameter was 1.2 to 4.7 (2.82 +/− 0.79) mm. The overall combined transverse diameter was 1 to 5.1 (2.87 +/− 0.78) mm. Accessory foramens of IOF were found in 13 (16.25 percent) skulls.

Conclusion: Knowledge of the anatomical characteristics of IOF locations, diameters, shapes, directions and its accessory foramens may have important implications on blocking the infraorbital nerve for surgical and local anaesthetic planning. Information on the shape of the foramens obtained from this study may provide additional guidance to surgeons when introducing needles in anaesthetic procedures.

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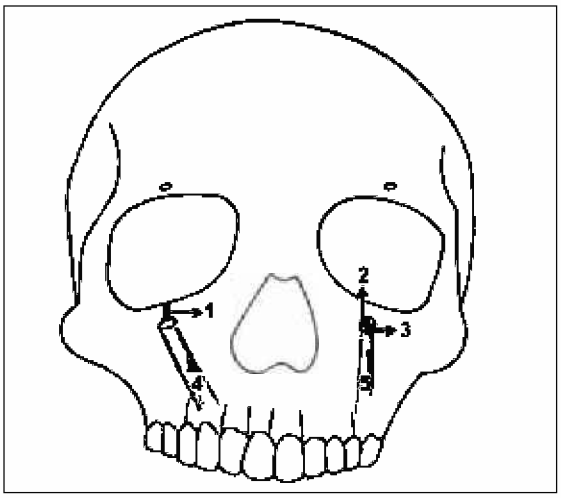

Fig. 1 Line diagram of a human skull (frontal view) shows the various morphometric measurements taken. 1: the measurement of the distance between the superior wall of the infraorbital foramen (IOF) and the infraorbital rim (IOR); 2: the measurement of the transverse distance between the medial and lateral margins of the IOF; 3: the measurement of the vertical distance between the superior and inferior margins of the IOF; 4: the inferomedial direction of the IOF; and 5: the vertical direction of the IOF.

Keywords: accessory foramen, directions, infraorbital foramen, locations, shapes

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INTRODUCTION

The infraorbital nerve continues inferiorly over the anterior wall of the maxilla and appears on the face through the infraorbital foramen (IOF), where it produces the palpebral, nasal and labial branches to supply the skin of the lower eyelid, conjunctiva, the lateral surface of the external nose and the upper lip, including the skin, mucous membrane and gum.[1-3] Several studies have been conducted on the morphometric assessment of the IOF.[4-13] However, there have been large variances in the results, such as reports on the presence of accessory supernumerary foramens.[4,12,14,15]

Large variations in measurements have been reported in the literature with regard to the distance between the IOF and the infraorbital rim (IOR). A

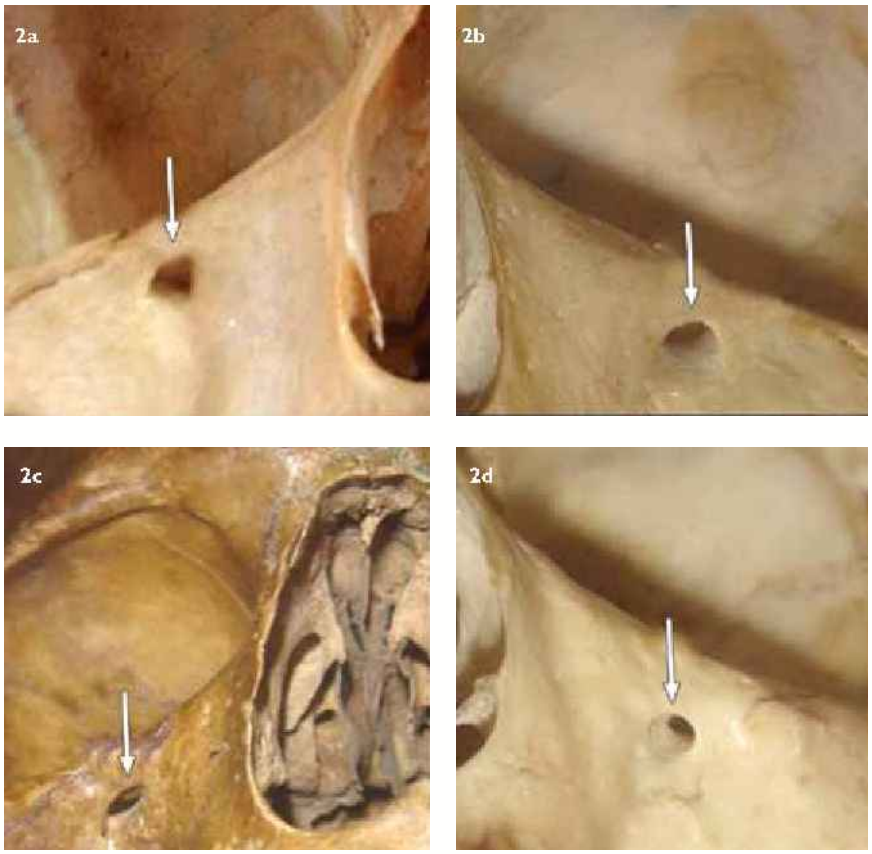

Fig. 2 Photographs (frontal view) of dry adult human skulls of unknown age show (a) a triangle-shaped IOF (arrow); (b) a semilunar-shaped IOF (arrow); (c) an oval-shaped IOF (arrow); and (d) a round-shaped IOF (arrow).

number of review articles on the surgical anatomy of the orbit have described the foramen as lying 1 cm,[16,17] 4–12 mm,[15,18] 4–5 mm,[8,19,20] and more than 10 mm[21] below the inferior margin of the orbit. The IOF is an important anatomical landmark that provides excellent analgesia for the closure of simple lacerations, biopsies, scar revisions, maxillofacial procedures, as well as various endoscopic and cosmetic cutaneous procedures.[16,22] Essential knowledge of regional anatomy is required in order to avoid injuries to the neurovascular bundles that pass through this foramen. The position of the IOF varies among racial groups.[23] For this reason, we investigated the shape, dimension, orientation and location of the IOF with respect to surgically encountered anatomical landmarks in South Indian dry adult skulls. Multiple (accessory) foramina of this foramen were also examined.

METHODS

A total of 80 dry South Indian adult human skulls of unknown age and gender were utilised for this study. These dry skulls were obtained from the Anatomy Department, Kasturba Medical College and Melaka Medical College, Manipal, India.

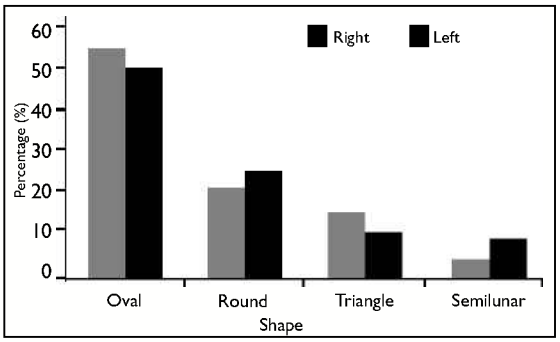

Fig. 3 Bar graph compares the mean percentage of right and left IOF shapes. The most commonly occurring shape of the IOF was oval.

In each skull, both sides of the IOF were measured by a single observer using a metal casing digital vernier caliper (Guilin Guanglu Measuring Instrument, Guilin, China), with an accuracy of up to 0.01 mm (Fig. 1). The transverse and vertical diameters, and the location of the IOF in relation to the IOR, were measured. The shape, size, orientation and accessory foramens were also documented. The shape of the IOF was assessed

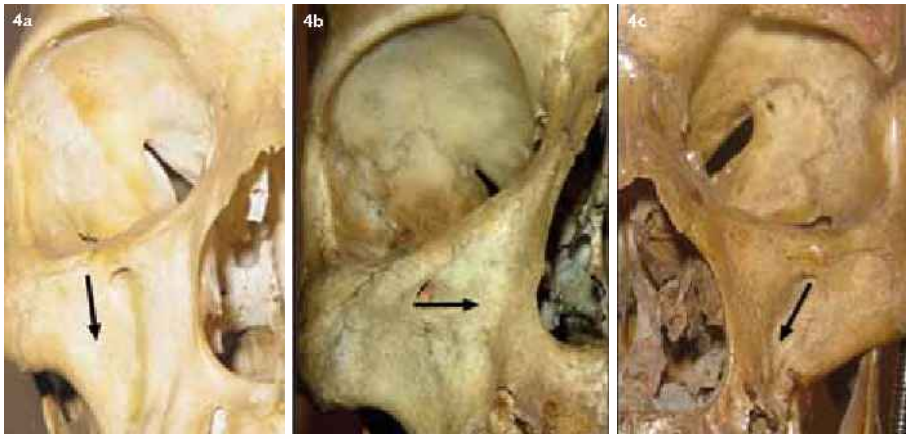

Fig. 4 Photographs (frontal view) of the dry adult human skulls of unknown age show (a) a vertically directed (arrow); (b) a medially directed (arrow); and (c) an inferomedially directed (arrow) intraorbital foramen.

Table I. Morphometric analysis of infraorbital foramen.

	Mean ± SD; range (mm)		
	Right side	Left side	Combined
IOF–IOR	6.49 ± 1.26; 4.1–10.9	6.65 ± 1.30; 4.4–11.5	6.57 ± 1.28; 4.1–11.5
TD	2.73 ± 0.73; 1–5.1	3.00 ± 0.81; 1.4–4.8	2.87 ± 0.78; 1–5.1
VD	2.79 ± 0.79; 1.2–4.7	2.85 ± 0.80; 1.4–4.6	2.82 ± 0.79; 1.2–4.7

SD: standard deviation; IOF–IOR: the distance between the infraorbital foramen (IOF) and the infraorbital rim (IOR); TD: transverse diameter of IOF; VD: vertical diameter of IOF

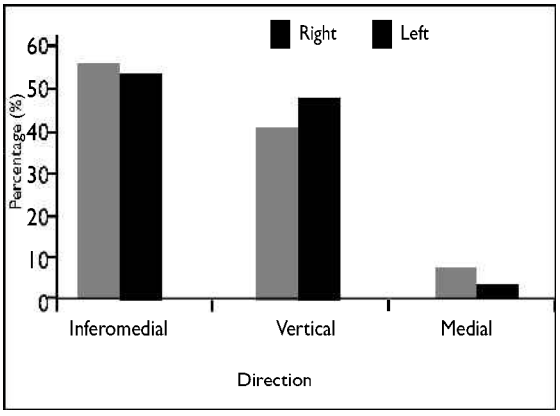

Fig. 5 Bar graph compares the mean percentages of right and left IOF directions. The most common direction of the IOF was inferomedial.

by direct inspection as either oval, semilunar, round or triangular. The direction of IOF was determined as being inferomedial, medial or vertical. All the measurements were taken twice, and the mean of the two values was used.

The following morphometric measurements were recorded: the distance between the superior wall of the IOF and IOR, the transverse distance between the medial and lateral margins of the IOF, and vertical distance between the superior and inferior margins of the IOF (Fig. 1). Child skulls and skulls in which the piriformis opening was damaged, either unilaterally or bilaterally, were excluded. The variables of age and gender were not considered. The samples were from the South Indian population only. The data was analysed using the GraphPad InStat statistical package version 3.06 (GraphPad Software Inc, San Diego, CA, USA). All the data was analysed for the range, mean and standard deviation (SD). The above parameters were statistically analysed using the paired *t*-test to compare the results of the right and left sides.

RESULTS

Among the 80 skulls studied, the IOF was oval-shaped on the right side in 44 (55.00%) skulls and on the left side in 41 (51.25%) skulls It was round-shaped on the right side in 18 (22.5%) skulls and on the left side in 21 (26.25%) skulls; triangle-shaped on the right side in 13 (16.25%) skulls and on the left side in ten (12.50%) skulls; and semilunar-shaped on the right side in five (6.25%) skulls and on the left side in eight (10.00%) skulls (Figs. 2 & 3).

The IOF were directed inferomedially on the right side in 44 (55%) skulls and on the left side in 42 (52.50%) skulls. 31 (38.75%) skulls were vertically directed on the right side and 35 (43.75%) on the left side, while five (6.25%) skulls were medially directed on the right side and three (3.75%) on the left side (Figs. 4 & 5). The results for the distance between the superior wall of the IOF and the IOR on both sides of all the skulls are documented in Table I. The distance was 4.1–10.9 (6.49 ± 1.26) mm on the right side and 4.4–

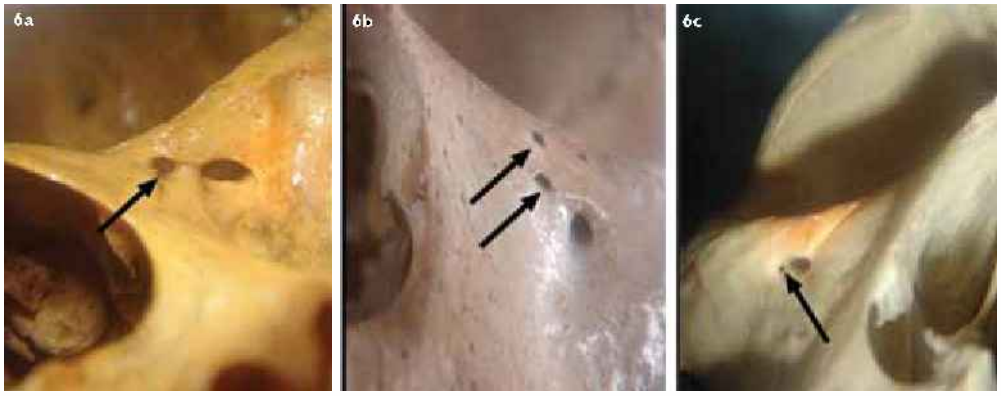

Fig. 6 Photographs (frontal view) of dry adult human skulls of unknown age show the accessory foramens in the IOF (arrows).

Table II. Comparison of the IOF parameters with the findings of previous studies.

Study	No. of samples	Mean ± SD; range of distance between IOF and IOR (mm)	Diameter (mm)		Shape (%)				Accessory foramen
			Vertical	Transverse	Oval	Round	Semilunar	Triangle	
Aziz et al[12]	47	8.3 ± 1.9; 2.5–15	4.5 ± 1.1						15
Cutright et al[23]	80	6.4 ± 0.3							
Kazkayasi et al[24]	35	7.19 ± 1.39			34.3	38	27.1		
Kazkayasi et al[25]	10				30	40	30		5
Elias et al[26]	210	6.71 ± 1.70							15.23
Agthong et al[29]	110	7.9 ± 0.02							4
Apinhasmit et al[28]	106	9.23 ± 2.03		3.35 ± 0.62	50	20.8	29.2		3.8
Gupta[29]	79	7.0 ± 1.6; 3.2–13.2							
Present study	80	6.57 ± 1.7; 4.1–11.5	2.82	2.88	53	24.37	8.13	14.5	16.25

IOF: infraorbital foramen; IOR: infraorbital rim; SD: standard deviation

11.5 (6.65 ± 1.30) mm on the left side. All the above parameters were compared between the right and left sides through the use of the paired *t*-test and were found not to be statistically significant. The overall combined distance between the IOR and IOF was 4.1–11.5 (6.57 ± 1.28) mm, as shown in Table I.

Measurements of the vertical and transverse diameters of the IOF were taken. The paired *t*-test revealed no significant difference between the right and left side IOF parameters, and hence, they were treated as a single group. The transverse distance between the medial and lateral margins of the IOF was 1.0–5.1 (2.73 ± 0.73) mm on the right side, and 1.4–4.8 (3.00 ± 0.81) mm on the left side. The overall combined vertical diameter was 1.2–4.7 (2.82 ± 0.79) mm. The vertical distance was 1.2–4.7 (2.79 ± 0.79) mm on the right side, and 1.4–4.6 (2.85 ± 0.80) mm on the left side. The right and left side measurements of all the above parameters were compared using the paired *t*-test and were found not to be statistically significant. The overall combined vertical diameter was 1.0–5.1 (2.87 ± 0.78) mm, as shown in Table I.

Accessory foramens of IOF were also identified in 13 (16.25%) skulls. They ranged from one to three in number and were located superomedial to the main IOF. Four skulls had accessory foramens on the right side (30.76%), out of which three skulls showed a single foramen (75.00%) and one skull showed triple foramen (25.00%). Nine skulls showed accessory foramens on the left side (69.23%), out of which seven skulls showed a single foramen (77.77%) and two skulls showed double foramen (22.22%) (Fig. 6).

DISCUSSION

The importance of the anatomical characteristics of facial foramens is increased during certain endoscopic procedures of the face. Knowledge of the position of the IOF is very useful to dentists as well as to head and neck surgeons for both diagnostic and clinical procedures.[23] The IOF contains the infraorbital nerve and vessels. The contents of the IOF can be injured during surgical procedures, and this may result in paraesthesia or anaesthesia. The position of the IOF in relation to the inferior orbital margin has been variably reported to lie between 4 mm and 10 mm.[12,20]

Various authors have reported on the morphometry of the IOF, as shown in Table II.[12,23-29]

The mean distance between the IOF and IOR in the present study was comparatively similar to that found in previous studies.[12,27,28] However, the studies by Aziz et al, Agthong et al and Apinhasmit et al have found a greater distance between the IOF and IOR than that in other studies.[12,27,28] A major factor that inhibits dentists from using the infraorbital nerve block is the fear of injury to the patient's eye.[30] Thus, knowledge of the distance between the IOF and IOR may be useful in identifying the location of the danger zone during dissection of the fracture of the anterior maxillary wall or infraorbital wall, as well as during other surgical procedures. The vertical diameter of the IOF was also measured in this study. However, we were unable to trace the data for the same parameter in the available literature for the purpose of comparison. The diameter of the IOF increases with the thickness of the infraorbital nerve and vessels. Since the diameter of the IOF is comparatively small in the present study, it may be difficult to approach the infraorbital nerve for nerve block.

Various authors have reported on the different shapes of the IOF.[24,25,27] The results of the present study are similar to those of Apinhasmit et al,[28] but the presence of semilunar-shaped IOF was found to be less compared to that found in the previous report.[28] We also found triangular-shaped IOF, but could not trace the data for the same parameter in the available literature for comparison. Elias et al and Apinhasmit et al have reported that most of the IOFs they had studied were in the inferomedial rather than the vertical direction.[26,28] This is similar to the results of the present study. However, we identified medially directed IOF in 5% of the skulls, but also could not locate this data in the available literature for comparison. The IOF was directed with a prominent groove in a few skulls in our study. The infraorbital nerve and its vessels run along the direction of the IOF. While passing the needle to block the nerve, the groove may play an important role in succeeding the anaesthesia. In a previous study, an accessory IOF was found in 4.7% of the skulls (5.4% in male and 4.26% in female skulls), with a higher frequency on the left side for both genders.[31] According to Hanihara and Ishida, accessory foramens are more commonly found in Northeast Asian skulls.[32] Our study also documented accessory IOFs in 16.25% of the skulls.

Most of the data in the available literature was based on studies that were carried out in the United States of America and the United Kingdom. Our study, on the other hand, represented the South Indian population, which differs in physical build from Western populations. Knowledge of the anatomical characteristics of the location, diameters, shapes, directions and accessory foramens of the IOF may have important implications for blocking the infraorbital nerve for surgical and local anaesthetic planning. Therefore, the risks associated with facial surgery may be reduced for the South Indian population if the anatomic morphometry is taken into consideration.

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