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MORPHOMETRIC INVESTIGATION OF INFRAORBITAL FORAMEN IN HUMAN DRY SKULLS AND IT'S CLINICAL IMPLICATIONS, PATNA: A CROSS-SECTIONAL STUDY.

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ABSTRACT

Background

The infraorbital foramen (IOF) is a key anatomical landmark on the maxillary bone, crucial for the exit of the infraorbital nerve and vessels. Precise knowledge of its morphology is vital for maxillofacial surgeries, anesthesia, and dental procedures to prevent complications such as nerve damage. This study provides detailed morphometric data on the infraorbital foramen in human dry skulls of the Indian population.

Methods

A cross-sectional investigation was carried out on sixty dry human skulls. The measurements included the oblique distance, the transverse diameter, and the sagittal distance. The shape, orientation, and existence of accessory infraorbital foramina on both sides of the skulls was noted. An analysis of the data was done using SPSS Version-23.

Results

The mean sagittal distance was 6.8 mm, transverse diameter was 14.3 mm, oblique distance was 22.5 mm, vertical diameter was 3.5 mm, and transverse diameter of the IOF was 4.2 mm. No significant variations were found between the right and left sides. The IOF was predominantly oval-shaped (75%) with a downward and medial orientation (83.3%). Accessory infraorbital foramina were present in 20% of the skulls, varying from 1 to 3 per skull.

Conclusion

The study provides comprehensive morphometric data on the IOF in the Indian population, indicating no significant bilateral differences. The predominance of oval-shaped foramina and the presence of accessory foramina have important clinical implications for surgical precision and patient safety.

Recommendations

Future studies should utilize advanced imaging techniques to validate these findings in living subjects. Surgeons should consider these anatomical variations to minimize complications during maxillofacial and dental procedures.

Keywords: *Infraorbital Foramen, Morphometric Analysis, Maxillofacial Surgery, Anatomical Variations.*
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INTRODUCTION

The infraorbital foramen (IOF) is a crucial anatomical landmark located on the maxillary bone, serving as the exit point for the infraorbital nerve and vessels. Understanding the precise location, size, and variation of the IOF is essential for clinicians and surgeons, particularly those specializing in maxillofacial surgery, anesthesia, and dental procedures. Accurate knowledge of IOF morphology aids in the prevention of nerve damage, which can lead to complications such as numbness, pain, and dysfunction in the midfacial region. Recent advances in imaging techniques and anatomical studies have highlighted the need for population-specific data to enhance clinical outcomes [1].

Population-specific anatomical variations in the IOF have been reported globally, emphasizing the importance of tailored anatomical data for different ethnic groups [2]. The Indian population, with its unique genetic and environmental influences, presents distinct anatomical features that may differ from other populations. Previous studies have indicated significant variations in the morphometry of the IOF across different populations, underscoring the necessity of region-specific research [3].

The morphometric characteristics of the IOF, including its size, shape, and positional relationships with surrounding anatomical landmarks, have critical clinical implications. For instance, in maxillofacial surgery, precise localization of the IOF is vital for performing infraorbital nerve blocks, which are commonly used for pain management and anesthesia in procedures involving the midface [4]. Additionally, the presence of accessory infraorbital foramina, which can vary in number and location, poses a challenge for surgeons and necessitates thorough preoperative planning to avoid inadvertent nerve damage [5].

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Recent studies have employed advanced imaging modalities, such as cone-beam computed tomography (CBCT), to obtain high-resolution anatomical data, enhancing the accuracy of morphometric analyses [6]. These techniques have proven invaluable in identifying subtle anatomical variations and providing detailed three-dimensional representations of the IOF and associated structures.

The study aimed at determining the morphometric characteristics of the infraorbital foramen (IOF) in human dry skulls of the Indian population.

METHODOLOGY

Study Design

A descriptive, cross-sectional analysis.

Study Setting

The study was conducted in a setting over four months from August 2023 to November 2023.

Participants

A total of 60 human dry skulls from the South Indian population were included in this study.

Inclusion Criteria

- Human dry skulls of the South Indian population without any visible damage or deformities.

Exclusion Criteria

- Foetal skulls

- Skulls with facial fractures

Sample size

To calculate the sample size for this study, the following formula was used for estimating a proportion in a population:

$$n = \frac{Z^2 \times p \times (1-p)}{E^2}$$

Where:

- n = sample size

- Z = Z-score corresponding to the desired level of confidence

- p = estimated proportion in the population

- E = margin of error

Bias

To minimize bias, all measurements were performed by a single trained observer to ensure consistency. Skulls were randomly selected to avoid selection bias.

Variables

Variables included sagittal distance, transverse diameter, oblique distance, vertical and transverse diameters, shape and direction of the IOF, and presence of accessory infraorbital foramina.

Data Collection

Data were collected by visually observing both sides of the skulls for the shape, direction of the IOF, and the presence of accessory IOF. Measurements were taken using a sliding Vernier caliper with an accuracy of 0.1 mm.

Procedure

1. Sagittal Distance Measurement

The sagittal distance between the infraorbital margin and the upper margin of the IOF was measured.

2. Transverse Diameter Measurement

The transverse diameter from the lateral margin of the pyriform aperture to the medial margin of the IOF was measured.

3. Oblique Distance Measurement

The oblique distance from the anterior nasal spine to the inferior margin of the IOF was measured.

4. Vertical and Transverse Diameter Measurement

The vertical and transverse diameters of the IOF were measured on both sides of the skull.

Statistical Analysis

Data analysis was done with SPSS (Version-23). To compile the data, descriptive statistics were employed. For each measurement, the mean and standard deviations were determined. Paired t-tests were utilised to analyse the differences between the left and right sides. A p-value of less than 0.05 was deemed statistically significant.

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Ethical considerations

The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

RESULT

A total of 60 human dry skulls from the Indian population were analyzed in this study. The measurements were taken on both sides of the skulls, and the data were statistically analyzed to determine the morphometric characteristics of the IOF.

The mean values, standard deviations, and ranges for the sagittal distance, transverse diameter, oblique distance, and vertical and transverse diameters of the IOF are presented in Table 1.

Paired t-tests were conducted to compare the measurements between the right and left sides of the skulls. The results are summarized in Table 2.

There were no statistically substantial variations in the measurements between the right and left sides ($p > 0.05$ for all comparisons).

The infraorbital foramen was predominantly oval-shaped in 45 skulls (75%) and round in 15 skulls (25%). The direction of the IOF was observed to be downward and medially oriented in 50 skulls (83.3%) and straight in 10 skulls (16.7%).

Accessory infraorbital foramina were observed in 12 skulls (20%). The number of accessory foramina varied from 1 to 3 per skull.

The morphometric data provided in this study have important clinical implications, particularly for surgical procedures involving the infraorbital nerve. The knowledge of the average distances and dimensions can aid surgeons in avoiding nerve damage during maxillofacial surgeries.

Table 1: Descriptive Statistics of IOF Measurements

Measurement	Mean (mm)	SD (mm)	Range (mm)
Sagittal distance	6.8	0.9	5.2-8.5
Transverse diameter	14.3	1.2	12.0-16.8
Oblique distance	22.5	1.7	19.5-25.8
Vertical diameter of IOF	3.5	0.5	2.5-4.6
Transverse diameter of IOF	4.2	0.6	3.1-5.6

Table 2: Comparison of IOF Measurements Between Right and Left Sides

Measurement	Right Side	Left Side	p-value
Sagittal distance	6.7 ± 0.9	6.9 ± 0.9	0.21
Transverse diameter	14.2 ± 1.3	14.4 ± 1.1	0.33
Oblique distance	22.4 ± 1.7	22.6 ± 1.7	0.40
Vertical diameter of IOF	3.5 ± 0.5	3.5 ± 0.5	0.89
Transverse diameter of IOF	4.2 ± 0.6	4.2 ± 0.6	0.95

Table 3: Frequency of IOF Shape and Direction

Characteristic	Frequency	Percentage (%)
Shape: Oval	45	75.0
Shape: Round	15	25.0
Direction: Downward/Medial	50	83.3
Direction: Straight	10	16.7

Table 4: Frequency of Accessory Infraorbital Foramina

Number of Accessory Foramina	Frequency	Percentage (%)
0	48	80.0
1	7	11.7
2	4	6.7
3	1	1.6

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DISCUSSION

The morphometric analysis of the IOF in 60 human dry skulls from the Indian population revealed several key findings. The study aimed to provide detailed measurements and observations relevant to clinical practices involving the infraorbital region. The transverse dimension from the lateral boundary of the pyriform aperture to the medial margin of the IOF was 14.3 mm, while the mean sagittal distance from the infraorbital margin to the top margin of the IOF was 6.8 mm. There was a 22.5 mm oblique gap between the inferior edge of the IOF and the anterior nasal spine. The IOF had transverse and vertical dimensions of 4.2 mm and 3.5 mm, respectively. These measurements help with surgical precision by offering a baseline for anatomical variances in the South Indian population.

The comparison between the right and left sides of the skulls showed no statistically significant differences in any of the measured parameters, indicating bilateral symmetry in the IOF's morphometric characteristics. This symmetry is crucial for surgeons planning bilateral procedures or using one side as a reference for the other. The majority of the IOFs were oval-shaped (75%), and the direction was predominantly downward and medially oriented (83.3%). These findings highlight the consistency in the anatomical features of the IOF within this population.

Accessory infraorbital foramina were found in 20% of the skulls, with variations ranging from one to three accessory foramina per skull. The presence of these additional foramina has significant clinical implications, as they may contain additional neurovascular bundles that could be affected during surgical interventions. Understanding the prevalence and location of these accessory foramina helps in avoiding inadvertent damage during procedures such as maxillofacial surgeries or regional anesthesia.

Overall, the results of this study provide comprehensive morphometric data on the IOF in the Indian population. The consistent measurements and observed anatomical features can serve as a valuable reference for clinicians and surgeons. The knowledge of the average distances, shapes, directions, and the occurrence of accessory foramina can enhance surgical accuracy and safety, reducing the risk of complications related to the infraorbital nerve. These findings underscore the importance of region-specific anatomical studies in improving clinical outcomes.

The IOF is a critical anatomical landmark for various surgical and anesthetic procedures in the maxillary region. Understanding its morphometric parameters helps in avoiding iatrogenic injuries during surgeries and provides essential information for effective regional anesthesia. A study focused on analyzing the anatomical variations in the IOF of South Indian dry skulls. The mean distances of the IOF from the piriform aperture, lower end of the alveolus of the maxilla, and infraorbital margin were measured. The study found the most common location of the IOF was in line with the second premolar tooth (59.01%) [7].

A study was done on the infraorbital foramen's location and its clinical implications in South Indian skulls. The study measured sagittal and transverse distances from various anatomical landmarks and noted that the most common shape of the IOF was semilunar. This information is critical for surgeons and anesthetists to avoid damaging the infraorbital nerve during procedures [8]. A comprehensive study analyzed the infraorbital foramen in North Indian populations. Although not specific to South India, the findings provide valuable comparative data on IOF dimensions and their surgical relevance. The study noted significant interindividual variations, emphasizing the importance of personalized surgical approaches [9].

A study was conducted in Lahore on the presence of accessory infraorbital foramina (AIOF). Although not specific to South India, the findings on the frequency and anatomical variations of AIOF are relevant for understanding potential complications in regional anesthesia and surgical interventions [10]. A study in the North Karnataka region, analyzed the IOF's precise location and variations. The study found significant variations in the distance of IOF from various landmarks, which are crucial for maxillofacial surgeries and regional block anesthesia [11].

Generalizability

The detailed morphometric data of the infraorbital foramen (IOF) in this study can help improve the precision and safety of maxillofacial surgeries, anesthesia, and dental procedures in the larger Indian population by highlighting critical anatomical variations and the prevalence of accessory foramina.

CONCLUSION

This study provides a comprehensive morphometric analysis of the IOF in human dry skulls of the South Indian population. The data indicate no significant bilateral differences in measurements, predominantly oval-shaped foramina with downward and medial orientation, and a 20% occurrence of accessory foramina. These findings have important implications for clinical practices involving the infraorbital region.

LIMITATIONS

The limitations of this study include a small sample population who were included in this study. Furthermore,

the lack of comparison group also poses a limitation for this study's findings.

RECOMMENDATION

Future studies should utilize advanced imaging techniques to validate these findings in living subjects. Surgeons should consider these anatomical variations to minimize complications during maxillofacial and dental procedures.

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LIST OF ABBREVIATIONS

IOF - Infraorbital Foramen

CBCT - Cone-beam Computed Tomography

AIOF - Accessory infraorbital foramina

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No funding received.

CONFLICT OF INTEREST

The authors have no competing interests to declare.

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