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ABSTRACT

Objective: A clear knowledge of the location of supraorbital foramen (SOF) is vital for the surgeons, particularly in endoscopic surgery and regional block in crania. The aim of this study was to analyze SOF and notch in skulls of various ancestries.

Methods: The anatomical variations of SOF and notch were examined in 100 adults skulls (55 males and 45 females) of the Malay, Chinese, and Indian ancestries by traditional measurement made with the Osirix software. The parameters included distance between supraorbital structure and nasal midline, shape, and transverse diameter of the SOF.

Results: It was manifested that bilateral supraorbital notch (SON) was the most prevalent combination in both sexes and ancestries (61%), while combined SON and foramen (11%) were the least prevalent characteristic. The mean distances of supraorbital structure from nasal midline bilaterally in males were slightly greater than females. The horizontal diameter of SOF, notch and their distances from the nasal midline showed no difference between ancestries.

Conclusion: This study would serve as a guide for the surgeons when surgery is performed on the scalp. It can help in the precise determination of reference points for supraorbital nerve foramen block for the Malaysians. In addition, the variations exhibited in supraorbital measurements inevitably revealed that sex and ancestry should be taken into consideration when choosing samples for anatomical classification of crania.

Keywords: Ancestry, Supraorbital foramen, Anatomy, Crania, Forensic.

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INTRODUCTION

The supraorbital foramen (SOF) presents as a notch bridged by fibrous tissue. It is a passage in the frontal bone at the junction of the medial and intermediate third of the supraorbital margin. It supplies sensation to a large region of the forehead and scalp [1]. The supraorbital margin possesses a SOF or notch in its inner third, which transmits the supraorbital vessels and nerve [2]. In 25% individuals, the notch is converted into a foramen by ossification of the periosteal ligament crossing it [3]. The supraorbital nerve is derived from the frontal nerve. It passes through the SOF or supraorbital notch (SON) to supply the upper eyelids and conjunctiva, after which it accompanies the supraorbital artery and ascends on the forehead region to divide into lateral and medial branches, which supplies the cutaneous part of the scalp up to lambdoid suture. Finally, the lateral branch passes through the epicranial aponeurosis, while the medial branch pierces the occipitofrontalis muscle [4].

The supraorbital nerve goes through the SOF to supply the skin over the forehead region and scalp [5]. Patients, who suffer from migraine, cluster headache, hyperhidrosis or secondary headache and were resistant to medications can be treated by supraorbital nerve blockade [6-8]. Supraorbital nerve blockade can be performed in various surgery such as facial surgery, surgical biopsy, supraorbital neuralgia, and cosmetic cutaneous surgery. Determination of the exact location of the supraorbital nerve is mandatory for precise and effective supraorbital nerve blockade [5,9]. It is mandatory for plastic endoscopic facial surgery to detect the most common nerve location [10,11]. The locations of supraorbital structures are distinct in different ancestries and sexes [12-15]. The male is characterized by large brows and supraorbital ridges (SOR) with more sloping forehead compared to female, who has small SOR. The localization of the supraorbital margin is important in facial reconstruction to create the reference lines for eyeball alignment in the center [16].

Exact estimation of the location of the SOF is highly essential in various surgeries such as transorbital eyebrow craniotomy, in which the SOF is considered as the reference point for many steps during surgery. Moreover, it is highly beneficial before any supraorbital nerve decompression is done, particularly when the decompression is performed under local anesthesia in the case of unrequired foraminotomy. Thus, this study will be useful in different ancestries so as to support the radiological investigation preoperatively. Moreover, anatomical determination of SOF may affect the decision in choosing the approach of the operation, which may be either through an endoscopic or transpalpebral approach. The latter approach is preferred in case of presence of the SOF [17].

Exact localization of SOF is helpful in optic nerve decompression through supraorbital keyhole extradural approach. This is attributed to minimum invasion produced by supraorbital keyhole extradural approach compared to transcranial approach. This method could be used in traumatic optic neuropathy, particularly in optic canal stenosis [18]. Supraorbital craniotomy is recommended and superior to standard pterional craniotomy. This is attributed to the supraorbital...
The aim of the present study was to analyze supraorbital structures morphometrically and to estimate their width and distances from nasal midline in adult Malaysian crania in postmortem computer tomography (CT) scan data collected from the National Institute of Forensic Medicine, Hospital Kuala Lumpur. The results were compared among ancestries to show the difference in the locations of supraorbital structures, which will have great implications in facial and cranial surgeries.

METHODS

This retrospective study was conducted on the postmortem CT scan cases retrieved from January 2012 to June 2016 from the National Institute of Forensic Medicine, Hospital Kuala Lumpur. The sample comprised 104 crania from 55 males and 45 females of the Malay, Chinese, and Indian ancestries. All cases were above 18 years old, which ranged from 18 to 75 years of age. Cases of fracture or previous craniofacial surgeries were excluded, in which four cases were found incomplete, and thus were removed from the study.

The SOF and SON were presented (Fig. 1). The distance between supraorbital structure and nasal midline was measured between nasion and the center of SON or SOF (Fig. 1). The transverse diameter of supraorbital structures, which represents the horizontal distances between the lower ends of their medial and lateral margins were also measured [20]. The crania were measured bilaterally by Osirix software 3D-volume rendering.

Statistical analysis

Descriptive statistics were conducted to display mean distances of supraorbital structures from nasal midline and horizontal diameter of supraorbital structures in males and females. The values were contrasted between the sexes by t-test (Table 3). Descriptive statistics were performed to show the mean distances of supraorbital structures from nasal midline between ancestries (Table 4).

RESULTS

Results revealed that there were combinations of SOF and SON, bilateral SON, and bilateral SOF. Bilateral SON was the most prevalent combination (61%) followed by bilateral SOF (15%). Combination of right SOF and left SON was found in 13% of cases, while the combination of right SON and left SOF was found in 13% of cases (Table 1).

By comparison between ancestries, bilateral SON was the most common profile, i.e. 23% Malay, 18% Chinese, and 20% Indian, and the combination of right SON and left SOF was the least common, i.e. 4% Malay, 4% Chinese, and 3% Indian (Table 2). Distances between SOF and SON from nasal midline showed that higher values were found in males than in females, i.e. 26.27 mm (right) and 26.17 mm (left) in males and 25.97 mm (right) and 25.08 mm (left) in females. However, there was no difference between distance of SOF or SON from the nasal midline neither indifferent sexes nor bilaterally (Table 3).

The parameters demonstrated comparable values across ancestries. In Malays, the distances of SOF or SON from nasal midline were 25.45 mm (right) and 25.73 mm (left), while in Chinese, the distances were 26.08 mm (right) and 25.82 mm (left), and in Indians, the distances were 26.89 mm (right) and 25.49 mm (left) (Table 4).

The mean horizontal diameters of SON were greater in males than females, i.e., 4.29 mm (right) and 4.15 mm (left) in males and 3.51 mm (right) and 3.76 mm (left) in females. Likewise, the mean horizontal diameters of SOF were greater in males than females, i.e., 3.51 mm (right) and 3.19 mm (left) in males and 3.46 mm (right) and 2.95 mm (left) in females (Table 5).

DISCUSSION

The importance of SOF or SON as an exit route for supraorbital nerve has great implications as it leads to critical issues to the surgeons, who have to manipulate this area, and need to exactly determine the location of these anatomical features to avoid nerve injury [5, 21, 22]. The current study aimed to study the variation of SOF and SON in Malaysian skulls. Results presented the presence of four combinations of bilateral SON as the most prevalent combination (61%), followed by bilateral SOF (15%) and the combination of both SOF and SON as the least observed manifestation (11%) (Table 1). These results were comparable with the study by Tomaszewska et al. who showed that bilateral SON to be the highest combination manifested in skulls coming from warm and temperate climate areas [23].

In addition, it was exhibited that bilateral SON was the most common trait in the Malaysians, i.e. 23% Malay, 18% Chinese, and 20% Indian, while the combination of right SON and left SOF was the least common, i.e., 4% Malay, 4% Chinese, and 3% Indian (Table 2). In the Egyptians, bilateral SON was the most common attribute displayed (30.51%), while bilateral SOF (18.64%) was the least [20]. In the Koreans, the unilateral notch was the most common feature, which accounted for 42.3% and

Table 1: Anatomical variations of supraorbital structures between males and females

| Variations in the same crania | Number of crania | Total (%) |
|------------------------------|-----------------|-----------|
| Rt | Lt | Males (55) | Females (45) | |
| SON | SON | 32 | 29 | 61 (61) |
| SOF | SOF | 8 | 7 | 15 (15) |
| SON | SOF | 7 | 6 | 13 (13) |
| SOF | SON | 8 | 3 | 11 (11) |

SON: Supraorbital notch; SOF: Supraorbital foramen

Table 2: Anatomical variations of supraorbital structures in Malay, Chinese, and Indian ancestries

| Variations in the same crania | Number of crania | Total (%) |
|------------------------------|-----------------|-----------|
| Rt | Lt | Malay (34) | Chinese (33) | Indian (33) |
| SON | SON | 23 | 18 | 20 | 61 (61) |
| SOF | SOF | 3 | 6 | 6 | 15 (15) |
| SON | SOF | 4 | 5 | 4 | 13 (13) |
| SOF | SON | 4 | 4 | 3 | 11 (11) |

SON: Supraorbital notch; SOF: Supraorbital foramen
3.19

| n         | Mean distance from the nasal midline (mm)±SD | Range | Mean distance of horizontal diameter±SD |
|-----------|---------------------------------------------|-------|----------------------------------------|
| Males     | 26.27±0.45                                  | 18.9–32.8 | 4.3±0.17                              |
| Females   | 25.97±0.65                                  | 19.3–46  | 3.99±0.19                              |
| p value   | 0.61                                        | 0.38                             |

SON: Supraorbital notch, SOF: Supraorbital foramen, SOR: Supraorbital ridges, SD: Standard deviation

### Table 4: The distance of SON and SOF from nasal midline in Malay, Chinese, and Indian ancestries

| Ancestry | Malay | Chinese | Indian |
|----------|-------|---------|--------|
|          | Rt    | Lt      | Rt     | Lt     |
| n        | 34    | 34      | 33     | 33     |
| Mean distance (mm) | 25.45  | 25.73   | 26.08  | 25.82  |
| Range (mm) | 20.8–31.4 | 18.8–33.6 | 18.9–32.8 | 18.3–32.2 |

SON: Supraorbital notch, SOF: Supraorbital foramen

### Table 5: The horizontal diameter of supraorbital structures bilaterally in males and females

| Mean distance for right and left sides | Horizontal diameter of SON | Horizontal diameter of SOF |
|---------------------------------------|-----------------------------|---------------------------|
|                                       | Rt | Lt | Rt | Lt |
|                                       | M  | F  | M  | F  | M  | F  | M  | F  |
| n                                    | 40 | 32 | 39 | 35 | 15 | 13 | 16 | 10 |
| Mean distance of horizontal diameter (mm) | 4.29 | 3.51 | 4.15 | 3.76 | 3.51 | 3.46 | 3.19 | 2.95 |
| Range (mm)                           | 2.3–7 | 1.8–7.4 | 2.15–7.5 | 2.6–5 | 1.95–4.19 | 1.82–4.8 | 1.74–4.22 | 2.18–3.65 |

M: Male, F: Female, SON: Supraorbital notch, SOF: Supraorbital foramen

39.5% on the left and right sides, respectively [24]. In the Turkish population, unilateral SON was the most common presentation [25]. The proportion of bilateral SON demonstrated in this study was consistent with another study in the Chinese population, in which bilateral SON was observed in 40.2% of cases, bilateral SOF in 24.8%, and the combination of SON and SOF was exhibited in 24.8% of cases [26]. Similar results were documented in the Gujarati Indians, in which bilateral SON was evidenced in 35.62% of cases, bilateral SOF in 21.45%, and the combination of SON and SOF was presented in 8.36% of cases [27]. In the Thai population, the skulls manifested bilateral SON in 50% of cases, bilateral SOF in 17%, and the combination of SON and SOF was viewed in 33% of cases [28]. Korean skulls manifested bilateral SON in 69.9% of cases and bilateral SOF in 28.9% of cases [29].

The lowest frequency of SON was displayed in the Egyptian, Nigeria, Palestine, India, and Burma populations [23]. These findings proved the distinctions in the location of four different combinations of SOF or SON across populations. The supraorbital nerve and vessels appear to be fixed in their positions in SON rather than in SOF. Studies have proven that the supraorbital neurovascular bundle is easily stretched during surgery of scalp in SOF. Thus, proper precaution should be taken, particularly during the reflection of scalp surgery in view of the high prevalence of SOF [26].

In the current study, the distance from SON to nasal midline was slightly greater in males than females, i.e. 26.27 mm (right) and 26.17 mm (left) in males and 25.97 mm (right) and 25.08 mm (left) in females. There was also no difference in the distances from SON to nasal midline between sides (Table 3). This result was in accordance with the studies performed in the Indians, Brazilians, and Egyptians. The distance between SOF or SON and nasal midline on both sides ranged between 20 mm and 29 mm. There was no difference in measurements of the parameters bilaterally between ancestries or sexes in Malaysia (Tables 3,4), and similar results were exhibited in the Egyptian, Indian, and Brazil populations [1,20,30].

The mean horizontal diameters of SON in Malaysian males were 4.29 mm (right) and 4.15 mm (left) and 3.51 mm (right) and 3.76 mm (left) in females (Table 5). In the Egyptians, the mean horizontal diameters of SON were 7.55 mm (right) and 7.84 mm (left) in male and 6.51 mm (right) and 6.84 mm (left) in female. Thus, the horizontal diameter of SON or SOF appeared to be broader in the Egyptians than Malaysians [20]. The mean horizontal diameter of SOF was greater in male than female and exhibited greater values on the right side than the left side in both sexes (Table 5).

In the Indian population, 111 skulls were evaluated for morphology, distance, and diameter of SOF, and results showed that the mean distance from nasal midline was 32.02 mm, the horizontal diameter of SON was 5.70 mm, and SOF diameter was 3.78 mm [31]. Unlike the present study, the size of SON or SOF was smaller, and the distance from nasal midline was also smaller in all ancestries. de Oliveira et al. reviewed the anatomical morphometric variation of infraorbital foramen in relation with sex and side of crania in the Northeastern Brazilians. The study revealed that the distance from intra-orbital foramen to the anterior nasal spine was greater in males than females on different sides (p<0.01) [32].

CONCLUSION

To the best of our knowledge, this is the first study focusing on the anatomy of supraorbital and frontal exits of the supraorbital nerve in...
the Malaysian population. The present study has achieved its aims in determining the anatomical positions and measurements of SOF or SON on different sides in males and females so that it could be used by the surgeons to perform surgery involving the scalp. It can aid in the precise determination of the reference points for supraorbital nerve blockade in the Malaysian population. The variations in supraorbital measurements manifested that sex and ancestry should be taken into consideration when choosing specimen for anatomical classification of the crania.

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AUTHOR’S CONTRIBUTIONS

Dr. Abdelnasser Ibrahim, Dr. Faridah Mohd Nor, Dr. Swarhib Mohamed, Dr. Srijit Das, Dr. Sohaya M. Attalla, Siti Noorain Abu Bakar, and Dr. Aspalillah Alias had contributed to the concept and design of the study, acquisition, analysis, interpretation of data, drafting the article, or revising it critically for important intellectual content and final approval of the version to be published.

CONFLICTS OF INTEREST

The authors have none to declare.

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