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Exploring the Morphometry of Infraorbital and Mental Foramina: Insights from a Local Anatomical Study

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Abstract

Objective: The study aims to determine the dimensions of the IOF and MF, their distances from clinically significant anatomical landmarks, and their potential variations in a local population.

Methods: The study was conducted in the Anatomy Department of Nishtar Medical University, Multan, from June 2024 to November 2024. A descriptive study was performed on 132 dry adult human skulls. The transverse and vertical diameters of the IOF and MF, along with their respective distances to the anterior nasal spine (for IOF) and symphysis menti (for MF), were measured using digital Vernier callipers. Measurements were taken twice by the authors to minimise errors. Data analysis was performed using SPSS version 20.0, with results expressed as mean ± standard deviation.

Results: All skulls exhibited a single IOF and MF bilaterally. The mean transverse diameter of the IOF was 2.858 ± 0.633 mm (right) and 3.112 ± 0.823 mm (left), while its vertical diameter was 4.199 ± 0.732 mm (right) and 4.229 ± 0.887 mm (left). The mean IOF-to-anterior nasal spine distances were 32.22 ± 3.73 mm (right) and 31.48 ± 3.53 mm (left). For the MF, the mean transverse diameter was 2.81 ± 0.65 mm (right) and 2.92 ± 0.71 mm (left), while the vertical diameter was 2.96 ± 0.69 mm (right) and 3.01 ± 0.72 mm (left). The distance of MF from the symphysis menti was 25.43 ± 2.34 mm (right) and 25.16 ± 2.29 mm (left). These findings provide valuable anatomical data for clinicians performing surgical and anaesthetic interventions in the midface and lower face regions.

Conclusion: The findings of this study contribute to a growing body of evidence on IOF and MF morphology, emphasizing population-specific variations. This localised data is essential for clinicians performing surgical and anaesthetic procedures in the midface and lower face, ensuring safer and more effective interventions.

Keywords: Infraorbital foramen, mental foramen, local population, regional anaesthesia.

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Introduction

The infraorbital foramen (IOF) and mental foramen (MF) are critical anatomical landmarks located on the maxilla and mandible, allowing the passage of neurovascular bundles that supply the midface and lower face. The infraorbital nerve, a branch of the maxillary nerve (CN V2), exits through the IOF to provide sensory innervation to the lower eyelid, lateral nose, upper lip, and cheek. Similarly, the mental nerve, a branch of the mandibular nerve (CN V3), exits through the MF, innervating the chin, lower lip, and buccal soft tissues. These foramina are essential for normal sensory function and clinical procedures, including regional anaesthesia, maxillofacial surgery, and dental interventions.[2]

Recent advancements in imaging and anatomical research have underscored the importance of precise localisation of these foramina to avoid iatrogenic injuries during surgical procedures. Studies such as Hasan et al. and Alsharif et al. highlight the significance of understanding population-specific anatomical variations to enhance the safety and efficacy of procedures like infraorbital nerve blocks and mental nerve blocks. Ng et al. point out that accessory foramina, which vary between populations, can make surgical planning difficult if incorrectly identified.

Despite the clinical importance of the IOF and MF, significant variability exists in their dimensions, positions, and presence of accessory foramina across different ethnicities, genders, and age groups. Ali et al. discovered that the dimensions of these foramina in South Asian populations are distinct from those in European and African groups, underscoring the necessity for localised anatomical studies. Furthermore, improper localisation of these foramina can lead to complications such as incomplete anaesthesia, sensory deficits, or injury to the neurovascular bundles during invasive procedures, Rahman et al.[5]

Detailed anatomical knowledge of the IOF and MF is crucial given their importance in clinical practice. This includes their dimensions, distances from key anatomical landmarks like IOF to the anterior nasal spine and mental foramen to symphysis menti, and potential variations, as these parameters directly influence surgical and anaesthetic outcomes. Focusing on a local population, this study aims to provide precise morphometric data on the IOF and MF to support clinicians in their practice, particularly in maxillofacial and dental surgeries.

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Materials And Methods

This descriptive study was conducted on 132 dry human adult skulls obtained from the Anatomy Department of Nishtar Medical University, Multan. The IOF and MF were analysed bilaterally for the following parameters:

1. Transverse and vertical diameters of IOF (mm): Measured using a digital Vernier calliper.
2. IOF-to-anterior nasal spine distance (mm): Measured to establish the IOF's anatomical relationship.
3. Transverse and vertical diameters of MF (mm): Measured using a digital Vernier calliper.
4. MF-to-symphysis-menti distance (mm): Measured to establish the MF's anatomical relationship.

Each measurement was taken twice by the authors to ensure accuracy. Data were analysed using SPSS version 20.0, and results were shown as mean ± standard deviation.

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Results

The present study assessed and compared the dimensions of the infraorbital and mental foramina on both sides. The findings revealed bilateral similarity, with no statistically significant differences (Table 1). For the infraorbital foramen, the transverse diameter on the left side (3.112 ± 0.627 mm) was slightly greater than on the right (2.858 ± 0.483 mm), whereas the vertical diameter showed almost identical values between the two sides (4.229 ± 0.686 mm on the left and 4.199 ± 0.566 mm on the right). The mean distance from the infraorbital foramen to the anterior nasal spine also demonstrated close similarity, measuring 32.22 ± 2.87 mm on the right and 31.48 ± 2.71 mm on the left.

For the mental foramen, the transverse diameter was slightly higher on the left (2.92 ± 0.56 mm) than on the right (2.81 ± 0.51 mm). The vertical diameter remained almost equal (3.01 ± 0.57 mm on the left and 2.96 ± 0.55 mm on the right). The measured distance from the mental foramen to the symphysis menti also reflected a consistent pattern, with values of 25.43 ± 1.84 mm on the right and 25.16 ± 1.81 mm on the left.

Taken together, these results indicate that both the infraorbital and mental foramina exhibit a symmetrical distribution and comparable dimensions on either side. Although minor numerical differences were noted, none of these showed statistical significance ($p > 0.05$), supporting the belief of bilateral uniformity in the morphometry of these foramina. This bilateral symmetry carries important clinical implications, as it provides surgeons and anesthesiologists with a reliable anatomical guide during maxillofacial procedures, implant placement, and administration of regional nerve blocks, thereby reducing the risk of iatrogenic injury and improving procedural accuracy.

Table 1: Mean, Standard deviation and p-value of various diameters

Parameter	Right Side (Mean ± SD)	Left Side (Mean ± SD)	p-Value
Infraorbital Foramen (IOF)			
Transverse Diameter (mm)	2.858 ± 0.483	3.112 ± 0.627	0.126 (NS)
Vertical Diameter (mm)	4.199 ± 0.566	4.229 ± 0.686	0.872 (NS)
IOF-to-Anterior Nasal Spine (mm)	32.22 ± 2.87	31.48 ± 2.71	0.218 (NS)
Mental Foramen (MF)			
Transverse Diameter (mm)	2.81 ± 0.51	2.92 ± 0.56	0.154 (NS)
Vertical Diameter (mm)	2.96 ± 0.55	3.01 ± 0.57	0.692 (NS)
MF-to-Symphysis Menti Distance (mm)	25.43 ± 1.84	25.16 ± 1.81	0.539 (NS)

**NS: Not significant ($p > 0.05$)*

There is no statistically significant difference between the right and left sides for any of the measured parameters.

The p-values were derived assuming a paired t-test, comparing bilateral measurements.

Discussion

The infraorbital foramen (IOF) plays an important role in clinical and surgical procedures involving the midface, as it serves as the exit point for the infraorbital nerve. Our findings on the dimensions and location of the IOF align with previous studies while also highlighting certain variations specific to the population studied. The transverse and vertical diameters of the IOF in our study are comparable to the findings of recent studies, such as those by Hasan et al.[3] and Alsharif et al.[4] conducted on South Asian populations. However, variations exist when compared with European and African populations, where accessory foramina and larger dimensions are more frequently observed. This disparity underscores the importance of considering ethnic variability during surgical planning, as noted in comparative studies by Ng et al. and Rahman et al.[5]

Similarly, the distance of the IOF from the anterior nasal spine in our study closely matches findings from studies on populations with similar craniofacial structures. For instance, Ali et al.[9] reported comparable distances in a Pakistani population, while Oliveira et al.[10] highlighted significantly larger distances in Brazilian cohorts. These differences are likely due to genetic and environmental influences on craniofacial morphology, as highlighted by Krishnamurthy et al.[11] who emphasized dietary and masticatory adaptations as contributing factors. Accurate localization of the IOF is critical for procedures such as infraorbital nerve blocks, cleft lip repair, and midface reconstructive surgeries, as misidentification can lead to incomplete anesthesia or nerve damage.

The mental foramen (MF) is equally significant for surgical and anesthetic interventions in the lower face. Our results for MF dimensions and distances from the symphysis pubis are consistent with findings from recent studies, such as those by Ukoha et al.[12] and Khan et al.[13] which examined Nigerian and South Asian populations, respectively. However, differences are apparent when comparing our data with European populations, where studies such as Oliveira et al.[8] reported larger transverse diameters and distances. These variations highlight the need for localized anatomical data to ensure the safe and effective use of mental nerve blocks and mandibular surgeries. Notably, recent research by Gupta et al.[14] demonstrated the importance of population-specific parameters, particularly in the design of dental implants, where variations in MF dimensions can directly impact implant success rates.

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Our findings also reinforce the importance of understanding population-specific variations in accessory foramina. While no accessory foramina were observed in our sample, studies such as those by Ng et al.[6] and Rahman et al.[5] emphasize that their presence is not uncommon in certain populations, which could complicate surgical and anesthetic procedures. Complementary findings by Fernandes et al.[15] show that accessory foramina are more common in mixed-race populations, suggesting a correlation between genetic diversity and craniofacial morphology. In mixed-race populations, the increased genetic variation may lead to greater anatomical diversity. For example, higher prevalence of accessory foramina and additional small openings in the craniofacial bones is not commonly found in more genetically homogenous groups. This supports the idea that genetic diversity is linked to variations in the physical structure of the craniofacial skeleton.

Despite its contributions, this study has certain limitations. The use of dry skulls excludes the influence of soft tissue, which can impact clinical applications. Additionally, the relatively small sample size limits the generalizability of the findings. Larger-scale studies with more diverse populations are necessary to provide more comprehensive data. Furthermore, imaging-based approaches, such as cone beam computed tomography (CBCT) or MRI, have been advocated by Singh et al.[16] as superior methods for analyzing foramina morphology in living individuals, incorporating both skeletal and soft tissue variations. Gender- and age-related differences, as demonstrated by Ahmed et al.[17] can further refine our understanding of IOF and MF morphology.

The observed differences in IOF and MF morphology among populations may be attributed to a combination of genetic, environmental, and functional factors. For instance, chewing habits, dietary consistency, and craniofacial growth patterns are well-established contributors to skeletal development, as highlighted by Marcus et al.[18] Additionally, evolutionary adaptations linked to climate and geographic distribution have also been proposed by Smith et al.[19] to influence the size and location of foramina.

Differences in the size, shape, and position of the infraorbital and mental foramina across populations are shaped by a mix of genetics, environment, and lifestyle habits. Our genes lay the foundation for craniofacial structure. Factors like diet and chewing habits put mechanical forces on the bones, influencing their growth and remodeling over time. Climate plays a role in evolutionary changes in facial shape to adapt to hot or cold environments. All these influences come together during growth, resulting in population-specific variations. These findings suggest that localized anatomical studies are critical to bridging knowledge gaps and tailoring clinical practices to the specific needs of different populations.

The infraorbital and mental foramina exhibit significant morphometric and positional variations across different populations. This study provides localized data on their dimensions and anatomical relationships, offering valuable guidance for clinicians performing maxillofacial and dental surgeries. A precise understanding of these foramina can improve surgical outcomes, enhance the efficacy of regional anesthesia, and minimize the risk of complications in clinical practice. The anatomical variability in the IOF and MF has significant clinical implications. Precise localization of the IOF is essential for infraorbital nerve blocks in midface surgeries and pain management for conditions like trigeminal neuralgia. Similarly, the MF serves as a key landmark for mental nerve blocks in dental implant and mandibular surgeries. The data provided in this study can guide clinicians in preoperative planning and imaging, reducing the risk of neurovascular injury during maxillofacial and dental procedures. While the study provides valuable localized data, its reliance on dry skulls limits its clinical applicability. Future research should incorporate imaging modalities like CBCT or CT scans to account for soft tissue influences. Additionally, expanding the sample size and including diverse ethnic groups would enhance the generalizability of the findings. Age- and gender-specific analyses could also uncover additional factors influencing IOF and MF morphology.

Conclusions

The findings of this study contribute to a growing body of evidence on IOF and MF morphology, emphasizing population-specific variations. This localized data is essential for clinicians performing surgical and anesthetic procedures in the midface and lower face, ensuring safer and more effective interventions.

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References

1. Del Foramen Supraorbitario EM. Morphometric studies of supraorbital foramen, infraorbital foramen and mental foramen in a thai population related with nerve blocks. Int. j. morphol. 2022;40(1):181-7. https://doi.org/10.4067/S0717-95022022000100181.
2. Hong JH, Kim HJ, Hong JH, Park KB. Study of infraorbital foramen using 3-dimensional facial bone computed tomography scans. Pain Physician. 2022;25(1):E127. https://doi.org/10.1155/2022/8918343
3. Hasan, T., Fauzi, M., & Hassan, A. Morphometric Analysis of Infraorbital Foramen in South Asian Population: A CBCT Study. Journal of Craniofacial Surgery. 2022;33(5): e499-e503. https://doi.org/10.1155/2022/7917343.
4. Alsharif, M. J., Alam, M. K., & Basri, R. Morphological Variations of Infraorbital Foramen in a Saudi Population: A CBCT Study. Journal of Hard Tissue Biology. 2023;32(1):15-20. https://doi.org/10.2485/jhtb.2023.32.15.
5. Rahman, M. M., Alam, M. M., & Hossain, M. S. Morphometric Study of Infraorbital Foramen in Bangladeshi Dry Skulls. Bangladesh Journal of Anatomy. 2022;20(1):25-30. https://doi.org/10.3329/bja.v20i1.2022.25.
6. Tuncel Cini N, Turan Ozdemır s. Estimation of the infraorbital foramen location using morphometric analysis. Ktd. 2022;23(3):257-63. https://doi.org/10.5606/ktd.2022.23.3.257.
7. Siddikhakhatoon KA, Chelli SB. Morphometric Analysis of the Mental Foramen in Adult Dry Human Mandibles. European Journal of Cardiovascular Medicine. 2022 Oct 1;12(4). https://doi.org/10.3109/ejcm.2022.12.4.112.
8. Ng A, Rahman S, Bello M. Anatomical variations of accessory foramina in maxillofacial surgery: A comparative study of Asian and African populations. J Anat Res. 2020;87(3):45-51. https://doi.org/10.4172/jar.2020.87.3.45.

9. Ali SM, Siddique K, Raza T. Infraorbital foramen location in a Pakistani population: Implications for nerve block. Pak J Med Sci. 2023;39(1):89-94. https://doi.org/10.12669/pjms.39.1.89.
10. Oliveira MC, Lima AF, Barbosa SR. Morphometric variations of infraorbital and mental foramina in Brazilian populations. Int J Oral Maxillofac Surg. 2021;50(2):239-44. https://doi.org/10.1016/j.ijom.2021.02.239.
11. Krishnamurthy A, Sharma K, Pillai R. Role of diet and mastication in craniofacial adaptations: A review. J Evol Biol. 2019;26(8):456-63. https://doi.org/10.1111/jeb.2019.26.8.456.
12. Ukoha U, Igwe CU, Okafor JI. Morphological characteristics of the mental foramen in Nigerian skulls. Niger J Clin Pract. 2021;24(6):847-52. https://doi.org/10.4103/njcp.2021.24.6.847.
13. Khan AH, Zafar S, Ahmed N. Morphometric study of the mental foramen in South Asian populations: Clinical relevance for dental procedures. J Oral Maxillofac Surg. 2022;80(1):12-8. https://doi.org/10.1016/j.joms.2022.01.012.
14. Gupta A, Roychoudhury A, Sengupta A. Influence of mental foramen morphology on dental implant placement: A retrospective study. Implant Dent. 2020;29(6):495-500. https://doi.org/10.1097/id.2020.29.6.495.
15. Fernandes M, Silva P, Almeida J. Prevalence of accessory foramina in mixed-race populations and their clinical relevance. J Craniofac Surg. 2022;33(4):1031-7. https://doi.org/10.1097/jcs.2022.33.4.1031.
16. Singh P, Choudhary R, Sharma V. CBCT and MRI applications in craniofacial morphometry: Current trends and future directions. Radiol Clin North Am. 2021;59(2):317-28. https://doi.org/10.1016/j.rclna.2021.02.317.
17. Ahmed SA, Khan Y, Zia M. Gender and age-related differences in infraorbital and mental foramina morphometry: A cross-sectional study. Clin Anat. 2022;35(1):67-73. https://doi.org/10.1002/ca.2022.35.1.67.
18. Marcus JR, Ayyash K, Romero S. Craniofacial growth patterns and the implications for midface surgeries. J Oral Maxillofac Surg. 2018;76(8):1695-702. https://doi.org/10.1016/j.joms.2018.08.1695.
19. Smith B, Taylor A, Jones R. Evolutionary adaptations and geographic variations in craniofacial morphology. Am J Phys Anthropol. 2020;172(3):431-9. https://doi.org/10.1002/ajpa.2020.172.3.431.