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Research Article

OSTEOMETRIC ANALYSIS OF SUPRAORBITAL FORAMEN AND NOTCH IN MALAYSIAN CRANIA

ABDELNASSER IBRAHIM[1,2], SOHAYLA M ATTALLA[3,4], ASPALILAH ALIAS[1,5], MOHAMED SWARHIB[1], SITI NOORAIN ABU BAKAR[1], SRIJIT DAS[6], FARIDAH MOHD NOR[1*]

[1]Department of Pathology, Universiti Kebangsaan Malaysia Medical Centre, Jalan Yaacob Latif, Bandar Tun Razak, 56000, Kuala Lumpur, Malaysia. [2]Department of Forensic Medicine and Clinical Toxicology, Faculty of Medicine, Al-Azhar University, Almokhayam Aldaem Street, Cairo, Egypt.[3]Department of Forensic Medicine and Clinical Toxicology, Faculty of Medicine, 60 Elgomhoria Street, Mansoura University, 35516, Mansoura, Egypt. [4]Forensic Medicine Unit, International Medical School, Management and Science University, Seksyen 13, 40100 Shah Alam, Selangor, Malaysia. [5]Department of Basic Sciences and Oral Biology, Faculty of Dentistry, Universiti Sains Islam Malaysia, Tingkat 15, Menara B, Persiaran MPAJ, Jalan Pandan Utama, Pandan Indah, 55100 Kuala Lumpur, Malaysia. [6]Department of Anatomy, Universiti Kebangsaan Malaysia Medical Centre, Jalan Yaakob Latif, Bandar Tun Razak, 56000 Kuala Lumpur, Malaysia. Email: mnfaridah@gmail.com

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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 blockade 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 thirds 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 later 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 craniotomy approach that has no significant swelling on the cerebral hemisphere and no intracranial hematoma, and thus, no shift of the midline structures [19].

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

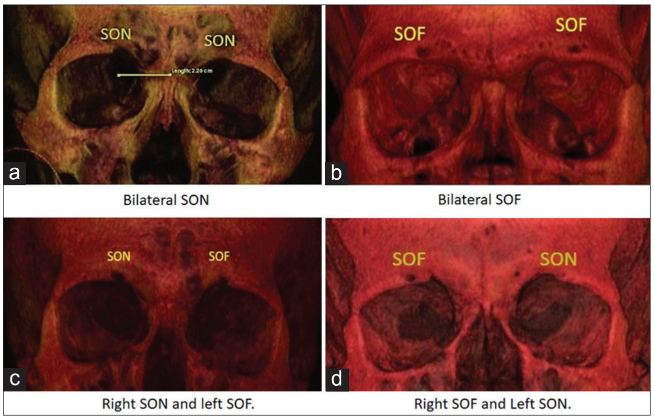

Fig. 1: (a-d) The anatomical variations of supraorbital foramen and notch

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)
SOF	SON	7	6	13 (13)
SON	SOF	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)
SOF	SON	4	5	4	13 (13)
SON	SOF	4	4	3	11 (11)

SON: Supraorbital notch, SOF: Supraorbital foramen

Table 3: The sex difference in the distance of SON/SOF and SOR from nasal midline and mean distance of the horizontal diameter of SON/SOF

Mean distance for sex	SON and SOF					
	Rt			Lt		
	Males	Females	p value	Males	Females	p value
n	55	45		55	45	
Mean distance from the nasal midline (mm)±SD	26.27±0.45	25.97±0.65	0.61	26.17±0.52	25.08±0.48	0.25
Range	18.9–32.8	19.3–46		16.6–36.3	18.3–35.6	
Mean distance of horizontal diameter±SD	4.3±0.17	3.99±0.19	0.38	4.14±0.2	4.16±0.21	0.37

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

Mean distance for ancestry	Malay		Chinese		Indian	
	Rt	Lt	Rt	Lt	Rt	Lt
n	34	34	33	33	33	33
Mean distance (mm)	25.45	25.73	26.08	25.82	26.89	25.49
Range (mm)	20.8–31.4	18.8–33.6	18.9–32.8	18.3–32.2	19.3–46	19.2–32.8

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 SOF rather than in SON. 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 SOF or 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 SOF or 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. Sohayla 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.

REFERENCES

1. Chrcanovic BR, Abreu MH, Custódio AL. A morphometric analysis of supraorbital and infraorbital foramina relative to surgical landmarks. Surg Radiol Anat 2011;33:329-35.
2. Abrahams P H, Craven JL, Lumley JS. Illustrated Clinical Anatomy. Boca Raton, FL: CRC Press; 2011.
3. Singh S, Bilodi AK, Suman P. Morphometric analysis on supra-orbital notches and foramina in south indian skull. Int J Cur Res Rev 2013;5:43-50.
4. Gray H, Standring S. Gray's Anatomy: The Anatomical Basis of Clinical Practice. 41th ed. Boca Raton, FL: Elseiver; 2016.
5. Gupta T. Localization of important facial foramina encountered in maxillo-facial surgery. Clin Anat 2008;21:633-40.
6. Dach F, Éckeli ÁL, Ferreira Kdos S, Speciali JG. Nerve block for the treatment of headaches and cranial neuralgias - A practical approach. Headache 2015;55 Suppl 1:59-71.
7. Alodeani EA. Botulinum toxin type A: An effective, safe and minimally invasive treatment option of axillary and palmar hyperhidrosis. Int J Pharm Pharm Sci 2016;8:237-40.
8. Jena S, Jena M, Patro N, Mishra S, Panda M,Dash M. Patterns of prescription and ADR monitoring of drugs in the management of neuropathic pain in a tertiary care teaching hospital. Int J Pharm Pharm Sci 2014;6:246-51.
9. Evans RW, Pareja JA. Supraorbital neuralgia. Headache: J Head Face Pain 2009;492:278-81.
10. Saylam C, Ozer MA, Ozek C, Gurler T. Anatomical variations of the frontal and supraorbital transcranial passages. J Craniofac Surg 2003;14:10-2.
11. Cutright B, Quillopa N, Schubert W. An anthropometric analysis of the key foramina for maxillofacial surgery. J Oral Maxillofac Surg 2003;61:354-357.
12. Beer GM, Putz R, Mager K, Schumacher M, Keil W. Variations of the frontal exit of the supraorbital nerve: An anatomic study. Plast Reconstr Surg 1998;102:334-41.
13. Hanihara T, Ishida H. Frequency variations of discrete cranial traits in major human populations. IV. Vessel and nerve related variations. J Anat 2001;199:273-87.
14. Malet T, Braun M, Fyad JP, George JL. Anatomic study of the distal supraorbital nerve. Surg Radiol Anat 1997;19:377-84.
15. Kimura K. Foramina and notches on the supraorbital margin in some racial groups. Kaibogaku Zasshi 1977;52:203-9.
16. Michael JT, Viner MD, Brogdon BG, editors. Brogdon's Forensic Radiology. Boca Raton: CRC Press; 2010. p. 116.
17. Garg RK, Lee KS, Kohn SC, Baskaya MK, Afifi AM. Can sonography distinguish a supraorbital notch from a foramen? J Ultrasound Med 2015;34:2089-91.
18. Wang X, Wu W, Zhang H, Lan Q. Endoscopic optic nerve decompression through supraorbital keyhole extradural approach: A Cadaveric study. Turk Neurosurg 2017;27:212-6.
19. Hui W, Wang H, Luo L, Ye Z, Li W, Chen C, *et al*. Clipping of anterior communicating artery aneurysms in the early post-rupture stage via transorbital keyhole approach-Chinese neurosurgical experience. Br J Neurosurg 2015;29:644-9.
20. El-Sheikh E, Nasr WF, Ibrahim AA. Anatomical variations of supraorbital notch and foramen: A study on human adult Egyptian skulls. Eur J Plast Surg 2014;37:135-40.
21. Rosenberg GJ. The subperiosteal endoscopic laser forehead (SELF) lift. Plast Reconstr Surg 1998;102:493-501.
22. Erdogmus S, Govsa F. Anatomy of the supraorbital region and the evaluation of it for the reconstruction of facial defects. J Craniofac Surg 2007;18:104-12.
23. Tomaszewska A, Tomczyk J, Kwiatkowska B. Characterisation of the supraorbital foramen and notch as an exit route for the supraorbital nerve in populations from different climatic conditions. Homo 2013;64:58-70.
24. Woo SW, Lee HJ, Nahm FS, Lee PB, Choi EJ. Anatomic characteristics of supraorbital foramina in korean using three-dimensional model. Korean J Pain 2013;26:130-4.
25. Turhan-Haktanır N, Aycicek A, Haktanır A, Demir Y. Variations of supraorbital foramina in living subjects evaluated with multidetector computed tomography. Head Neck 2008;30:1211-5.
26. Cheng AC, Yuen HK, Lucas PW, Lam DS, So KF. Characterization and localization of the supraorbital and frontal axis of the supraorbital nerve in Chinese: Anatomic study. Ophth Plast Reconstr Surg 2006;22:209-13.
27. Trivedi DJ, Shrimanker PS, Kariya VB, Pensi CA. A study of supraorbital notches and foramina in Gujarati human skulls. Nat J Integ Res Med 2010;1:1-6.
28. Apinhasmit W, Chompoopong S, Methathrathip D, Sansuk R, Phetphunphipat W. Supraorbital notch/foramen, infraorbital foramen and mental foramen in Thais: Anthropometric measurements and surgical relevance. J Med Assoc Thai 2006;89:675-82.
29. Chung MS, Kim HJ, Kang HS, Chung IH. Locational relationship of the supraorbital notch or foramen and infraorbital and mental foramina in Koreans. Acta Anat (Basel) 1995;154:162-6.
30. Cugati NS, Kumar S. Localization and morphometric evaluation of supraorbital and infraorbital foramen in Dravidian Population of Southern India: A paleoantropological study on dry skulls. IOSR J Dent Med Sci 2013;5:18-23.
31. Webster RC, Gaunt JM, Hamdan US, Fuleihan NS, Giandello PR, Smith RC, *et al*. Supraorbital and supratrochlear notches and foramina: Anatomical variations and surgical relevance. Laryngoscope 1986;96:311-5.
32. Cisneiros de Oliveira LC, Silveira MP, de Almeida Júnior E, Reis FP, Aragão JA. Morphometric study on the infraorbital foramen in relation to sex and side of the cranium in Northeastern Brazil. Anat Cell Biol 2016;49:73-7.