

Morphometric Study of Accessory Infraorbital Foramen in Northern Indian Human Skull

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ABSTRACT

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

Materials and methods: A total of 72 dry Indian adult human skulls of unknown age and gender were studied. Presence and position were noted. In each skull, the position of AIOF on both sides was measured using a metal casing Vernier caliper, with the IOF as the reference point. The number of accessory foramen was also noted.

Results: Accessory IOFs were seen only in 4.16% in our study and all seen were single in number. Half of those accessory foramen were present on medial and half were present on superomedial position as compared with the main IOF; 50% of present accessory foramens were located at a distance of lesser than 2 mm and 50% were located at a distance of more than 2 mm. The mean location of AIOF was 3.1 mm from main IOF.

Conclusion: Knowledge of the anatomical characteristics of AIOF may have important implications on blocking the infraorbital nerve for surgical and local anesthetic planning. Information on the foramens obtained from this study may provide additional guidance to surgeons when introducing needles in anesthetic procedures. The surgeons must remember this during nerve block since injury to any branch can result in sensory loss and incomplete nerve block.

Keywords: Accessory infraorbital foramen, Indian human skull, Morphometry.

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INTRODUCTION

Essential knowledge of regional anatomy is required in order to avoid injuries to the neurovascular bundles

that pass through this region. The IOF is the exit point of infraorbital nerve and vessels over anterior aspect of face. The infraorbital nerve appears on the face through the IOF, where it gives 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. The IOF is an important anatomical landmark for anesthesia that provides excellent analgesia for the closure of simple lacerations, biopsies, scar revisions, maxillofacial procedures, as well as various endoscopic and cosmetic cutaneous procedures.^{1,2} Presence of accessory foramen may complicate the surgical procedures on face.

Several studies have been conducted on the morphometric assessment of the AIOF. Large variations in measurements have been reported in the literature with regard to the distance between the IOF and the AIOF. A number of review articles on the surgical anatomy of the orbit have described the foramen as lying medial, superomedial, inferomedial to main IOF. It is essential to know the direction of AIOF while passing needle to block the nerve and to direct the probe in radiofrequency neurotomy procedures.

For this reason, the study was conducted to assess the presence, orientation, and location of the AIOF with respect to one of the surgically encountered anatomical landmarks IOF in North Indian dry adult skulls.

OBJECTIVE

The objective of the article is to study the morphological and topographical anatomy of the AIOF in relation to the IOF, which is necessary in clinical situations that require regional nerve blocks.

MATERIALS AND METHODS

Type of study: Museum-based cross-sectional observational study.

Place of study: This study was conducted in the Department of Anatomy, Varun Arjun Medical College and Rohilkhand Hospital, Shahjahanpur, Uttar Pradesh, India. Skulls from the museum of Anatomy Department of Rohilkhand Hospital & Medical College, Bareilly, India, were also included.

Duration of study: It was a horizontal study from November 2016 to June 2017.

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Table 1: Number of accessory infra orbital foramen (AIOFN) on left and right sides

AIOFN (N) number→	Right		Left		Combined	
Parameter↓	Right	%	Left	%	Combined	%
Absent	66	91.67	72	100	138	95.8
One	6	8.33	0	0	6	4.16
Total	72	100%	72	100	144	100

Table 3: Total distance of AIOFD from the main IOF (in mm)

AIOFD Parameter↓	Number of sides	Percent	Total
1.2	3	50	1.2
5	3	50	5
Total	6	100	3.1

Study samples: Seventy-two dry human adult skulls of unknown age and sex.

Inclusion criteria: Human dry skulls complete in all respects.

Study tool: Single observer using a metal casing Vernier caliper with an accuracy of up to 0.01 mm, transparent scale, double tip compass.

Study technique: Single observer method.

Analysis of data: Data obtained were collected and analyzed statistically using Statistical Package for the Social Sciences software and Microsoft Excel 2007.

Methodology

After taking permission from the appropriate authorities, measurements were taken. In each skull, the AIOF on both sides was measured using a metal casing Vernier caliper, with the IOF as the reference point. The IOF's location and orientation of the AIOF were also documented.

RESULTS

Single IOF was seen (i.e., no accessory foramen) in 66 (91.67%) skulls on right side and in 72 (100%) skulls on right side. But single accessory foramen was seen in 6 (8.33%) skulls on right side only (Table 1), thus overall presence of single accessory IOF was in 4.16% sides. Among those present, the location was medial to the main IOF in 3 (4.17%) skulls and superomedial in 3 (4.17%) skulls (Table 2). When present, the accessory foramen was at a mean distance of 1.2mm in 50% cases and in rest of 50% cases it was at a mean distance of 5mm in rest (50%) of the presents, thus overall mean distance was 3.1 mm from main IOF (Table 3).

DISCUSSION

The importance of the anatomical characteristics of facial foramina is increased during certain 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 therapeutic clinical procedures.

Table 2: Position of AIOFLOC

Parameter ↓	AIOFLOC right		AIOFLOC left		Total sides	
	right	%	left	%	sides	%
Absent	66	91.67	72	100	138	95.83
Medial	3	4.17	0	0	3	2.08
Superomedial	3	4.17	0	0	3	2.08
Total	72		72		144	100.00

The IOF contains the infraorbital nerve and vessels. The infraorbital nerve is responsible for sensory innervations to the part of the face between the lower eyelid and the upper lip. The IOF and canal containing the infraorbital nerve are important anatomic structures for surgery and anesthesia of the upper lip, nose, and medial cheek. The knowledge of precise location of IOF and the course of infraorbital nerve is necessary for various clinical procedures, such as administration of regional anesthesia as in case of repair of cleft lip and other maxillofacial surgeries and to determine accurate point in a case of treating trigeminal neuralgia.³ The IOF is also an important reference point in orbital surgeries,⁴ and is an important surgical parameter for external access for maxillary sinus (Caldwell–Luc operation) representing its upper limit.⁵ The knowledge of location of IOF is mandatory to avoid injuries of eye during nerve block because it accounts for less local tissue edema during surgery, thus allowing for good intrasurgical conditions and to identify danger zone of its location during dissection of the comminuted fracture of anterior maxillary wall or inferior orbital wall rhinoplasty and type 1 Le Fort osteotomies. Head and neck dentists and surgeons have to know the exact position of IOF,^{6,7} because the anesthetic drug must be put on the foramen in order that it diffuses by the canal and causes the anterior superior alveolar nerve block (that appears on the infraorbital canal 6.0 to 10.0 mm before the infraorbital nerve emerges on the foramen), and in consequence, the block of the branches (which proceed that nerve) that supply the central superior incisors, lateral incisor and superior canine, ipsilateral to the blocked nerve.⁸ The contents of the IOF can be injured during surgical procedures, and this may result in paresthesia or anesthesia. Obviously, the surgeon must understand the morphology of these structures. Anatomically, the IOF is located on the same sagittal plane as the supraorbital foramen (or notch) and mental foramen. Figún and Garino⁶ pointed out that the topography of IOF presents unquestionable interesting facts on the anesthesia practice of anterior alveolar and superior alveolar nerve and the infraorbital branch because the foramen is an excellent reference point to intraoral functions and extraoral approach. The location is approximately 5 to 7 mm inferior to the infraorbital margin.⁸ In the available literature, variation in position and morphometry of IOF among different populations

has been reported. The present study provided valuable information on the detailed morphometry and position of the IOF in an adult Indian population. Population-specific linear measurements concerning the location of IOF would facilitate precise identification of the IOF in therapeutic, diagnostic, anesthetic, and surgical procedures of the maxillofacial region.⁹

Evidence shows a wide variation in the occurrence of multiple IOF among different populations.¹⁰⁻¹³ Multiple facial foramina have been associated with the branching of nerves during development and may explain cases of failure during infiltrative anesthesia for maxillofacial procedures.¹ Furthermore, the existence of multiple foramina in a minority of patients also has a clinical implication, as injury to any branch of the infraorbital nerve that exits through these foramina; and intraneural local anesthetics or nerve retraction during surgery may result in sensory deficit and partial nerve blockage.¹¹

Gruber² reported first the presence of accessory IOF and described five independent foramina. Kadanaff et al.¹⁴ found it double in 9%, triple in 0.5%, and greater than

3 in 0.3%. Bressan et al.¹⁵ demonstrated AIOF in 5.4% males, 4.26% in females with high frequency on the left side in both males and females. According to Hanihara and Ishida,¹⁶ AIOF were more commonly found in Northeast Asian skulls. Boopathi et al.¹⁷ reported AIOF in 16.25% of skulls in South Indians.

Accessory IOFs were seen only in 4.16% in our study and all seen were single in number. Half of those accessory foramen were present on medial and half were present on superomedial position as compared with the main IOF; 50% of present accessory foramens were located at a distance of lesser than 2 mm and 50% were located at a distance of more than 2 mm. It was nearly the same as 3.7% by Ilayperuma et al.,¹⁸ 4.85% by Ongeti et al.,¹³ 3.8% by Apinhasmit et al.¹⁰ and Elias et al.,¹⁹ 4.7% by Bressan et al.¹⁵ It was much less as compared with 13.3% by Janghu et al.,²⁰ 16.25% by Boopathi et al.,¹⁷ and 15% by Aziz et al.¹¹ A comparative analysis of different studies is given in Tables 4 to 6. The surgeons must remember this during nerve block since injury to any branch can result in sensory loss and incomplete nerve block.

Table 4: Position of AIOFLOC in relation to main IOF

Parameter→ Study↓	AIOFLOC Absent (%)	AIOFLOC Medial (%)	AIOFLOC SUP-MED (%)	INF-MED (%)
Our study	95.83	2.08 (50% of present)	2.08 (50% of present)	
Janghu et al. ²⁰		15.8		
Sarala Devi et al. ²¹			92.3 (of present)	
Tezer et al. ²²			93.3	6.7
Boopathi et al. ¹⁷			Mostly	
Canan et al. ²³			79.6 of present	

INF-MED: Inferomedial; SUP-MED: Superomedial

Table 5: Number of AIOFACN)

Parameter→ Study↓	AIOFN (N) number Absent (%)	Present (%)	AIOFN (N) number-ONE (%)	AIOFN (N) number-> ONE (%)
Our study	95.83	4.16 (8.3-R; 0-L)	4.16 (8.3-R; 0-L)	
Gaur et al. ²⁴			3.03 (M) 2.9 (F)	1.51 (M)
Janghu et al. ²⁰	84.2	13.3	13.3	
Sarala Devi et al. ²¹			5.6 (M), 4.8 (F)	0.8 (M)
Tezer et al. ²²		7 (9L; 4R)	7	
Boopathi et al. ¹⁷		16.25	76 of present	24 of present
Ilayperuma et al. ¹⁸	96.30	3.70		All of present
Lopes et al. ²⁵		9.1		
Ongeti et al. ¹³		4.8	3.9	1.9
Ghaus and Faruqi ²⁶	All			
Apinhasmit et al. ¹⁰		3.8	3.3	0.5
Bressan et al. ¹⁵		4.7		
Elias et al. ¹⁹	85.23 (R) 87.14 (L)	3.8 B/L	10 B/L	2.38 (R) 1.42 (L)
Bressan et al. ¹⁵		4.7		
Kazkayasi et al. ²⁷	90		5	5
Aziz et al. ¹¹		15		
Canan et al. ²³			11.5	1.28
Carolineberry and Berry ²⁸		6.7		

R: Right; L: Left; M: Male; F: Female; B/L: Bilateral

Table 6: Mean distance (in mm) of AIOFD from the main IOF

Study↓ Parameter→	AIOFD (<2 mm)	AIOFD (>2 mm)
Our study	50%–1.2 mm	50%–5 mm
Sarala Devi et al ²¹		7.07 mm

Table 7: Summary of present study

Parameter of AIOF ↓	Our findings ↓
AIOF	Present–4.16% Absent–95.83%
Number of AIOF	One–4.16% >One–0%
Position of AIOF in relation to main IOF	Medial–2.08% Superomedial–2.08%
Mean distance of AIOF from main IOF	<2 mm–2.08% (1.2 mm) >2 mm–2.08% (5 mm)

However, we were unable to trace the data for the same parameter in the available literature for the purpose of comparison, except one²¹ which showed the mean location of AIOF at 7.07 mm from the main IOF.

CONCLUSION

Most of the data in the available literature were based on studies that were carried out in the foreign samples. Our study, on the contrary, represented the Indian population which differs in physical build from Western populations. Comparison of results from previous studies makes the large variation of the anatomical characteristics of the AIOF evident, not only due to the diversity of the used parameters, but also due to the distinct investigated populations. With a possibility of these characteristics being dependent on population groups, this study makes the morphometric study of these foramen in the population of India relevant. The various mean distances along with standard deviation as elaborated in (Table 7) determine the exact position of AIOF in Indian population and may be first-hand vital information to the concerned clinicians to avoid complications during surgical procedures and nerve block. Besides, these results can play a role in the performance of surgical procedures in the periorbital area in order to prevent the involvement of neurovascular structures which cross these foramen.

All these findings are important for performing local nerve block and surgery on the face, especially periorbital regions, in order to avoid the neurovascular structures passing through these foramina.

CLINICAL RELEVANCE

Multiple facial foramina have been associated with the branching of nerves during development and may explain a few cases of failure during infiltrative anesthesia for maxillofacial procedures.

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