Original article:

Morphometric analysis of infraorbital foramen in South Indian dry skulls
Tewari S¹, Gupta C², Palimar V³, Kathur SG⁴

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.

Introduction

Infraorbital foramen (IOF) is an important anatomical landmark situated bilaterally on the anterior surface of the maxilla below the infraorbital 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 of the nose and the premolar teeth. Infra orbital vessels are branches of maxillary artery which supplies the area adjoining 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

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A total of 60 dry skulls were used for the study. Exclusion criteria were 1) Skulls of children and 2) 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.

The 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.

**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 3.45mm which were almost similar to the results found by varshney R, Sharma N and singh R.7-9

In the present study mean 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 Comparison 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. Aziz et al observed the location of IOF in line with the first premolar tooth in White, Black, and Hispanics skulls, verifying the racial differences among these. 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. 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.
References

1. Aziz SR, Marchena JM, Puran A. Anatomic characteristics of the infraorbital foramen: A cadaver study. J Oral Maxillofac Surg 2000; 58:992-6.

2. Gaur KK, Nair S, Trivedi GN, Guptha SD. Anthropometric measurements of infraorbital foramen in dried human skulls. Int J Biol Med Res 2012; 3(3): 2003-2006.

3. Gruber W. A hook shaped canal over and above the infraorbital foramen. Arch Pathol Anat Physiol Klin Med 1878; 72:494-6.

4. Kazkayasi M, Ergin A, Ersoy M, Bengi O, Tekdemir I, Elhan A. Certain anatomic relations and the precise morphometry of the infraorbital foramen--canal and groove: An anatomical and cephalometric study. Laryngoscope 2001; 111:609-14.

5. Shaik HS, Shepur MP, Desai SD, Thomas ST, Maavishettar GF, Haseena S. Morphometric analysis of infraorbital foramen position in South Indian skulls. Indian J Innovations Dev 2012; http://iseeadyar.org/ijid.html.

6. Boopathi S, Chakravarty MS, Dhalapathy S, Anupa S. Anthropometric analysis of the infraorbital foramen in a South Indian population. Singapore Med J, 2010; 51(9): 730-735.

7. Varshney R, Sharma N. Infraorbital foramen - Morphometric study and clinical application in adult Indian skulls. Saudi J Health Sci, 2013; 2:151-5.

8. Sharma S, Sharma A, Thakur C, Modi BS. Anthropometric measurements of infraorbital foramen and its anatomic variations in dried human skulls. Int J Anat Res, 2015; 3(4):1487-1490. DOI: 10.16965/ijar.2015.272.

9. Singh R. Morphometric analysis of infraorbital foramen in Indian dry skulls. Anat Cell Biol, 2011; 44:79-83.

10. Panniker JI, Kumar V, Veerannasetty VK. Anthropometric analysis of infraorbital foramen in human dry skulls. NUIHS, 2016; 6 (2): 27-30.

11. Elias MG, Silva RB, Pimentel ML, Cardoso VTS, Rivello T, Babinski MA. Morphometric analysis of the infraorbital foramen and accessories foramina in Brazilian skulls. Int J Morphol, 2004; 22(4):273-278.

12. Agthong S, Huanmanop T, Chentanez V. Anatomical Variations of the Supraorbital, Infraorbital, and Mental Foramina Related to Gender and Side. J Oral Maxillofac Surg, 2005; 63:800-804.

13. Macedo VC, Cabrini RR, Faig-Leite H. Infraorbital foramen location in dry human skulls. Braz J Morphol Sci, 2009; 26(1):35-38.

14. Lokanayaki V. Anatomic variations of infraorbital foramen. CIB Tech Journal of Surgery 2013; 2(2):30-36.

15. Chrcanovic BR, Abreu MHNG and Custódio ALN. Surg Radiol Anat, 2011; 33: 329. doi:10.1007/s00276-010-0698-1.