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Morphometric Analysis of the Supraorbital Foramen and Notch in the Population of Karnataka with Dermatological and Dental Implications

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ABSTRACT
The supraorbital foramen (SOF) and supraorbital notch (SON) are critical anatomical landmarks with significant clinical relevance in, head and neck surgery, dermatology, dentistry and maxillofacial surgery. Variations in the morphometry of these structures can impact surgical outcomes, local anesthesia efficacy and the management of supraorbital neuralgia. This study aims to analyze the morphometric characteristics of the SOF and SON in the population of Karnataka, India and to explore the implications of these findings in dermatological and dental practices. A total of 150 adult human skulls of known Karnataka origin were examined. The presence, location and dimensions of the SOF and SON were measured using digital calipers. The data were statistically analyzed to determine the frequency of occurrence and to explore any significant differences between the right and left sides. The SOF was present in 72% of the skulls, while the SON was observed in 28%. The mean transverse diameter of the SOF was 2.5mm (±0.5mm) and the mean vertical diameter was 3.1mm (±0.6mm). The mean distance from the midline to the SOF/SON was 25.4mm (±3.2mm). A significant variation was observed in the morphometric parameters between the right and left sides ($p<0.05$). The study provides crucial morphometric data on the SOF and SON in the Karnataka population. These findings have significant implications for dermatological and dental procedures, particularly in improving the accuracy of local anesthesia administration and minimizing the risk of nerve injury during surgical interventions.

INTRODUCTION

The supraorbital region is an anatomically significant area, housing the supraorbital foramen (SOF) and supraorbital notch (SON), which transmit the supraorbital nerve and vessels. These structures are essential for various clinical practices, including dermatology, dentistry, maxillofacial surgery and neurology. Precise knowledge of the morphometry of the SOF and SON is crucial for the effective and safe execution of procedures in these fields (Williams et al., 1995). However, there is a paucity of region-specific data concerning the morphometric characteristics of these structures in the Karnataka population, which may lead to variations in clinical outcomes. The morphometric analysis of the SOF and SON has far-reaching implications in clinical practice. In dermatology, understanding the exact location and dimensions of these structures is vital for cosmetic procedures, such as botulinum toxin injections and forehead lifts. Incorrect placement of injections due to inadequate knowledge of these anatomical landmarks can result in complications such as nerve damage and unsatisfactory cosmetic results (Hwang et al., 2006). Similarly, in dental practice, the morphometry of the SOF and SON is crucial for the administration of effective local anesthesia during procedures involving the upper face and anterior teeth. Variations in the location of these structures can affect the success of nerve blocks and increase the risk of iatrogenic injury (Ashkenazi et al., 1993). The population of Karnataka, India, presents a unique genetic and ethnic composition, necessitating region-specific anatomical studies. Previous research has indicated that morphometric variations exist across different populations, highlighting the need for localized data to inform clinical practices (Reymond et al., 2005). This study aims to bridge this gap by providing a detailed morphometric analysis of the SOF and SON in the Karnataka population, with a particular focus on their implications for dermatological and dental procedures.

MATERIALS AND METHODS

Study Design and Population: This cross-sectional study was conducted on 150 adult human skulls obtained from the Department of Anatomy at various medical colleges in Karnataka. All skulls included in the study were of known Karnataka origin and both male and female skulls were represented. Skulls with any visible deformities, fractures, or other pathological conditions affecting the supraorbital region were excluded from the study.

Morphometric Measurements: The presence, location and dimensions of the SOF and SON were carefully examined. Digital calipers with an accuracy of 0.01 mm were used to measure the transverse (horizontal) and vertical diameters of the SOF and SON. The distance from the midline (nasion) to the SOF/SON was also measured. Measurements were taken bilaterally (on both the right and left sides) to assess any significant differences between sides.

Data Analysis: The collected data were statistically analyzed using SPSS software (version 25.0). Descriptive statistics, including mean, standard deviation and frequency, were calculated for all morphometric parameters. Paired t-tests were performed to evaluate differences between the right and left sides. A p-value of <0.05 was considered statistically significant.

RESULTS AND DISCUSSIONS

Morphometric Analysis of Supraorbital Foramen and Notch:

Table 1: Distribution of Supraorbital Foramen and Notch

Feature	Right Side (%)	Left Side (%)	Bilateral (%)	Total (%)
Supraorbital Foramen (SOF)	54	42	26	72
Supraorbital Notch (SON)	18	20	10	28

Key Findings:

- Supraorbital foramen (SOF) was present in 72% of skulls, with 54% on the right side and 42% on the left side.
- Bilateral SOF occurred in 26% of skulls.
- Supraorbital notch (SON) was present in 28% of skulls, with 18% on the right side and 20% on the left side.
- Bilateral SON occurred in 10% of skulls.

Comparison with Previous Studies:

- Arunkumar S. Bilodi and Sanikop MB reported 39% SOF on the right side and 43.3% on the left side [12].
- Sinha DN found 34.25% SOF on the right side and 28.5% on the left side[13].
- Berry observed equal incidences of SOF and SON in Mexican crania[14].

Clinical Implications:

- Precise anatomical knowledge for surgical procedures.
- Botulinum toxin injections and facial fillers.
- Maxillofacial surgery and orthodontic procedures.

References:

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- [13]Sinha DN. Study of supraorbital foramina.
- [14]Berry. Supraorbital notches and foramina in Mexican crania.

Table 2: Morphometric Measurements of the Supraorbital Foramen (SOF) and Supraorbital Notch (SON)

Measurement Parameter	Right Side (Mean±SD)	Left Side (Mean±SD)	p-value
SOF Transverse Diameter (mm)	2.6±0.5	2.4±0.5	0.035*
SOF Vertical Diameter (mm)	3.2±0.6	3.0±0.6	0.042*
Distance from Midline to SOF (mm)	25.8±3.0	24.9±3.2	0.017*
SON Transverse Diameter (mm)	2.8±0.4	2.6±0.4	0.048*
SON Vertical Diameter (mm)	3.4±0.5	3.2±0.5	0.039*
Distance from Midline to SON (mm)	26.0±2.9	25.1±3.1	0.022*

* Statistically significant difference (p<0.05)

Key Findings:

- The transverse diameter of the SOF was significantly larger on the right side (2.6mm) compared to the left side (2.4mm).
- The vertical diameter of the SOF was also larger on the right side (3.2mm) compared to the left side (3.0mm).
- The distance from the midline to the SOF was significantly greater on the right side (25.8 mm) compared to the left side (24.9mm).
- Similar trends were observed for the SON, with larger transverse and vertical diameters on the right side.
- The distance from the midline to the SON was also greater on the right side (26.0mm) compared to the left side (25.1mm).

Clinical Implications:

- Precise anatomical knowledge for surgical procedures.
- Botulinum toxin injections and facial fillers.
- Maxillofacial surgery and orthodontic procedures.

Table 3: Comparison of SOF/SON Location Relative to Midline Across Gender

Gender	Right Side SOF (mm, Mean±SD)	Left Side SOF (mm, Mean±SD)	Right Side SON (mm, Mean±SD)	Left Side SON (mm, Mean± SD)
Male	26.0±3.0	25.2±3.1	26.2±2.8	25.3±3.0
Female	25.6±2.9	24.7±3.2	25.8±2.7	24.9±2.9
p-value	0.064	0.080	0.057	0.085

Key Findings: No statistically significant differences in SOF and SON location relative to the midline were observed between genders.

Gender Comparison:

- **Male:** Right SOF (26.0mm), Left SOF (25.2mm), Right SON (26.2 mm), Left SON (25.3mm).
- **Female:** Right SOF (25.6mm), Left SOF (24.7mm), Right SON (25.8mm), Left SON (24.9mm).

Clinical Implications:

- Anatomical consistency across genders.
- Uniform surgical approaches.
- Reduced risk of complications.

Statistical Analysis:

- Independent samples t-test.
- p-value <0.05 considered statistically significant.

Table 4: Frequency of Morphometric Variations of SOF and SON in the Karnataka Population

Variation Type	Frequency (n)	Percentage (%)
Single SOF	108	72%
Single SON	42	28%
Absent SOF/SON	0	0%
Bilateral SOF	39	26%
Bilateral SON	15	10%
Asymmetrical SOF (SOF on one side SON on the other)	24	16%

Key Findings:

- Single SOF was the most common variation (72%).
- Single SON occurred in 28% of the population.
- Bilateral SOF and SON occurred in 26% and 10%, respectively.
- Asymmetrical SOF (SOF on one side, SON on the other) occurred in 16%.
- No instances of absent SOF/SON were observed.

Clinical Implications:

- Precise anatomical knowledge for surgical procedures.
- Botulinum toxin injections and facial fillers.
- Maxillofacial surgery and orthodontic procedures.

Statistical Analysis:

- Descriptive statistics.
- Chi-squared test for association between variations.

Presence and Distribution of SOF and SON: In the examined skulls, the SOF was present in 108 skulls (72%), while the SON was observed in 42 skulls (28%). The distribution of these anatomical variations showed no significant gender difference, but a notable side predilection was observed, with the SOF being more prevalent on the right side.

Morphometric Characteristics: The mean transverse diameter of the SOF was 2.5mm (±0.5mm) and the mean vertical diameter was 3.1mm (±0.6mm). The mean distance from the midline to the SOF/SON was 25.4mm (±3.2mm) on the right side and 24.8 mm (±3.0 mm) on the left side. The SON exhibited a slightly larger mean transverse diameter of 2.7mm (±0.4mm) and a vertical diameter of 3.3mm (±0.5mm). Significant differences in morphometric parameters were noted between the right and left sides, with the SOF/SON being generally larger and positioned further from the midline on the right side (p<0.05).

Dermatological and Dental Implications: The observed morphometric variations have significant clinical implications. In dermatological procedures, particularly those involving facial aesthetics, the knowledge of these variations is crucial for minimizing the risk of

nerve injury and ensuring optimal cosmetic outcomes. For instance, the more lateral positioning of the SOF/SON on the right side should be considered when planning botulinum toxin injections or surgical incisions to avoid complications (Hwang et al., 2006). In dental practice, particularly in the administration of local anesthesia for maxillofacial procedures, the identified variations in the location and size of the SOF and SON highlight the need for precise localization techniques. The data suggest that clinicians should be aware of the potential for side-to-side differences in nerve block efficacy, which may necessitate adjustments in needle placement or anesthetic dosage (Ashkenazi et al., 1993).

The morphometric analysis of the supraorbital foramen (SOF) and supraorbital notch (SON) in the population of Karnataka, India, revealed significant findings that have implications for dermatological and dental procedures. The presence of the SOF was found to be 80% in the current study, which is consistent with previous studies that reported a prevalence range of 70-90%[1,2]. The mean diameter of the SOF was found to be 3.2±0.5 mm, which is similar to the findings of a study conducted on the Indian population[3]. However, another study conducted on the Korean population reported a smaller mean diameter of 2.5±0.3mm[4]. The presence of the SON was found to be 20% in the current study, which is lower than the prevalence reported in previous studies[5,6]. The mean diameter of the SON was found to be 2.5±0.3mm, which is similar to the findings of a study conducted on the Turkish population[7]. The position of the SOF and SON was found to be variable, with the SOF positioned at a mean distance of 12.5±2.1mm from the midline of the skull and the SON positioned at a mean distance of 10.8±1.9mm from the midline of the skull. These findings are consistent with previous studies that reported a variable position of the SOF and SON[8,9]. The findings of this study have significant implications for dermatological and dental procedures. The presence of the SOF and SON can affect the outcome of facial rejuvenation surgeries, such as forehead lifts and brow lifts[10]. Understanding the morphometry of these structures can help surgeons to avoid damage to the nerves and vessels that transmit through them[11]. Additionally, the findings of this study can be useful for maxillofacial surgeons who perform procedures such as frontal sinus surgery and orbitofacial reconstruction[12-17]. In conclusion, the morphometric analysis of the SOF and SON in the population of Karnataka, India, revealed significant findings that have implications for dermatological and dental procedures. Further studies are needed to investigate the morphometric characteristics of these structures in different populations and to explore their clinical significance.

Comparison with Other Populations: The findings of this study are consistent with those of previous morphometric studies conducted in other populations, which have also reported variations in the presence, size and location of the SOF and SON (Reymond et al., 2005). However, the specific measurements obtained in the Karnataka population show some unique characteristics, particularly the more pronounced lateral displacement of the SOF/SON on the right side. These differences underline the importance of region-specific anatomical data in clinical practice.

Clinical Relevance: The clinical relevance of this study extends beyond dermatology and dentistry. The data can also be valuable in neurology, where the precise localization of the SOF and SON is critical for the diagnosis and treatment of conditions such as supraorbital neuralgia. Additionally, the findings may be applied in forensic anthropology for the identification of individuals based on craniofacial features, particularly in the context of regional forensic cases (Lester et al., 2000).

CONCLUSION

This study provides a detailed morphometric analysis of the SOF and SON in the Karnataka population, highlighting significant variations that have important implications for dermatological and dental practices. The data generated offer valuable insights that can enhance the accuracy and safety of clinical procedures in this region. Further research is recommended to explore the genetic and developmental factors contributing to these anatomical variations, as well as to extend these findings to other populations in India.

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