Journal of Morphological Sciences
J Morphol Sci
Brazilian Society of Anatomy

Original Article
J Morphol Sci 2025;42:73-81

# Morphological Study of Supraorbital Foramen and Supraorbital Notch in Dry Human Skulls in Northeast Brazil

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**Disclose and conflicts of interest: none to be declared by all authors**

**ABSTRACT**
**Introduction:** the supraorbital foramen (SOF) and notch (SON) are important anatomic landmarks, they provide passage for the supraorbital artery, nerve, and vein, contributing to the innervation, irrigation, and venous drainage of the frontal region.
**Objectives:** The objective of this study was to evaluate the morphology of SOF/SON and their variations in dry human skulls from Northeastern Brazil.
**Methods:** the study was carried out on 96 dry human skulls, which were opened to analyze the shape, length and anatomical variations of the SOF/SON. Data analysis considered $p<0.05$ as significant.
**Results:** it was found, in the sample, 147 Supraorbital Foramina/Notches (73 in female skulls and 74 in male skulls). Among the findings, single notches (44.8%) were the most common. The SOF/SON-NM distance was higher in females on the right (22.7±3.67) and left (22.7±3.67) side. The distance between the right and left SOF/SON was smaller in female skulls. And was found no significant differences between the sexes in the diameter of supraorbital foramina/notches, the distance between SON/SOF-TCFB.
**Conclusion:** this analysis observed a higher prevalence of single notches in male and female orbits, that the different shapes were most common in male skulls, and the ASF was most commonly found in females. The results provide important data that help to understand the different variations of supraorbital exits found in the northeast Brazilian population and their locations on the fronto-orbital area.
**Keywords:** Anatomy; Brazil; Orbit; Supraorbital Foramina; Supraorbital Notch.

## Introduction

The frontal bone is rich in anatomical landmarks such as notches and foramina, which serve as pathways for neurovascular structures. These structures play pivotal roles in several medical procedures, including surgical interventions, local anesthesia administration, and other invasive techniques, making their morphological understanding crucial for healthcare practitioners[1].

Among these landmarks, the supraorbital foramen (SOF) and supraorbital notch (SON) stand out as key features of the frontal bone. Positioned along the supraorbital margin, they provide passage for the supraorbital artery, nerve, and vein, contributing to the innervation, irrigation, and venous drainage of the frontal region. Additionally, an accessory supraorbital foramen (ASF) has been described in literature, further emphasizing the complexity and variability of these structures[2].

Clinically and surgically, the SOF/SON hold significant importance since injury to the structures traversing these landmarks can jeopardize the neurovascular supply of the forehead region. Procedures involving dermal fillers, forehead elevation, and analgesia administration necessitate precise knowledge of local anatomy to prevent complications such as necrosis, hematoma formation, or sensory deficits[3].

Given the clinical relevance and variability of these structures, this study aims to investigate the morphology and morphometry of the SOF and SON, along with their sexual dimorphism, in dry skulls from Northeastern Brazil. This research, being the first of its kind in this region, seeks to provide valuable insights into the anatomical characteristics of these landmarks, aiding healthcare professionals in minimizing the risk of neurovascular damage during procedures in this area.

## Materials and Methods

This observational study took place at the Morphology Department of Federal University of Paraíba (UFPB) and was approved by the Research

DOI: 10.51929/jms.42.73.2025
ISSN 2177-0298

Ethics Committee under Certificate of Presentation for Ethical Appreciation (CAAE) 68587723.8.0000.5188. Ninety-six (96) dry adult human skulls from the Human Anatomy Laboratory of UFPB were included, ensuring proper conservation for accurate measurement of variables. Skull sexing followed morphological characteristics based on anthropometric standards. SOF/SON types were classified according to their anatomical presentation in the skulls[4] (Figure 1), and the presence of accessory supraorbital foramen (ASF) was assessed.

An analog caliper MXT® (range 0-150 mm, accuracy 0.02 mm) and a ruler were used for a morphometric analysis of the main landmarks of the anterior skull related to the SOF and SON. They are detailed in Figures 2 and 3.

Qualitative and quantitative analysis were recorded using the latest versions of Word and Excel. The data analysis was performed using Jamovi version 2.3.24. Comparison was done between genders and between right and left antimers. The QQ plot curve and the W Shapiro-Wilk test were used to determine the normality of the samples according to each group analyzed. Data from the QQ plot suggestive of normality and data from the W Shapiro-Wilk test that presented $p>0.05$ were considered parametric and their measurements were recorded as Mean ± SD. Data with QQ plot suggestive of non-normality and W Shapiro-Wilk test presenting $p<0.05$ were considered non-parametric and their measurements recorded as Median ± IQR. Comparison between groups for paired or unpaired samples was done by t-Test and Mann-Whitney U Test, respectively. Values of $p < 0.05$ were considered as significant.

## Results

Ninety-six (96) dried skulls were included in the analysis (48 females and 48 males), then, the presence or not of 96 supraorbital foramina/notches (SOF/SON) and their anatomical presentation on each side (192 in total) were analyzed. In male skulls, they were absent in 22 assessments (10 on the right side and 12 on the left side), and, in female skulls, they were absent in 23 assessments (8 on the right side and 15 on the left side) (Table 1). Therefore, 147 Supraorbital Foramina/ Notches types (73 in female skulls and 74 in male skulls) were found in this study. Of these, 3 types of SOF/SON were different from the classification used in this study[4], with 2 found in male skulls and 1 in a female skull. In the male skulls, one presented a notch and two foramina, and the other presented a double notch and double foramen. The female skull presented a notch and two foramina.

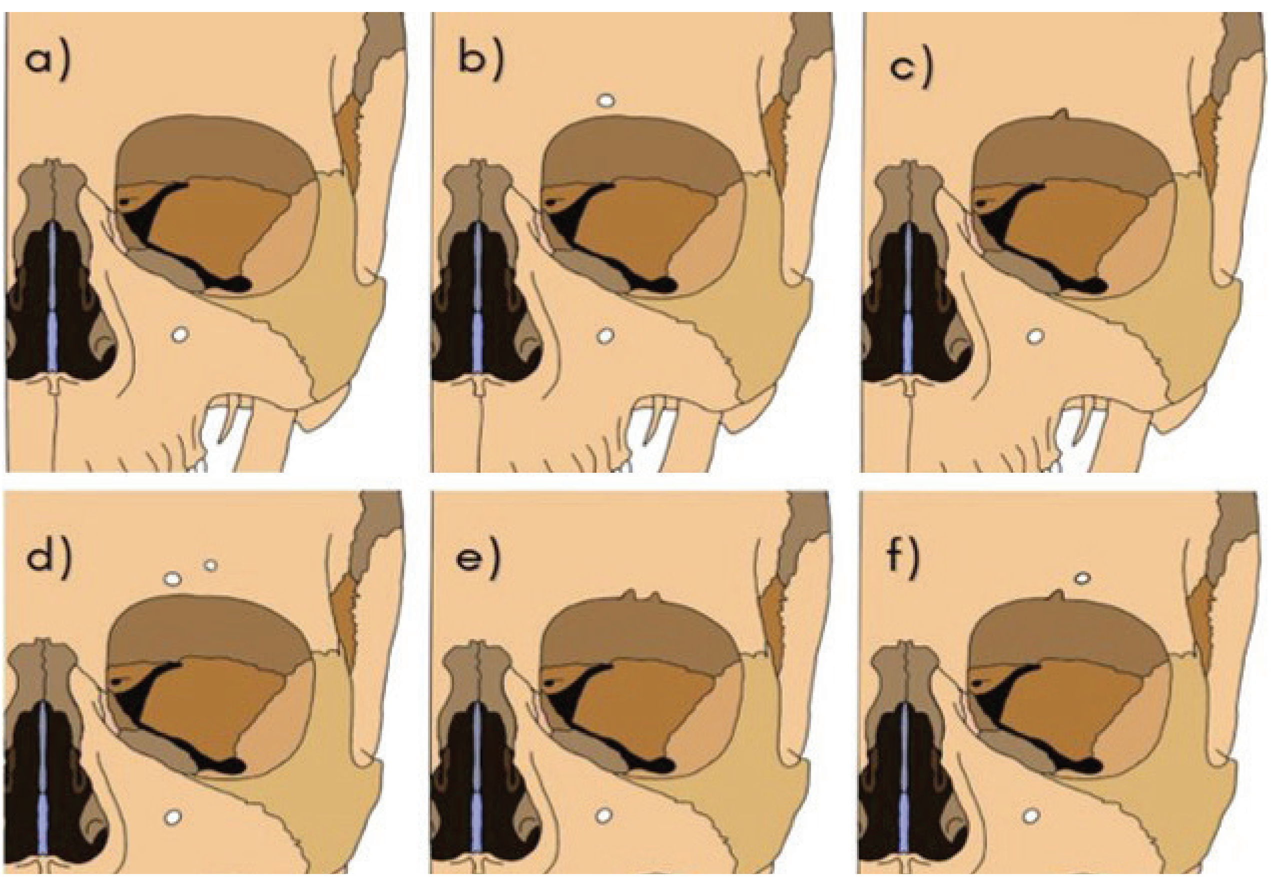


**Figure 1.** Classification of Supraorbital Foramen and Notch.
Legend: a) Absence; b) Single foramen; c) Single notch; d) Double foramen; e) Double notch; f) Notch and foramen.

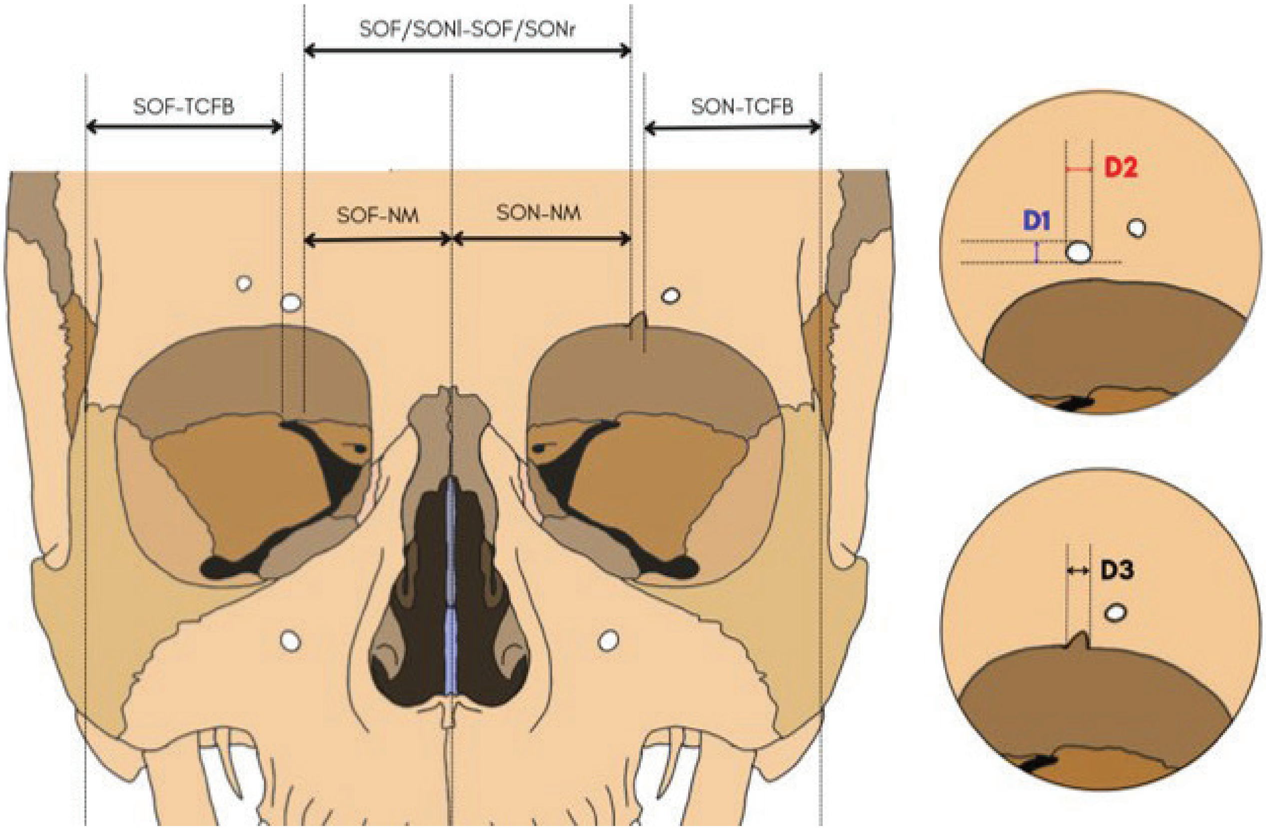


**Figure 2.** Morphometric parameters of the supraorbital foramen (SOF) and notch (SON) in relation to important anatomical landmarks.
Legend: D1: vertical diameter of SOF; D2: horizontal diameter of SOF; D3: horizontal diameter of SON; SOF/SONl-SOF/SONr: distance between the medial margins of the left and right SOFs/SONs; SOF/SON-NM: distance from the medial margin of SOF/SON to Nasal Midline; SOF/SON-TCFB: distance from the lateral margin of SOF/SON to the imaginary line that passes through the most lateral part of the Temporal Crest of the Frontal Bone; SOF-SM: distance from the inferior margin of SOF to Supraorbital Margin.

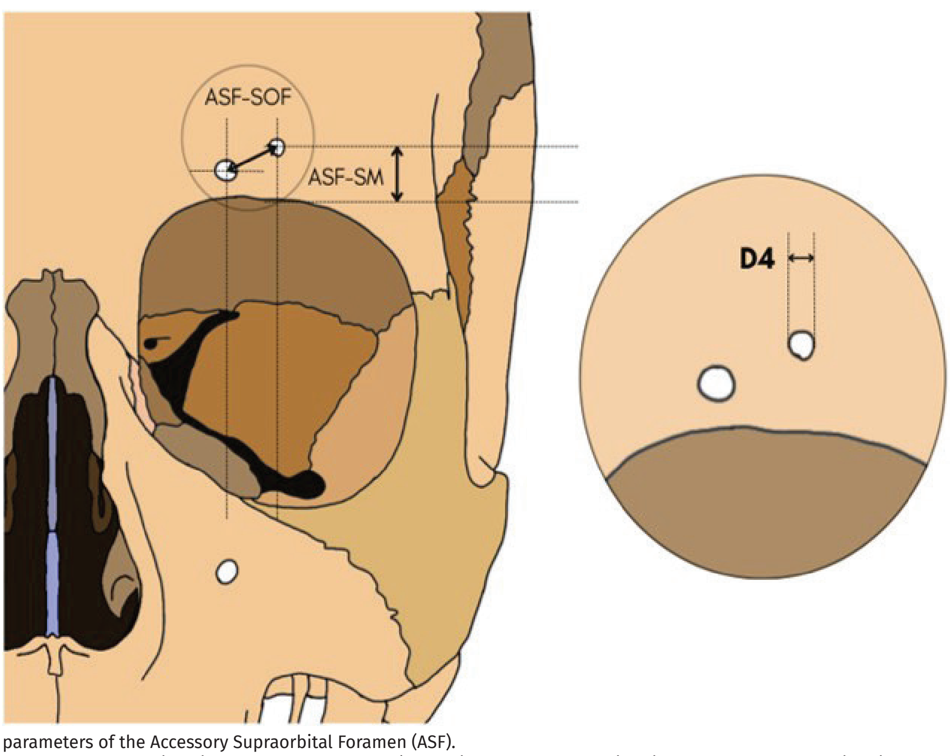


**Figure 3.** Morphometric parameters of the Accessory Supraorbital Foramen (ASF).
Legend: SOF: supraorbital foramen; D4: major diameter of ASF; ASF-SOF/SON: distance from the midpoint of the ASF to the midpoint of the SOF or SON; ASF-SM: distance from the midpoint of the ASF to the supraorbital Margin.

On both sexes it was possible to identify a prevalence of single notches (Table 1). The presence of a single notch on the right side was 13 (6.8%) in male skulls and 16 (16.7%) in female skulls. On the left side, it was 17 (8.9%) in male skulls and 20 (10.5%) in female skulls. The single foramen on the right side was observed in 26 skulls, 14 male and 12 female (7.4% and 6.3%, respectively). The single foramen on the left side was observed in 15 skulls, 8 male and 7 female 4.2% and 3.7%, respectively). The presence of a double foramen was seen in the same amount in male and in female skulls, on the left side, 4 (2.1%) skulls each. On the right side, the double foramen was seen in 4 skulls, 3 male and 1 female (2.1% and 1.5%, respectively). The notch and foramen on the right side was observed in 15 skulls, 5 male and 10 female (2.6% and 5.2%, respectively). The notch and foramen on the left side was observed in 9 skulls, 7 male and 2 female (3.7% and 1.0%, respectively).

The morphometric data of the selected parameters to evaluate the SOF/SON are tabulated in Table 2. On the right side, it was found that the female SOF/SON-NM distance (22.7±3.67) was smaller (p=0.006) than the male SOF/SON-NM distance (25.8±3.77). On the left side, the same finding was observed (22.7±3.67 versus 24.4±2.04, p=0.008). Furthermore, it was observed that the distance between the right and left SOF/SON was smaller in female skulls (43.2±8.43) than in male skulls (49.8±9.11) (p=0.006) on the left side. No differences were found between the sexes in the parameters D1, D2, D3, and the distance between SON/SOF-TCFB (p>0.05). Also, no differences were found between right and left in all the parameters (p>0.05).

The data related to the incidence of ASF in the sample skulls are tabulated in Table 3. A total of 42 ASFs were found in the entire sample, with 16 (38.0%) located only on the right side, 12 (28.5%) only on the left side, and

**Table 2.** Mean(mm) or Median(mm) ± SD or IQR values of supraorbital foramen/notch measurements in both sexes.

| | MALE | | | | FEMALE | | | |
|---|---|---|---|---|---|---|---|---|
| | Right side | | Left side | | Right side | | Left side | |
| Para Meters | Min- Max | Mean/ Median | Min-Max | Mean/ Median | Min- Max | Mean/ Median | Min- Max | Mean/ Median |
| D1 | 1.29-2.83 | *2.02 ±0.52 | 0.98-2.91 | 1.88 ±0.83 | 1.28-2.94 | 1.83 ±0.56 | 1.00-2.73 | 1.80 ±0.48 |
| D2 | 1.46-4.69 | *2.74 ±1.13 | 1.20-7.10 | 3.25 ±1.15 | 1.29- 4.36 | 2.59 ±1.62 | 1.84-4.30 | 2.90 ±0.89 |
| D3 | 1.50-11.60 | 4.42 ±3.64 | 2.30-7.59 | *4.67 ±1.67 | 2.64-8.22 | 5.43 ±2.22 | 1.64-8.17 | 5.21 ±3.21 |
| SOF/SONl- SOF/ SONr | 39.4-70.8 | | 49.8±9.11 ** | | 34.0-55.4 | | 43.2±8.43 ** | |
| SOF/SON-NM | 19.4-38.8 | *25.8 ** ±3.77 | 20.7-27.3 | 24.4 ** ±2.04 | 16.6-36.2 | *22.7 ** ±3.67 | 17.0-29.6 | 22.7 ** ±2.04 |
| SOF/SON-TCFB | 18.4-29.1 | 24.8 ±2.98 | 19.5-31.0 | 24.4 ±3.22 | 17.1-32.4 | 24.6 ±5.21 | 19.8-28.4 | 23.6 ±3.81 |

SOF: Supraorbital Foramen; SON: Supraorbital Notch; D1: Vertical Diameter of SOF; D2: Horizontal Diameter of SOF; D3: Horizontal Diameter of SON; NM: Nasal Midline; TCFB: Temporal Crest of the Frontal Bone; r: Right; l: Left; Max/Min: Maximum and Minimum values; * Values described as mean ± SD. The other linear measurements were described as median ± IQR. ** p<0.05.

**Table 1.** Percentage distribution of supraorbital foramen/notch shape in skulls from Northeastern Brazil.

| Shape – SOF/SON | Male skulls | | Female skulls | | TOTAL |
|---|---|---|---|---|---|
| | Right | Left | Right | Left | |
| **Absence** | 10 (5.2) | 12 (6.3) | 8 (4.2) | 15 (7.9) | 45 (23.8) |
| **Single Foramen** | 14 (7.4) | 8 (4.2) | 12 (6.3) | 7 (3.7) | 41 (21.6) |
| **Single Notch** | 13 (6.8) | 17 (8.9) | 16 (8.4) | 20 (10.5) | 66 (34.9) |
| **Double Foramen** | 3 (1.5) | 4 (2.1) | 1 (0.5) | 4 (2.1) | 12 (6.3) |
| **Double Notch** | 1 (0.5) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (0.5) |
| **Notch and Foramen** | 5 (2.6) | 7 (3.7) | 10 (5.2) | 2 (1.0) | 24 (12.6) |
| **TOTAL** | 46 (24.3) | 48 (25.3) | 47 (24.8) | 48 (25.3) | 189 (100) * |

Data is presented as N (%). N = total number of SOF/SON identified in the respective orbitofrontal region; (%) = percentage distribution in relation to the total orbitofrontal regions analyzed; SOF = Supraorbital Foramen; SON = Supraorbital Notch. *3 assessments of the 192 orbitofrontal regions analyzed were different from the classification used in this study.

**Table 3.** Incidence of Accessory Supraorbital Foramen (ASF) in skulls from Northeastern Brazil.

| Incidence - ASF | Male skulls | Female skulls | TOTAL |
|---|---|---|---|
| **Right side** | 6 (14.2) | 10 (23.8) | 16 (38.0) |
| **Left side** | 8 (19.0) | 4 (9.5) | 12 (28.5) |
| **Bilateral** | 10 (23.8) | 4 (9.5) | 14 (33.3) |
| **TOTAL** | 24 (57.1) | 18 (42.8) | 42 (100) |

Data is presented as N (%). N = total number of ASF analyzed in the study; % = percentage distribution in relation to the total accessory supraorbital foramina found in this study.

14 (33.3%) found bilaterally. The incidence of ASF was higher among male skulls 24 (57.1%) compared to female skulls 18 (42.8%). An interesting finding of the study was the observation of double accessory foramina, which were exclusively found in male skulls. One (1.0%) male skull was found with a double accessory foramen on the left side only. Additionally, two (2.0%) male skulls were found with a double accessory foramen on the right side, which also presented an accessory foramen on the left side, classifying them as having bilateral ASF. Overall, the incidence of double ASF was 3.1%, considering the total sample of 96 observed skulls. Finally, it was observed that 63 (65.6%) skulls did not present ASF, with 31 male skulls and 32 female skulls (32.3% and 33.3% respectively).

The morphometric data related to ASF are tabulated in Table 4. The distance between the ASF and the supraorbital margin in male skulls was 4.18±2.47, which was significantly higher (p=0.05) than female skulls (2.53±1.20). No differences were found between the sexes for the measurements of D4 and ASF-SON/SOF. No differences were found between sides for all the measurements.

## Discussion

Understanding the morphological characteristics of the supraorbital foramen is of utmost importance in medicine, especially in craniofacial anatomy, neurology, and plastic surgery. This understanding is vital in procedures involving the upper orbital wall, including frontal sinus obliteration, orbital decompression, botox injections, forehead facial filling, fracture exploration, and orbital exenteration, avoiding damage to the nerves and blood vessels passing through this foramen[5]. Thus, studying the anatomy of the supraorbital foramen or notch, and its variations according to the ethnic diversity of the population, is crucial. This study, the first of its kind in the Northeastern population of Brazil, could support professional medical work and prevents clinical complications.

Considering the need to have a precise anatomical knowledge about the supraorbital exits, previous publications on this subject were analyzed. Among these studies, seven performed an analysis of dry skulls[6-11], four by image exams[12-15] and two by cadaveric dissection[16,17]. In the present study, 192 dry orbitofrontal regions (96 male and 96 female) were analyzed providing an average profile of supraorbital foramina and notches in Northeastern Brazil.

The present study followed a Thai classification[4] on the shapes of SOF and SON, and observed the predominance of a single-notch supraorbital exit in 34.9% of the orbits analyzed, similarly with 2 reports in Sri Lanka[9,18], and 1 in Midwest Brazil[8], although these studies have found a higher percentage within their samples (64.81%, 72.4% and 77.72%, respectively). Despite the samples from Northeast and Midwest Brazil showing the single-notch as the predominant shape, the northeast sample exhibits a greater variety of shapes according to the Thai classification used in this study. However, other studies (Table 5) had different results. For example, a South Korean and a Turkish study found a single-foramen predominance of supraorbital exits[14,15], both studies used CT images to analysis.

Regarding the morphometrical measures of the present study, it was observed that the SOF vertical diameter (D1) in males and females were respectively 2.02±0.52 mm and 1.83±0.56 mm, on the right side, and 1.88±0.83 mm and 1.80±0.48 mm, on the left side (Tables 6 and 7). Therefore, it is noted that this diameter is larger in males than females, although

**Table 4.** Mean(mm) or Median (mm) ± SD or IQR values of accessory supraorbital foramen measurements in both sexes.

| | MALE | | | | FEMALE | | | |
|---|---|---|---|---|---|---|---|---|
| | Right side | | Left side | | Right side | | Left side | |
| Para Meters | Min- Max | Mean/ Median | Min- Max | Mean/ Median | Min- Max | Mean/ Median | Min- Max | Mean/ Median |
| D4 | 1.21- 3.03 | 1.91 ±0.81 | 0.72- 3.40 | 1.79 ±1.01 | 0.60- 2.98 | 2.48 ±1.15 | 1.49- 2.63 | 1.86 ±0.70 |
| ASF-SON/ SOF | 0.02- 20.8 | 6.96 ±2.41 | 0.02- 16.1 | 6.53 ±7.52 | 0.21- 12.8 | 4.77 ±7.42 | 0.99- 8.84 | 3.44 ±3.66 |
| ASF-SM | 2.12- 10.5 | *4.18 ** ±2.47 | 1.43- 7.10 | 3.58 ±2.17 | 0.05- 5.66 | 2.53 ** ±1.20 | 1.79- 4.70 | 3.30 ±0.96 |

SOF: Supraorbital Foramen; SON: Supraorbital Notch; R: Right; L: Left; SM: Supraorbital Margin; Max/Min: Maximum and Minimum values; Lat: Lateral; Med: Medial. Mean and Max/Min are presented in millimeters. * Values described as mean ± SD. The other linear measurements were described as median ± IQR. ** p<0.05.

**Table 5.** Comparison of previous and present studies of different shape variations of Supraorbital Exits, N (%).

| Shape – SOF/SON | Present study (Brazil) | Ilayperuma *et al.*, 2014[9] (Sri Lanka) | Nanayakkara *et al.*, 2018[18] (Sri Lanka) | Ferrareto *et al.*, 2021[8] (Brazil) | Woo *et al.*, 2013[15] (South Korea) | Tezer *et al.*, 2017[14] (Turkey) |
|---|---|---|---|---|---|---|
| | **189** | **108** | **127** | **183** | **790** | **196** |
| Absence | 45 (23.8) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 85 (10.76) | 34 (17.35) |
| Single Foramen | 41 (21.6) | 38 (35.19) | 32 (27.6) | 39 (21.19) | 313 (39.62) | 118 (60.2) |
| Single Notch | 66 (34.9) | 70 (64.81) | 84 (72.4) | 143 (77.7) | 296 (37.47) | 25 (12.75) |
| Double Foramen | 12 (6.3) | 0 (0.0) | - * | 0 (0.0) | 36 (4.56) | 19 (9.7) |
| Double Notch | 1 (0.5) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 15 (1.9) | 0 (0.0) |
| Notch and Foramen | 24 (12.6) | 0 (0.0) | - * | 1 (0.54) | 45 (5.7) | 0 (0.0) |

Data is presented as N (%). N = total number of SOF/SON identified in the respective orbitofrontal region; (%) = percentage distribution in relation to the total orbitofrontal regions analyzed; SOF = Supraorbital Foramen; SON = Supraorbital Notch. * The number of skulls with Accessory Supraorbital Foramina was 11 (8.66) in total, but the study does not specify if there was Double Foramen or Notch with ASF.

no statistical difference was found in the results of the present study. These results are in agreement with the findings of a Bosnian analysis (1.98±0.76 mm in males and 1.83±0.73 mm in females)[11] (Table 7). However, a Sri Lankan research found slightly higher values of this diameter (2.17±1.10 mm in males and 2.04±0.97 mm in females)[9]. The lower values found in Bosnian and Brazilian populations compared to the Sri Lankan population could raise the possibility that there is, perhaps, a greater chance of compression of the supraorbital vessels and nerves, however, there is no epidemiological evidence, to the best of our knowledge, of these findings. Furthermore, this view is limited from an anatomical point of view, since smaller foramina will consequently have smaller neurovascular structures in proportion, which would not justify an increase in compression of these structures.

The mean horizontal diameter of SOF (D2) found in males and females was, respectively, 2.74±1.13 mm and 2.59±1.62 mm on the right side; and 3.25±1.15 mm and 2.90±0.89 on the left side. While the mean horizontal diameter of SON (D3) in male and female was respectively 4.42±3.64 mm and 5.43±2.22 mm on the right; and 4.67±1.67 mm and 5.21±3.21 mm on the left side. These results are consistent with an Egyptian morphometric analysis[7] (Table 7). However, other studies using image exams, from South Korea[12] and USA[13] has shown minor values of D2 and D3. These differences can be explained by previous studies which suggest that populations from warm regions, like Brazilians and Egyptians, have a lower chance of presenting supraorbital foramina, and generally will present a large notch[19]. In fact, these SOFs that are more present in the northern hemisphere could even result in a greater chance of nerve compression and some types of migraine in this population, given the smaller "space" of a completely closed foramen compared to a partially open and larger notch.

Another point analyzed in this study was the distance between supraorbital exits and the Nasal Midline (NM). The present study has observed higher values in males compared to females (Tables 6 and 7). Previous studies from USA[16], Thailand[17] and South Korea[12,15], presented similar values. Beyond that, a study conducted in the United States found that the distance to the supraorbital nerve exits from the midline influences the caliber of their major axons. This could be helpful for searching nerve axons during the corneal neurotization, providing better clinical outcomes than other nerves with minor caliber, such as supratrochlear nerves[20].

Other important landmark analyzed in the present study was the Temporal Crest of the Frontal Bone (TCFB). No differences between antimeres and sexes were found (p>0.05) and similar results were found in the literature[6,10,11] (Tables 6 and 7). Both distances from supraorbital exit to nasal midline and the temporal crest of frontal bone may help surgeons to locate this opening and avoid injuring the neurovascular bundles. The distance to the TCFB has a special surgical significance because it can be an important landmark for anticipating the location of SON/F during the routine coronal dissection when it is difficult intraoperatively to exactly identify the midline of the skull.

The analysis of morphological features of the supraorbital region also revealed a presence of 42 (22.7% of the total analyzed antimeres) accessory supraorbital foramina in the total sample, with a higher incidence among male skulls 57.1% of the orbits with ASF) compared to female skulls (42.8%). Also, ASF was found more exclusively on the right side (38%) compared to the left side (28.5%). A Bosnian study observed an incidence of ASF in 16.67% of the total sample, and also a higher incidence in male skulls[11]. However, previous studies whose samples presented accessory supraorbital foramina[18,21] have found a higher incidence on females. The existence of an accessory supraorbital foramen explains the cause of incomplete analgesia or anesthesia in some procedures in this region, as the branches passing through these exits may not be achieved during a regional nerve block of

**Table 6.** Comparison of previous and present studies measurements of Supraorbital Exits.

| | Present study (Brazil) | | | | Cutright *et al.*, 2003[16] (USA) | | | | Apinhasmit *et al.*, 2006[6] (Thailand) | | Woo *et al.*, 2013[15] (South Korea) | | | | Mishra *et al.*, 2014[10] (India) | | Ilayperuma *et al.*, 2014[9] (Sri Lanka) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | | F | | M | | F | | M | F | M | | F | | M | F | M | F |
| | R | L | R | L | W | B | W | B | | | R | L | R | L | | | | |
| D1 | *2.02 ±0.52 | 1.88 ±0.83 | 1.83 ±0.56 | 1.80 ±0.48 | - | - | - | - | - | - | - | - | - | - | - | - | 2.17 ±1.10 | 2.04 ±0.97 |
| D2 | *2.74 ±1.13 | 3.25 ±1.15 | 2.59 ±1.62 | 2.90 ±0.89 | - | - | - | - | - | - | 2.50 ±0.84 | 2.40 ±0.75 | 2.15 ±0.75 | 2.23 ±0.74 | 2.45 | 1.8 | 4.60 ±1.67 *** | 4.28 ±1.06 *** |
| D3 | 4.42 ±3.64 | *4.67 ±1.67 | 5.43 ±2.22 | 5.21 ±3.21 | - | - | - | - | - | - | 3.49 ±1.65 | 3.33 ±1.70 | 3.23 ±1.79 | 3.38 ±1.77 | 5.43 | 3.09 | - | - |
| SOF/SON-NM | *25.8 ** ±3.77 | 24.4 ** ±2.04 | *22.7 ** ±3.67 | 22.7 ** ±2.04 | 24.1 ±0.4 | 26.1 ±0.9 | 22.3 ±0.5 | 25.5 ±0.5 | 25.73 ±4.48 | 24.10 ±3.75 | F: 28.11 ±4.29 N: 24.29 ±2.45 | F: 27.32 ±4.15 N: 23.72 ±2.28 | F: 26.86 ±3.73 N: 22.88 ±2.53 | F: 26.13 ±3.56 N: 22.26 ±2.00 | 24.20 | 23.31 | 26.12 ±3.89 | 24.40 ±2.76 |
| SOF/ SON-TCFB | 24.8 ±2.98 | 24.4 ±3.22 | 24.6 ±5.21 | 23.6 ±3.81 | 27.1 ±0.4 | 26.8 ±0.5 | 26.9 ±0.5 | 24.6 ±0.5 | 27.16 ±4.04 | 25.54 ±3.48 | - | - | - | - | 23.46 | 22.09 | 31.56 ±4.47 | 29.52 ±3.48 |

SOF/N: Supraorbital Foramen/Notch; D1: Vertical Diameter of SOF; D2: Horizontal Diameter of SOF; D3: Horizontal Diameter of SON; R: Right; L: Left; W: White (ethnicity); B: Black (ethnicity); F: Foramen; N: Notch; NM: Nasal Midline; TCFB: Temporal Crest of the Frontal Bone; Mean values presented in millimeters (mm); * Values described as mean ± SD. The other linear measurements were described as median ± IQR; ** p<0.05; *** Mean values represented both SOF and SON.

**Table 7:** Comparison of previous and present studies measurements of Supraorbital Exits.

| | Present study (Brazil) | | | | El Sheikh *et al.*, 20147 (Egypt) | | | | Hong *et al.*,201412 (South Korea) | | Pourtaheri and Guyuron, 201813 (USA) | | Voljevica *et al.*, 202211 (Bosnia and Herzegovina) | | Pruksapong *et al.*, 202217 (Thailand) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | | F | | M | | F | | | | | | M | F | M | F |
| | R | L | R | L | R | L | R | L | R | L | R | L | | | | |
| D1 | *2.02 ±0.52 | 1.88 ±0.83 | 1.83 ±0.56 | 1.80 ±0.48 | - | - | - | - | - | - | - | - | 1.98 ±0.76 | 1.83 ±0.73 | - | - |
| D2 | *2.74 ±1.13 | 3.25 ±1.15 | 2.59 ±1.62 | 2.90 ±0.89 | 3.33 | 3.32 | 2.89 | 3.13 | 2.85 ±0.77 | 2.78 ±0.66 | 1.19 ±1.12 | 1.26 ±1.04 | 3.75 ±1.36 *** | 3.58 ±1.04 *** | 3.39 ±1.09 | |
| D3 | 4.42 ±3.64 | *4.67 ±1.67 | 5.43 ±2.22 | 5.21 ±3.21 | 7.55 | 7.84 | 6.51 | 6.84 | 3.60 ±1.28 | 3.57 ±1.96 | 2.15 ±1.79 | 2.24 ±2.07 | - | - | 3.97 ±0.99 | |
| SOF/ SON-NM | *25.8** ±3.77 | 24.4 ** ±2.04 | *22.7 ** ±3.67 | 22.7 ** ±2.04 | 20.94 | 21.72 | 20.04 | 20.00 | F: 26.8 ±4.08 N: 23.4 ±2.75 | F: 26.0 ±2.80 N: 22.9 ±3.16 | F: 2.66 ±0.55 N: 2.34 ±0.34 | F: 2.83 ±0.47 N: 2.18 ±0.26 | 24.87 ±3.63 | 22.46 ±3.07 | 22.34 ±3.05 | 23.58 ±2.42 |
| SOF/ SON-TCFB | 24.8 ±2.98 | 24.4 ±3.22 | 24.6 ±5.21 | 23.6 ±3.81 | - | - | - | - | - | - | - | - | 29.71 ±3.58 | 27.89 ±3.26 | - | - |

SOF/SON: Supraorbital Foramen/Notch; D1: Vertical Diameter of SOF; D2: Horizontal Diameter of SOF; D3: Horizontal Diameter of SON; R: Right; L: Left; F: Foramen; N: Notch; NM: Nasal Midline; TCFB: Temporal Crest of the Frontal Bone; Mean values presented in millimeters (mm); * Values described as mean ± SD. The other linear measurements were described as median ± IQR; ** p<0.05; *** Mean values represented both SOF and SON.

SOF/SON. The results of the present study and the literature shows clearly the need for caution, especially according to the patient's ethnic origin, since it could increase the risk of iatrogenic injury to the nerve fibers passing through ASF during surgeries, which may cause sensory deficits.

The data of the diameter and distance to anatomical landmarks of ASF are relatively scarce in the literature. However, the current study seems to reveal important measures, such as the mean distance from ASF to the main supraorbital exit. They were 6.96±2.41 mm and 4.77±7.42 mm (male and female, respectively) on the right side, and 6.53±7.52 mm and 3.44±3.66 mm, on the left side. Larger distances were reported from India[5], where they classify the distance according to the position of the accessory foramina around the main exit. The distances observed in this study were called medial (right: 8.62±1.23 mm; left: 9.11±1.78 mm), lateral (right: 8.75±0.74 mm; left: 7.07±0.53 mm) and superior (right: 3.3±0.41 mm; left: 3.08±0.22 mm). These findings suggest that the Northeast Brazilian population has the supraorbital nerve accessory branches closer to the SOF/SON than Indian population, consequently it could have a smaller chance of nerve or vessels injuries by an incision far away from the main foramen or notch.

Variations in supraorbital exits were analyzed in this study based on their osteological presentation. This analysis, logically, causes a limitation in the evaluation of all the anatomical components related to the supraorbital foramina, such as vessels, nerves, nerve distribution patterns, etc. Moreover, it was not possible to classify the skulls by age and ethnic group, which could influence the anatomical variations and explain better the morphological findings in this study. However, the results presented in this study can present an important non-invasive methodology to acquire anatomical data of supraorbital exits to perform safer surgical procedures, especially in Northeastern Brazil.

## Conclusion

The present study demonstrates a higher prevalence of single notches in the skulls analyzed and an extensive network of morphometric data peculiar to the studied population. Also, it was possible to identify that the ASF was most commonly found in male skulls and its specific location appears to be closer to the supraorbital foramen when compared to the current literature available. These results could help the understanding of the different variations of supraorbital exits, in Northeast Brazil, which can favor the performance of safe procedures in this region.

## Acknowledgements

"The authors sincerely thank those who donated their bodies to science so that anatomical research and teaching could be performed. Results from such research can potentially increase scientific knowledge and can improve patient care. Therefore, these donors and their families deserve our highest respect"[22].

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Received: November 5, 2024
Accepted: June 30, 2025

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