Original Article

Topographic evaluation of infraorbital foramen and its reference to facial bony landmarks –A secured aid for infraorbital nerve block

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ABSTRACT

Objective

Detailed knowledge regarding the precise location of infraorbital foramen is necessary to avoid iatrogenic nerve injury during surgery. This study was designed to study the various morphometric measurements of the infraorbital foramen.

Materials and methods

Infraorbital foramina from fifty dry adult skulls were observed for variations in shape, number, and location to facial bony landmarks and maxillary teeth measured.

Results

The most common shape of the IOF on the right side was oval (40%), and on the left side of the skull, it was circular (44%). The horizontal diameters of the IOF were higher on left side (3.04±0.75mm in males, 3.26+0.91mm in females) than that of on right side (2.70+0.94mm in males and 2.70+1.15mm) which confirmed to be statistically significant difference.

Conclusion

There were no significant changes in other dimensions of IOF between male and female skulls and between the right and left sides. However, the distance from IOF to the zygomatico-maxillary suture and to the occlusal plane was noticeably higher in males when compared to females.

Keywords

Infraorbital nerve block, oral maxillofacial surgery, otolaryngology, infraorbital foramen

INTRODUCTION

Foramina are the focus of numerous research and are frequently the subject of morphometric studies. According to the data found in scientific literature, morphometric examination of infraorbital foramen (IOF) is relatively uncommon. Research shows that, even though metric evaluation of the infraorbital foramen is done using the constant parameters, the results obtained are often inconsistent owing to ethnic and sexual differences. Hence, this paper represents one such effort to provide valuable and precise morphometric data on the location of IOF.

Infraorbital foramina are located bilaterally below the bony orbit on the anterior surface of the maxilla bone. They transmit the infraorbital nerve (ION) and infraorbital vessels [1]. ION is the nerve of choice for anesthesia during surgical treatments like neuralgia, manifesting facial pain. This procedure requires prerequisite knowledge regarding the exact location of the IOF and the incidence or presence of any accessory infraorbital foramen. The presence of accessory

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infraorbital foramen is the common cause of anesthesia failure [2] and may result in bleeding with a wide range of sensory disturbances [3]. Anesthetic blockade of the ION in the IOF is an alternate therapy for maxillary division neuralgia, performed commonly during maxillofacial surgeries [4]. Therefore, to warrant secure and effective regional anesthesia and to reduce the risk of harming the neurovascular structures during surgery, thorough knowledge of the exact anatomical position and the variation of the IOF is essential. Hence, the study was designed to evaluate the morphometrics and exact location of IOF and AIOF (accessory infraorbital foramen) using nearby bony landmarks on the skull.

MATERIALS & METHOD

One hundred IOF were assessed morphometrically from 50 dried human skulls (31 males and 19 female skulls). The presence of Infraorbital foramina was ascertained bilaterally before further evaluation. Broken or malformed skulls affecting the area of IOF were excluded from the evaluation. The topographic location of the IOF was noted with respect to its presence in line with upper premolar and or molar teeth. The relevant morphometric measurements of the foramen were performed using Vernier caliper (Figure-1) as per the following parameters:

a. The vertical and horizontal diameter of the foramen.
b. Distance from the location of the IOF to the following adjacent bony landmarks were measured:
    a. Vertical distance to maxillary midline
    b. Vertical distance to infraorbital rim
    c. Horizontal distance to zygomatico-maxillary suture
    d. The distance from IOF to supraorbital notch / foramen
    e. Vertical distance to occlusal plane of upper teeth

Mean and standard deviations (mean ± SD) were calculated from these measurements. Statistics and t-test values were tabulated using SPSS v 16.0 software. A p-value of less than 0.05 was considered a statistically significant difference. The measurements were then evaluated based on gender and side.

RESULTS

The descriptive statistical analysis of various morphometric analysis are tabulated in tables 1 to 4. All measurements were depicted in mm. The most common location of IOF on the left side was found to be between first and second maxillary molar teeth whereas on right side it is in line with second premolar of maxilla.

Most common shape of the IOF on right side was noted to be oval (40%) and next higher frequency was circular shaped (32%). This is reversal on left side where the most common shape was circular (44%), followed by the prevalence of oval shape (38%). The detailed frequencies on other shapes on both sides are represented in Table -1

The horizontal diameters of the IOF were higher on the left side (3.04±0.75mm in males, 3.26+0.91mm in females) than that on the right side (2.70+0.94mm in males and 2.70+1.15mm) which confirmed to be a statistically significant difference ($p<0.05$) (Table 2).

The descriptive data of morphometric measurements taken from the IOF to the neighboring bony landmarks of the face are summarized in Table -3 (side and gender-wise). According to the analysis, there were no significant changes in the values between males and females and between the right and left sides. However, the distance from IOF to the zygomaticomaxillary suture and to the occlusal plane is noticeably higher in males when compared to females.

A morphometric comparison of IOF with respect to the right and left sides is shown in Table 4. According to the data, a statistically significant difference ($*p<0.05$) was observed in the distance between IOF to zygomatico-maxillary suture concerning gender only on the right side.

DISCUSSION

The orbital and oculoplastic surgical procedures require a precise understanding of the location of the infraorbital foramen to avoid accidental injury to the nerves passing through the foramen. The study aimed to provide an inclusive morphometric evaluation of IOF and its relationship to accessible peripheral bony landmarks to establish the exact location of the foramen. Many studies done earlier have studied the morphometrics of the infraorbital foramen in different ways. Still, the authors have emphasized several discordances, such as the methodology used for the measurement and analysis. Even though studies on CT scans are more accurate,

studies dealing with dry bones are still acceptable and prevalent [5]. The advantage of dry skulls is that they can be replicated in diverse geographical settings, including developing countries where radiological analyses are not possible [6].

The IOF's different shapes and horizontal and vertical measurements were studied to explore its favorability for needle insertion. The IOF is oval, semilunar, or round [7]. The present study noted the variability in the shape of IOF. While the predominant oval shape was found on the right side, circular IOF was more frequently present on the left side. It was also observed that if a skull had a round IOF on the left side, there was also a round IOF on the right side. This result is similar to previous studies, which generally indicate that the shape is symmetrical within individuals [8,9].

Apart from the varied morphometric diversity among the genders and different populations of individuals, the site of IOF in relation to the maxillary teeth is also variable [10, 7]. Deepthi et al. reported that the most common position of the IOF with maxillary teeth is about 37.5% and 55.9% on the right and left sides, respectively, and is represented by a plane that passes vertically through the buccal cusp of second premolar [11]. In our study, we observed a higher incidence of the relative position of the IOF in the line corresponding between the second and first upper molar on the left side and in the line with the second upper premolar on the right side. These findings are almost similar to those reported by previous studies [12,13]. Studies have stated that considerable anatomical variations do exist in the current surgical guideline, which states that the supraorbital foramen, infraorbital foramen, and mental foramen are equidistant from the midline. Hence, surgeons performing surgical procedures on the face may need to adjust their methodology to enhance patient care [14].

A unique gender-based observation from our data is the distance between IOF and the zygomaticomaxillary suture on the right side. Here, the difference between the males and females is statistically significant, which was not observed on the left side. Although our literature search agrees that sexual dimorphic parameters and ethnic variability exist, less information is available on the origin of these differences, especially concerning the possible relation with the general size of the cranium, which the previous studies have not considered. To understand the exact patterns in adults, ontogenetic patterns need to be considered [15,16]. Several researchers indicate that the growth of the cranium may influence the morphology and course of the ION during growth and development [17,18]. The IOF appears early in ontogeny and remains relatively stable, retaining its position relative to the cranial base, while the surrounding structures may grow and reposition around it [19,20]. We hypothesize that this might be the reason for the observed variations in the morphometry of IOF. The variation in the occurrence of the neurovascular bundle has clinical implications regarding the failure of local and regional anesthesia and the risk of nerve damage during surgical interventions involving the maxillary region [21, 22, 23].

CONCLUSION

The present results indicate that the IOF's location and morphology are asymmetrical between the right and left sides. However, the morphometric variations are found only in the distance between IOF and zygomatico-maxillary sutures when compared between male and female skulls. This could be attributed to the topographic variability. Nevertheless, the accurate location of IOF regarding morphometry using the facial landmarks as reported here is easy and reliable, which is essential in dentistry, otolaryngology, and specific maxillofacial surgical approaches.

DECLARATION

Conflict of interest: NONE

Ethical clearance: Not applicable

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Author Contributions

Conceptualization and methodology: RB, NK; Investigation: RB, AS; Formal analysis: NK, AAP; Visualization and writing – original draft: AAP; Writing – review and editing: NK, AAEE, VPS; Supervision: RB, NK. All authors have read and agreed to the final version of the manuscript

Figure-1: Morphometric measurement of infraorbital foramen of dried skull using Vernier caliper

Table-1: Shape of IOF on right and left side

Shape	Right side (n=50)	Left side (n=50)
Oval	40%	38%
Semilunar	24%	16%
Circular	32%	44%
Absent	4%	2%

Table-2: Gender and side wise descriptive analysis of Horizontal and vertical diameter of IOF

	Male (n=31) (Measurements in mm)		Female (n=19) (Measurements in mm)	
Parameters	Mean ±SD (Right side)	Mean ±SD (Left side)	Mean ±SD (Right side)	Mean ±SD (Left side)
Horizontal diameter	2.70±0.94	3.04±0.75 *	2.70±1.15	3.26±0.91*
Vertical diameter	2.67±1.02	2.43±0.64	2.54±0.57	2.40±0.57

*p<0.05

Table 3: Descriptive analysis of morphometry of IOF with the facial bony landmarks in males and females.

	Male (n=31) (Measurements in mm)		Female (n=19) (Measurements in mm)	
Parameters	Mean ±SD (Right side)	Mean ±SD (Left side)	Mean ±SD (Right side)	Mean ±SD (Left side)
Distance from IOF to MM	37.40±3.36	36.98±3.35	37.26±3.59	36.74±2.99
Distance from IOF to IOR	6.26±1.45	6.61±1.55	6.02±1.88	6.47±1.49
Distance from IOF to ZM	17.69±2.73	17.58±2.54	15.87±2.27	16.10±2.73
Distance from IOF to SOF	40.94±3.84	39.91±2.36	39.93±2.65	40.03±2.91
Distance from IOF to Occlusal plane	28.15±4.22	27.92±4.21	26.12±3.57	26.98±4.46

IOF- Infraorbital foramen, MM- maxillary midline, IOR- Infraorbital margin, ZM- Zygomatico-maxillary suture, SOF- Supraorbital foramen

Table-4: Descriptive analysis of morphometry with comparison of gender and sides. *IOF- Infraorbital foramen,*

Parameters	Gender	N	Right side (in mm)	Left side (in mm)
			Mean ±SD	Mean ±SD
Distance from IOF to MM	Males	31	37.40±3.36	36.98±3.35
	Females	19	37.26±3.59	36.74±2.99
Distance from IOF to IOR	Males	31	6.26±1.45	6.61±1.55
	Females	19	6.02±1.88	6.47±1.49
Distance from IOF to ZM	Males	31	17.69±2.73*	17.58±2.54
	Females	19	15.87±2.27	16.10±2.73
Distance from IOF to SOF	Males	31	40.94±3.84	39.91±2.36
	Females	19	39.93±2.65	40.03±2.91
Distance from IOF to Occlusal plane	Males	31	28.15±4.22	27.92±4.21
	Females	19	26.12±3.57	26.98±4.46

*p<0.05

MM- maxillary midline, IOR- Infraorbital margin, ZM- Zygomatico-maxillary suture, SOF- Supraorbital foramen

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