Original article:

Morphometric analysis of infraorbital foramen in South Indian dry skulls

Tewari S[1], Gupta C[2], Palimar V[3], Kathur SG[4]

Abstract

Objective- The infraorbital foramen is located on the maxillary bone 1 cm under the infraorbital margin. Infra orbital nerve blocks are done in children for managing the postoperative pain which can occur after cleft lip operation and endoscopic sinus operation. Infraorbital nerve can also be damaged in cases of zygomatic complex fractures which are one of the most common facial injuries. So, this study was undertaken to analyze the anatomical variations by comparing various morphometric measurements of infraorbital foramen in dry skulls of adult South Indian population. Materials and methods- 60 dry skulls of unknown sex were used for the study. Various measurements and distance from various surgical landmarks were measured to evaluate the location of infraorbital foramen on both sides. Statistical Analysis was done for the above measurements mean and standard deviation, median, range, and mode were calculated. ***Results***: The mean distance of infraorbital foramen from piriform aperture, lower end of alveolus of maxilla and infraorbital margin was 18.39, 27.88 and 7.09mm on the right and 17.89, 27.31 and 6.95mm on the left side. The mean vertical and horizontal diameter was 3.78 and 3.50mm on the right side and 3.48 and 3.35mm on the left side. In our study, the most common site of IOF in Indian skulls was found to be in line with the second premolar tooth (59.01%), followed by its position between the first and second premolar tooth (27.87%). ***Conclusion-*** These results will be helpful for surgeons while doing maxillofacial surgery and regional block anesthesia.

Keywords: Infraorbital foramen; Infraorbital margin; Piriform aperture; Alveolus of maxilla; Maxillofacial surgeries.

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Introduction

Infraorbital foramen (IOF) is an important anatomical landmark situated bilaterally on the anterior surface of the maxilla below the infrorbital margin and it allows the passage of infraorbital nerve and vessels.[1] The Infra orbital nerve is a continuation of maxillary nerve. It is purely sensory in function. It comes out from IOF after traversing the infra orbital canal and emerges on the face.It ends by dividing into palpebral, nasal and labial branches which supply the skin over the lower eyelid, conjunctiva,lateral aspect of external surface of nose, upper lip, ala ofthe nose and the premolar teeth. Infra orbital vessels are branches of maxillary artery which supplies the areaadjoining IOF.[2]

Infraorbital nerve block through IOF and canal is used to anesthetize the lower eyelid, upper lip, lateral nose, upper teeth and related gingivae. The infraorbital nerve block is used to accomplish regional anesthesia in the maxillo-facial region for diagnostic, surgical and other invasive procedures.[3] Therapeutic infraorbital nerve blocks are used in intractable

1. Siddharth Tewari, Undergraduate Student(2nd MBBS), Kasturba Medical College, Manipal University, Manipal India, 576104
2. Chandni Gupta, Associate Professor, Department of Anatomy, Kasturba Medical College, Manipal University, Manipal India, 576104.
3. Vikram Palimar, Professor, Department of Forensic Medicine, Kasturba Medical College, Manipal University, Manipal India, 576104.
4. Sneha Guruprasad Kathur, Professor and Head, Department of Anatomy, Kasturba Medical College, Manipal University, Manipal India, 576104

Correspondence to: Dr. Chandni Gupta, Associate Professor, Department of Anatomy, KMC Manipal,India 576104, E-mail:chandnipalimar@gmail.com

and pharmacologically unresponsive trigeminal neuralgia.[4] Knowledge of exact location, shape, and direction of IOF is of paramount importance to decrease anesthetic complication. Despite its surgical importance hardly any information is available regarding it precise location and morphology in South Indian population. Infraorbital nerve can also be damaged during zygomatic complex fractures which are one of the most common facial injuries.[5] The key factor which prevents the dentists from using the infraorbital nerve block is the damage to the patient's eye.[6]

Presence of accessory IOF foramina can be troublesome during anesthetization of the region innervated by infraorbital nerve. Therefore, the present study was conducted on dry adult skulls of South Indian population to determine the accurate position, shape and direction of IOF as well as to record the frequency of occurrence of accessory IOFs and their relation to the main IOF.

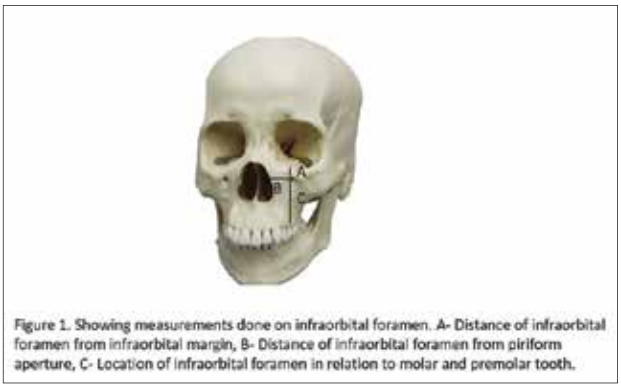

Figure 1. Showing measurements done on infraorbital foramen. A- Distance of infraorbital foramen from infraorbital margin, B- Distance of infraorbital foramen from piriform aperture, C- Location of infraorbital foramen in relation to molar and premolar tooth.

Materials and methods

A total of 60 dry skulls were used for the study. Exclusion criteria were 1) Skulls of children and2) Skulls with damaged piriformis opening/lower end of alveolus of maxilla.

All parameters were measured in the following planes:

Sagittal plane: A plane parallel to the mid-sagittal plane and passing through the center of infraorbital foramen was adopted for taking various vertical dimensions

Transverse plane: A plane passing through the center of infraorbital foramen and perpendicular to the above-mentioned sagittal plane was used for measuring transverse dimensions

After aligning the skull in Frankfurt horizontal plane, following parameters were measured to evaluate the location of infraorbital foramen on both sides of skull. First, vertical(VD) and horizontal diameters(HD) of the infraorbital foramen were measured and presence of accessory foramina was also noted. Distance from center of infraorbital foramen to infraorbital margin(IOF-IOM) and lower end of alveolus of maxilla (IOF-LAM) along the sagittal plane was measured. Along the transverse plane, distance between piriform aperture and center of infraorbital foramen(IOF-PA)was measured. The locational relationship of the infraorbital foramen in relation to the upper teeth was also recorded as either in line with the longitudinal axis of the upper second premolar or first molar tooth or as lying between the adjacent upper first and second premolars or between second premolar and first molar tooth.

Table 1:Statistical analysis of IOF regarding its location

DIMENSIONS	Mean ±SD			Median		Mode		Range	
	Right	Left	P value	Right	Left	Right	Left	Right	Left
IOF-IOM	7.09 ± 1.83	6.95± 1.76	0.017	7.09	7.0	6.0	7.0	3.5-14	4-12.5
IOF-PA	18.39± 2.23	17.89±2.52	0.024	18.0	18.0	18.0	18.0	13 -23	12-24
IOF-LAM	27.88± 4.25	27.31±4.45	0.037	28.0	27.0	30.0	25.0	20-36	17-38
VD	3.78± 0.35	3.48 ± 1.12	0.048	3.5	3.0	4.0	03.0	1-5	1-6.5
HD	3.50± 0.91	3.35± 0.85	0.013	3.5	3.0	4.0	03.0	1.5 -6	1-5.5

The measurements was taken with double-tipped compass and then transferred to calipers (least count 0.01 mm) to measure the distances.

Statistical Analysis: From the above measurements, mean and standard deviation (mean ± SD), median (range), and mode was calculated. Data analysis was done by using Statistical Package for Social Sciences (SPSS) 19 version, and $P < 0.05$ was considered statistically significant.

Results

The mean, standard deviation, median, mode, range and p value of all the measured parameter for infraorbital foramen on both right and left side is shown in table 1.

TThe range provides an indication of the location of the infraorbital foramen depending upon sample space and the dispersion of values. The mean distance is indicative of the infraorbital foramen location. The standard deviation provides variability in the position of the foramen around mean position. This is very vital information for rapidly locating this foramen during surgical procedures. The mode is the dimension which helps us to know the value which is found in most of the subjects of same racial group. Therefore, this distance should be considered when locating the infraorbital foramen during maxillofacial surgery in South Indian Population.

All parameters measured of the IOF displayed significant results while comparing both sides as the p value was <0.05.

The locational relationship of the infraorbital foramen in relation to the upper teeth either in line with the longitudinal axis of the upper second premolar or first molar tooth or as lying between the adjacent upper first and second premolars or between second premolar and first molar tooth is shown in table 2.

Table 2: Location of infraorbital foramen along upper teeth

Location of infraorbital foramen	Frequency n (%)
Between first and second premolar	17 (27.868)
In line with second premolar	36 (59.01)
Between second premolar and first molar	4 (6.55)
In line with first molar	4 (6.55)

Discussion

The infraorbital nerve and vessels pass through the infraorbital foramen therefore, knowledge of its location is very essential to surgeons and anesthetists for various surgical procedures in the Indian population.

Varshney R**,** Sharma N found that the mean vertical and horizontal diameters of IOF on the right side are 3.94 and 3.31 mm, while those on the left side are 3.89 and 3.25 mm, while singh R found it as 3.39, 3.19mm and 3.75, 3.52mm. the values in the present study the values are 3.78, 3.50 and 3.48, 3.45mm which were almost similar to the results found by varshney R, Sharma N and singh R.[7-9]

In the present studymean distance between the infraorbital foramen and the midpoint of the infraorbital margin on left side was 6.95mm and 7.09mm on the right side,which is close to the results got by Shaik et al.[5] Comparision of our results with other authors is shown in Table 3.

Table 3:Comparative mean distances between IOF and IOM

Study	No. of skulls	Mean ± SD(mm)	
		Right	Left
Panniker JI et al [10]	60	5.96 ± 1.59	6.07 ±1.83
Aziz et al. [1]	47	8.3 ± 1.9	8.1 ±1.9
Elias et al. [11]	210	6.71± 1.7	6.83 ± 1.83
Agthong et al. [12]	110	7.8 ±0.2	8.0 ±0.2
Boopathi et al. [6]	80	6.49 ±1.26	6.65 ±1.30
Macedo et al.[13]	295	6.28 ± 1.79	6.45 ± 1.76
Singh R, [9]	55	6.12 ± 1.79	6.19 ± 1.81
Shaik et al. [5]	125	7.06±1.81	7.20 ± 1.71
Lokanayaki,[14]	100	6.12 ± 1.43	6.53± 1.53
Varshney et al [7]	100	7.65±1.35	7.11±1.73
Present study	61	7.09±.1.83	6.95± 1.76

Comparision of the result of mean distance of the infraorbital foramen from the piriform aperture with our authors is described in Table 4.

Table 4: Comparative mean distance between IOF and PA

Study	No. of skulls	Mean distance(mm)	
		Right	Left
Pannicker JI et al [10]	60	16.7	16.63
Macedo et al.[13]	295	17.75	17.60
Singh R. [9]	55	15.31	15.80
Bruno et al. [15]	80	14.65	14.79
Lokanayaki V [14]	100	16.58	16.38
Varshney et al [7]	100	17.34	17.58
Present study	61	18.39	17.89

In our study, the most common site of IOF in Indian skulls was found to be in line with the second premolar tooth (59.01%), followed by its position between the first and second premolar tooth (27.87%). Sharma et al found that the majority of IOF were oriented to second premolar teeth on the right side and between second premolar and first molar on the left side.[8] Aziz et unobserved the location of IOF in line with the first premolar tooth in White, Black, and Hispanics skulls, verifying the racial differences among these.[1] In the present study IOF was observed at the first molar tooth (6.55% of Indian skulls) this advocates a possibility of either a complicating or failed infraorbital nerve block during regional anesthesia.

The mode of the distances of the infraorbital foramen and the infraorbital margin on both sides of the skull was 6mm on right side and 7 mm on left side. The mode of infraorbital foramen and piriform aperture distances on both sides was 18mm. Mode is the value which provides the most frequent distances to be used when locating the infraorbital foramen precisely in relation to piriform aperture or the infraorbital margin.

However surgeons should consider the skew values to prevent surgical complications in the head and neck region and the anesthetist should consider these values for anesthetic failures of nerve block. Skew values are very rare values but their incidences cannot be ruled out. Although the skew values of these distances in data set influence the mean making the analysis more subjective, the results of this analysis will be very useful to surgeons and anesthetist.

Information regarding the size and symmetry of the skull foramina is helpful for radiologists when diagnosing difficult pathologies of the skull foramina by using computed tomography/magnetic resonance imaging.[7]

The various mean distances constrained by standard deviation as elaborated in table/s determine the exact position of infraorbital foramen in Indian population and may be vital information to concerned clinicians to avoid complications during surgical procedures and nerve block. The skew values found in present study alert the surgeons to avoid anesthetic failures and other procedures involving infraorbital foramen.

Conclusion

Thus, the data obtained in this study is at par with studies conducted by different authors of various geographical areas. So the information derived here in identifying the precise location IOF will help surgeons to reduce the adverse outcome of the surgeries centered on IOF in patients of South Indian origin. This information is also useful for morphologists who conduct their research on people of different populations and geographical regions.

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