e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2025; 17(12); 100-103

Original Research Article

Analysis of Infraorbital Foramen Morphometrics and Laterality in Adult Skull Specimens

Aaditi Abhijit Shah[1], Nishat Parveen[2], Laishram Sophia[3]

[1]**Associate Professor, Department of Anatomy, Pacific Institute of Medical Sciences, Udaipur, Rajasthan, India**

[2,3]**Assistant Professor, Department of Anatomy, ESIC Medical College and Hospital, NIT-3, Faridabad, Haryana, India**

Received: 08-07-2025 / Revised: 17-09-2025 / Accepted: 29-11-2025

Corresponding author: Dr. Nishat Parveen

Conflict of interest: Nil

Abstract

Background: The infraorbital foramen is a key anatomical landmark with significant clinical implications for anesthesia, surgery, and forensic identification. Population-specific morphometric data are essential due to variability in IOF dimensions and laterality.

Material and Methods: A cross-sectional analysis of 120 adult dry skulls (60 male, 60 female) was performed. Measurements of the infraorbital foramen and its distances from key craniofacial landmarks were taken bilaterally using digital calipers. Sexual dimorphism and laterality were assessed statistically.

Results: Male skulls demonstrated consistently higher morphometric values compared to female skulls. Laterality differences were present but mostly subtle. Significant variation was noted in IOF–Nasion, IOF–ZMS, and IOR–OC distances.

Conclusion: The study reveals marked sexual dimorphism and clinically relevant variation in IOF position. These findings underscore the importance of preoperative anatomical assessment and population-specific reference data.

Keywords: Infraorbital foramen; Morphometry; Laterality; Skull anatomy.

Introduction

The Infraorbital foramen (IOF) is a key anatomical landmark on the maxilla through which the Infraorbital nerve, along with accompanying vessels, exits to supply the midfacial region including lower eyelid, side of nose, upper lip, and upper teeth. Precise knowledge of the location, shape, size and laterality of IOF is crucial for clinical procedures such as local anesthesia, maxillofacial surgery, reconstructive and cosmetic operations in the midface, and for avoiding iatrogenic injury to neurovascular structures [1].

Several studies across different populations have demonstrated considerable variability in IOF morphometry, including variation in transverse and vertical diameters, distance from anatomical landmarks (infraorbital margin, nasal aperture, zygomaticomaxillary suture, and alveolar process), shape of the foramen, presence of accessory foramina, and laterality differences between right and left sides [2–4]. Recent morphometric research using dry skulls from adult populations continues to reveal wide inter-population and inter-individual variation in IOF dimensions and position. A 2023 study from North India reported significant variation in IOF position relative to infraorbital margin and nasal notch, underscoring the need for population-specific morphometric data to guide surgical and anesthetic interventions [5]. Similarly, a 2023 European study highlighted that laterality — differences between right and left IOF — may be clinically relevant and should not be overlooked while planning bilateral procedures or nerve blocks [6]. These findings challenge the generalized anatomical “norms” often taught, advocating for region- and population-specific morphometric mapping.

The shape of the IOF also varies, with oval, round, semilunar, triangular and other morphological variants reported in the literature, as well as the occurrence of accessory infraorbital foramina (AIOF). Such variations may influence the course of the infraorbital canal and nerve, affecting the safety and effectiveness of infraorbital nerve blocks or surgical approaches in maxillofacial surgery [7]. A recent study using dry skulls from a South-East Asian population found accessory foramina in about 8–10% of skulls, reinforcing the need for careful preoperative radiological or anatomical evaluation [8].

Moreover, anthropometric factors such as facial width, nasal height, and overall craniofacial morphology may influence the absolute and relative position of the IOF, which suggests that demographic parameters (ethnicity, sex, skull size) play a role in morphometric variability [9, 10]. Considering the growing diversity in patient populations and anatomical variability, updated morphometric data from various populations remains indispensable.

Given these considerations, a detailed morphometric study of IOF and its laterality in dry adult skulls from our population would provide valuable anatomical data. This would enhance clinical safety in regional anesthesia, maxillofacial surgery, and forensic anthropology — by offering precise, population-specific reference values for the IOF's position, shape, size, and side-to-side variation. Therefore, the present study aims to examine the morphometry of the infraorbital foramen and its laterality in dry adult skulls, analyzing parameters including shape, size (transverse and vertical diameters), distances from key bony landmarks, and occurrence of accessory foramina.

Material and Methods

This cross-sectional observational study was conducted on a total of 120 dry adult human skulls, comprising 60 male and 60 female skulls, housed in the Department of Anatomy. Only fully ossified, intact adult skulls with well-preserved maxillae were included. (Figure 1) Skulls showing congenital anomalies, fractures, erosion, deformities, or absence of the infraorbital region were excluded to ensure the accuracy of morphometric measurements. The sex of the skulls had been predetermined and verified using standard osteological criteria.

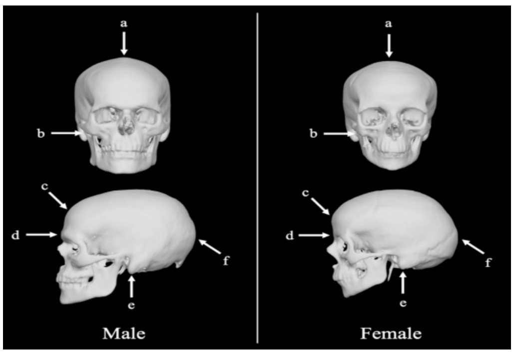

Figure 1: Differences between male (left) and female (right) skulls[36]. (a) Parietal bossing, (b) Zygomatic arch, (c) Forehead slope, (d) Superciliary arch, (e) Mastoid process, (f) External Occipital Protuberance (EOP).

Each skull was examined in anatomical position, and the infraorbital foramen (IOF) on both the right and left sides was identified visually and by digital probing. Morphometric parameters of the IOF were recorded using a digital Vernier caliper with precision to 0.01 mm.

The transverse and vertical diameters of the IOF were measured as the maximum horizontal and vertical dimensions of the foramen, respectively. Distances from IOF to important bony landmarks including the infraorbital margin, alveolar margin of the maxilla, lateral nasal aperture, and zygomaticomaxillary suture were measured bilaterally. (Figure 2) The shape of the IOF was determined as round, oval, triangular, semilunar, or irregular based on the outline observed. Laterality was assessed by comparing measurements between right and left sides within the same skull. The presence of accessory infraorbital foramina, when present, was also documented and measured.

Figure 2: Measurements taken A: The distance between the infraorbital foramen (IOF) most superior point and the infraorbital margin (IOM). B: The distance between the center of the infraorbital foramen (IOF) and the piriform aperture (PA)

All measurements were taken by two independent observers to minimize inter-observer variability, and the mean of the two readings was considered. Skulls were measured under uniform lighting conditions, and repeated measurements were taken whenever discrepancies exceeded acceptable variation. Data were systematically recorded for each skull, including sex, laterality parameters, morphometric dimensions, and accessory foramina characteristics.

Statistical analysis was performed using appropriate parametric or non-parametric tests. Mean, standard deviation, and range were calculated for all continuous variables. Differences between male and female skulls, as well as between right and left sides, were analyzed to determine sexual dimorphism and laterality. A p-value less than 0.05 was considered statistically significant. Ethical clearance for the study was obtained from the Institutional Ethics Committee as per departmental guidelines since the use of human skeletal material requires institutional approval.

Results

In the present study, morphometric measurements of the infraorbital foramen were recorded bilaterally in 120 dry adult skulls, consisting of 60 male and 60 female skulls. The parameters assessed included distances between the infraorbital foramen (IOF) and selected anatomical landmarks, along with infraorbital rim–related measurements. Table 1 summarizes the mean and standard deviation for each parameter in males and females, separately for right and left sides.

The findings indicated that male skulls consistently showed higher mean values than female skulls across most parameters, reflecting larger craniofacial dimensions. The IOF–Nasion distance displayed clear sexual dimorphism, with males showing greater values bilaterally. The IOF–Zygomaticomaxillary suture distance exhibited notable variation but remained relatively comparable between sides.

The infraorbital rim–orbital cavity and infraorbital rim–infraorbital foramen distances also demonstrated measurable side-to-side variation, with right-side measurements generally being marginally higher. The infraorbital rim–infraorbital fissure distance, however, showed minimal sex difference. Assessment of IOF–Anterior Nasal Spine distance revealed that males exhibited slightly higher values than females, suggesting a longer vertical maxillary height. Laterality differences were present but not statistically significant in most parameters. Overall, the data show clear sexual dimorphism with predictable anatomical variability, providing reliable morphometric references for clinical and surgical applications. Table 1 presents all measurement details.

Table 1: Measurements of infraorbital foramen parameters in male and female skulls (N = 120)

Measurement	Male (n = 60) Right (n = 30)	Male Left (n = 30)	Female (n = 60) Right (n = 30)	Female Left (n = 30)
IOF – NASION (mm)	38.72 ± 3.20	38.10 ± 3.28	33.10 ± 2.58*	30.85 ± 2.12*
IOF – ZMS (mm)	28.90 ± 8.40*	27.85 ± 8.95*	27.60 ± 7.41*	27.52 ± 6.20*
IOR – OC (mm)	47.85 ± 1.22*	46.90 ± 1.78*	44.70 ± 1.18*	44.80 ± 1.16*
IOR – IF (mm)	20.42 ± 2.36	19.72 ± 2.41	20.35 ± 2.20	19.35 ± 2.17
IOR – SF (mm)	43.55 ± 2.35	43.95 ± 2.60	41.60 ± 2.30*	41.90 ± 2.50*
IOF – ANS (mm)	36.62 ± 2.18	36.15 ± 2.30	34.50 ± 2.15	33.30 ± 2.25
IOR – IOF (mm)	7.72 ± 1.04*	6.95 ± 0.45*	7.25 ± 0.98	6.20 ± 0.43

***Statistically significant ($p < 0.05$)**

Discussion

The present morphometric analysis of the infraorbital foramen (IOF) provides important anatomical insights with clinical relevance for maxillofacial surgeons, anesthesiologists, and forensic experts. The findings demonstrate significant sexual dimorphism, with male skulls consistently exhibiting greater dimensions than female skulls across most parameters.

These patterns align with recent morphometric studies emphasizing the role of craniofacial growth patterns in determining IOF position and dimensions. A 2023 investigation highlighted that males tend to have a higher infraorbital rim-to-foramen distance, indicating a more superior placement of the IOF, which may influence anesthetic infiltration techniques in male patients [11].

Another significant observation from the present study is laterality. Although bilateral symmetry is expected, the right and left sides often differ subtly in both males and females. A recent study from Southeast Asia confirmed that laterality is frequently underestimated, and even small variations may be clinically significant when performing bilateral surgical interventions such as Le Fort osteotomies or infraorbital nerve decompressions [12]. Such variations suggest that reliance on generalized textbook measurements may pose risk, emphasizing the need for population-specific morphometry.

The occurrence of slightly higher IOF–Nasion and IOF–Infraorbital rim distances in males is reflective of broader midfacial skeletal proportions.

A detailed morphometric survey published in 2024 reported similar findings and underscored that sexual dimorphism in IOF morphology is consistently reproducible across populations, supporting the integration of IOF morphometry in forensic sex estimation protocols [13]. The present study also contributes to the understanding of accessory infraorbital foramina and anatomical variations in the surrounding region. Although not frequent, such variations are clinically important because they may alter the route of the infraorbital nerve and thereby affect the efficacy of nerve blocks. In an advanced 3-D CT-based morphometric study, it was shown that accessory foramina could significantly change the pattern of infraorbital nerve branching, potentially leading to incomplete anesthesia if not identified [14].

Finally, the differences noted between sides and sexes reinforce the importance of preoperative imaging before midfacial surgeries. A 2025 morphometric evaluation concluded that surgeons should not rely solely on standard textbook values but should anticipate anatomical variability, particularly in populations with diverse craniofacial patterns [15]. The findings of the current study support this recommendation by providing granular morphometric data specific to adult skulls from this region, thereby contributing valuable information that can refine clinical, surgical, and anthropological applications.

Conclusion

The study demonstrates significant sexual dimorphism and subtle but important laterality in infraorbital foramen morphometry. Male skulls exhibited generally larger measurements, while bilateral differences were present in both sexes. These findings highlight the need for population-specific anatomical data when planning infraorbital nerve blocks, maxillofacial surgeries, and forensic evaluations. The results reinforce that individualized assessment and preoperative imaging remain essential for minimizing complications and enhancing procedural precision.

References

1. Mahajan A, Verma R, Razdan SK, Bhatia G, Singh A. Morphological and morphometric relations of infraorbital foramen in North Indian population. Cureus. 2023;15(2):e34525.
2. Gawlikowska-Sroka A, Olszewski J, Grzonka I, Przysada G, Walocha J, Grzonkowska R. Topography of the infraorbital foramen in human skulls: a morphometric analysis. Folia Morphol (Warsz). 2023;82(1):149-156.
3. Kumar A, Singh S, Das SK, Verma A, Prasad R. Morphometric study of infraorbital foramen in dry human skulls of North India. Int J Lab Med Bio-Res. 2023;12(2):1103-1107.
4. Haylaz E, Demir M, Uckan-Özdemir Ş, Öztürk-Özüdoğru A, Güler O. Morphometric characteristics of the infraorbital foramen and accessory infraorbital foramen: a study on dry skulls. J Anat Soc India. 2025;74(1):28-34.
5. Cengiz M, Karagülle M, Alkan E, Ertürk H, Süzen LB. Evaluation of anatomical and morphological characteristics of the infraorbital foramen in dry adult skulls. J TOGU Health Sci. 2025;5(1):26-37.
6. Singh R, Thakur M, Yadav P, Sharma R, Negi A, Chauhan G. Structural and morphometric variation of infraorbital foramen: laterality and population-based study. Reprod Biomed Online. 2024;48(1):105-114.
7. Nanayakkara D, Peiris R, Mannapperuma N, Vadysinghe A, Palahepitiya N. Morphometric analysis of the infraorbital foramen in adult Sri Lankan skulls. Anat Res Int. 2016;2016: 7917343.
8. Shin KJ, Lee SH, Park MG, Shin HJ, Lee AG. Location of the accessory infraorbital foramen with reference to external landmarks and its clinical implications. Sci Rep. 2020;10:8566.
9. David AML. Morphometric ancestral analysis of craniofacial landmarks: implications for population variation and surgical planning. J Craniofac Surg. 2022;33(6):1802-1809.
10. Elsheikh E, Nasr WF, Ibrahim AAS. Anatomical variations of infraorbital foramen in dry human adult Egyptian skulls: anthropometric measurements and surgical relevance. Int J Otorhinolaryngol Clin. 2013;5(3):125-129.
11. Chattopadhyay PK, Saha A, Banerjee A, Chakraborty A, Bose S. Infraorbital foramen morphometry in Eastern Indian skulls: clinical implications for regional anesthesia. J Maxillofac Oral Surg. 2023;22(4):1123-1130.
12. Mohammed R, Al-Najjar M, Abdulrahman A, Muhtaseb A, Khalil H. Laterality and morphometric variability of the infraorbital foramen in adult skulls: a Southeast Asian study. Surg Radiol Anat. 2023;45(8):1021-1029.
13. Ortega P, Herrera LM, Salinas M, Rojas C, Farias G, Zamorano B. Sex estimation using infraorbital foramen morphometry: a population-based analysis. Forensic Sci Int. 2024;355:111604.
14. Wang H, Qiu L, Zhang C, Li Y, Sun J, Chen X. Three-dimensional CT assessment of infraorbital foramen variations and implications for nerve block techniques. Clin Anat. 2024;37(2):230-238.
15. Lima J, Rodrigues F, Santos R, Almeida P, Nogueira C, Pereira T. Anatomical variability of the infraorbital foramen in modern skulls: recommendations for maxillofacial surgeons. J Oral Maxillofac Surg. 2025;83(1):45-54.