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A study of the supraorbital notch and foramen in North Indian human crania

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SUMMARY

Anatomy of the supraorbital region is important to avoid injury to the supraorbital neurovascular bundle in carrying out craniofacial surgery and in supraorbital nerve block. The present study aimed to examine in detail adult human crania from the north Indian region to ascertain the prevalence of supraorbital notch and foramen and their localization, and to compare these findings with globally available data. Seventy-one dry adult human crania from the north Indian region were examined for the presence of supraorbital notch or foramen, and their unilateral and bilateral prevalence was calculated. Distance of supraorbital notch or foramen was measured from the nasal midline and frontozygomatic suture. Data were compiled, tabulated and statistically analyzed.

The prevalence of the supraorbital foramen was 19.01%, out of which it was bilateral in 11.27% cases, while prevalence of the supraorbital notch was 80.99%, out of which it was bilateral in 73.24% cases. 7.75% cases had notch on one side and foramen on the other side. Mean perpendicular distance of the supraorbital notch or foramen from the nasal midline was 24.64 ± 3.35 mm on right side and 24.88 ± 2.63 mm on left side, while the mean distance of the supraorbital notch or foramen from the frontozygomatic suture was 30.94 ± 2.63 mm on right side and 30.76 ± 2.70 mm on left side, showing no significant difference between right and left sides. We noticed that there are differences in prevalence and position of the supraorbital notch or foramen in different global regions. The results of the present study will serve as a guide to surgeons carrying out craniofacial surgery and will also provide ethnic data for anthropologists and forensic experts about the supraorbital notch and foramina.

Key words: Supraorbital notch – Supraorbital foramen – Supraorbital nerve

INTRODUCTION

Knowledge of the anatomy of the supraorbital region is important for forehead and brow lift surgery to avoid the injuries of the neurovascular bundles passing through supraorbital notches and foramina. Damaged supraorbital neurovascular bundle is an important complication reported with varying frequency during anterior orbital approach, fronto-glabellar reconstruction flap, blepharospasm, and Graves disease surgery, and in supraorbital nerve block for procedures like closure of facial wounds, treatment of migraine and chronic paroxysmal hemicranias.

The supraorbital margin is formed entirely by the squamous part of the frontal bone, which is interrupted at the junction of its sharp lateral 2/3rd and rounded medial 1/3rd by the supraorbital fora-

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men/notch (Standring et al., 2008). In 25% individuals, the notch is converted into foramen by ossification of the periosteal ligament crossing it (Hollenshed, 1966), and has been referred as supra orbital ligament in literature (Duke, 1961). It has also been hypothesised that the occurrence of the supraorbital notches is greater in populations from warm regions compared with cold regions, as this would provide a broader exit route for the neurovascular bundle, and this may be related to the thermoregulatory processes in the supraorbital region (Tomaszewska et al., 2013). In the roof of the notch or foramen, there is a small aperture that transmits diploic vein that joins with the supraorbital vein. The supraorbital foramen/notch transmits the supraorbital artery, veins and nerve. These vessels and nerve supply the skin of the forehead, scalp, upper eyelid and nose. Clinically, nerve bundles emerging from these foramina could probably be injured during surgical procedures, resulting in paresthesia or anesthesia. Excessive dissection and retraction close to such neurovascular bundles can cause scarring, which may lead to entrapment neuropathies and painful neuralgias. In case of absence of supraorbital foramina or notches, supraorbital vessels and nerves are more prone for injury due to sharp supraorbital margin. This morphological study of the supraorbital foramen will therefore entail a careful examination of adult human skulls in order to ascertain the prevalence of notches and foramina and their localization in north Indian crania for proper analysis.

MATERIALS AND METHODS

Seventy-one adult north Indian dry human crania of unknown age and gender were analysed in the Department of Anatomy of Moti Lal Nehru Medical College, Allahabad, India in collaboration with Rohilkhand Medical College & Hospitals, Bareilly, India and Institute of Dental Sciences, Bareilly, India. All samples were adult crania without any apparent abnormalities like cranial deformation (saggital or coronal synostosis), lytic lesion, exostosis or skull fractures. The principal criteria used to determine adult status were complete fusion of the sphenooccipital synchondrosis and fully erupted third molars, if available.

The supraorbital margin of each skull was carefully observed on each side for the presence of supraorbital notch or foramen, and their unilateral or bilateral prevalence was calculated (Fig. 1).

Other parameters studied were perpendicular distance between the supraorbital notch/foramen to the nasal midline and distance between the supraorbital notch/foramen to the frontozygomatic suture (Fig. 2). The midline of the forehead was established by dropping a suture from the vertex of the skull through the nasion to the anterior nasal spine and inter-maxillary suture line. The measurements were done with vernier callipers accurate to 0.02 mm for linear measurement on both sides. Observations thus made were compiled and tabulated. All the measurements were expressed in Mean ± SD in mm. (SD=standard deviation). Paired 't' test was used to analyze the difference between the data from right and left sides. Unpaired 't' test was performed to compare with other population data. Care was exercised to differentiate the supraorbital foramen from the frontal foramen/notch, which is often present medial to the supraorbital foramen/ notch (Berry and Berry, 1967; Standring et al., 2008).

RESULTS

Supraorbital exits were present in all 142 orbits in the form of notch or foramen. None of the crania showed multiple supraorbital foramina or notches on either side.

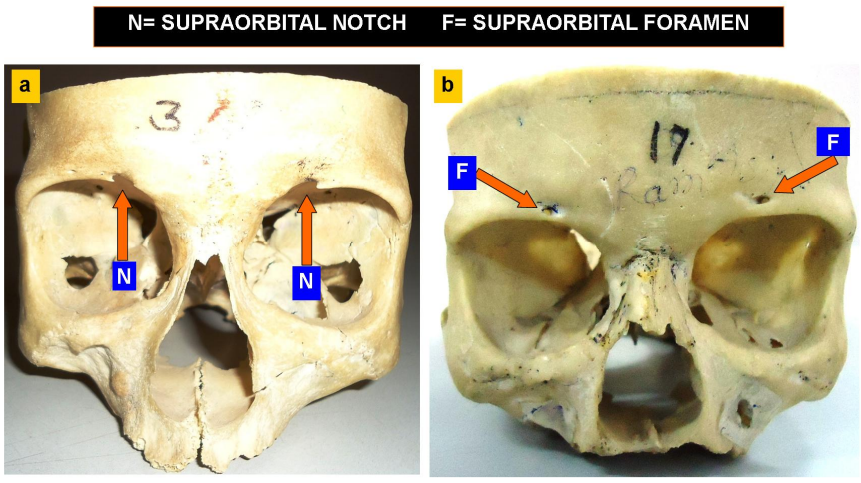

Fig.1. Human crania showing the supraorbital notch **(a)** and supraorbital foramen **(b)**

Out of 71 human crania (142 orbits), the supraorbital foramen was present only in 27 orbits (8 bilateral, 3 on left side and 8 on right side). Thus over all prevalence of the supraorbital foramen is 19.01%, while bilateral prevalence of the supraorbital foramen is only 11.27%, however unilaterally the supraorbital foramen is present in 7.75% (5.63% on right side and 2.11 % on left side) (Table 1).

The supraorbital notch was present in 115 orbits (52 bilateral, 8 on left side and 3 on

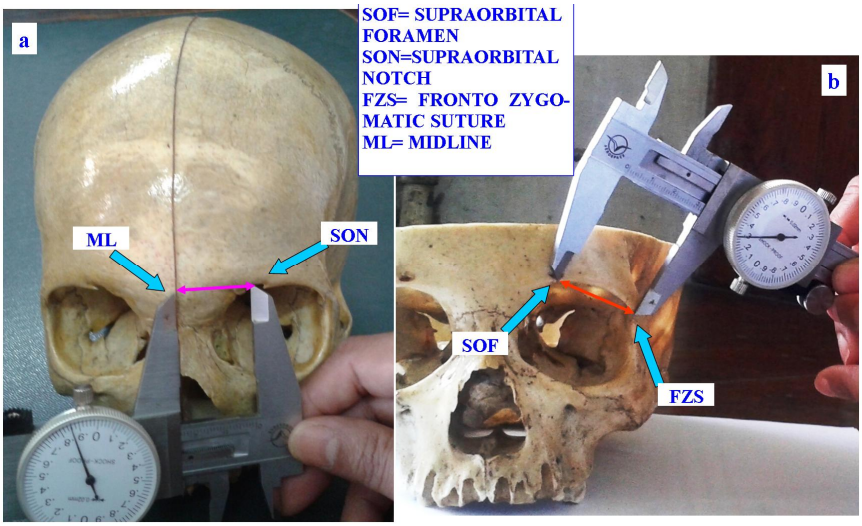

Fig. 2. Measuring of perpendicular distance of the supraorbital notch or foramen from the nasal midline- *pink line* **(a)** and distance of the supraorbital notch or foramen from the frontozygomatic suture – *red line* **(b)**

right side). Thus over all prevalence of the supraorbital notch is 80.99%, while bilateral prevalence of the supraorbital notch is 73.24%, however unilaterally the supraorbital notch is present in 7.75% (2.11% on the right side and 5.63% on the left side) (Table 1).

Mean perpendicular distance of supraorbital notch or foramen from nasal midline was 24.64 ± 3.35 mm. on the right side ranging from 20.12 mm. to 32.93 mm, and 24.88 ± 2.63 mm. on the left side ranging from 20.39 mm. to 35.79 mm, while mean distance of the supraorbital notch or foramen from frontozygomatic suture was 30.94 ± 2.63 mm. on the right side ranging from 26.58 mm. to 37.02 mm and 30.76 ± 2.70 mm. on the left side ranging from 24.19 mm. to 35.11 mm, showing no significant difference between right and left side (Table 2).

DISCUSSION

The supraorbital foramen and the supraorbital notch are considered “epigenetic” characters, since they may be seen as products of genetically determined growth processes of other tissues (e.g. nerves, vessels and muscles) affecting bone information. They have been called ‘quasi-continuous variations' by some researchers (Grunenberg, 1952), 'nonmetrical variants' by others (Berry and Berry, 1967) and 'discontinuous traits' or 'discrete traits' by others (Hauser and De Stefano, 1989).

Previously Berry and Berry (1967), Dodo (1980, 1987), Hauser and De Stefano (1989) and Hanihara (2001) did large-scale analyses of discrete cranial traits to assess interpopulation relationships. According to Dodo (1974) and Hauser & De Stefano (1989), most of the discrete traits in human cranium can be classified into 3 categories: vessel and nerve related variation; hyperostotic variation; and hypostotic variation. The present study is focused on the presentation of the supraorbital foramen, which are often included in the category of vessel and nerve related variations.

In the present study of 71 north Indian adult human crania, it was noticed that the supraorbital notch (80.99%) was found more frequently than

Table 1. Prevalence of the measured parameters

Parameter			Number of skulls
Supraorbital foramen	bilateral		8
	unilateral	Right sided	8
		Left sided	3
Supraorbital notch	bilateral		52
	unilateral	Right sided	3
		Left sided	8

Table 2. Distance of the supraorbital notch/foramen from the midline and from the frontozygomatic suture.

Parameter	Mean distance (right + left side) (mean ±SD in mm.)	Right side (mean ±SD in mm.)	Left side (mean ±SD in mm.)	Paired *t* test
Perpendicular distance of supraorbital foramen/notch from midline	24.76 ±3.50	24.64 ± 3.35	24.88 ±2.63	t=0.40 p>0.05^{NS}
Distance of supraorbital foramen/ notch from frontozygomatic suture	30.85 ±2.63	30.94 ±2.63	30.76 ±2.70	t=0.40 p>0.05^{NS}

NS= not significant. SD= standard deviation

the supraorbital foramen (19.01%) similar to most of the previous studies. As compared to the frequency of supraorbital foramen in north Indian population in the present study, the frequency of the supraorbital foramen is far higher in Chinese (Cheng et al., 2006), Thai (Apinhasmit et al., 2006), North American and South American population (Berry and Berry, 1967) but lower than the frequency of the supraorbital foramen in Burmese, Egyptian, Punjabi (India) and Nigerian population (Berry and Berry, 1967).

The frequency of the supraorbital foramen in the north Indian population in the present study is significantly lower than the findings of Dodo (1987), who found the frequency of supraorbital foramen to be 39.4%, 44.6% and 46.8% in northwest, south and east India respectively. Similarly, the findings of the present study are not consistent with the findings of Hanihara (2001), who found the frequency to be 39.5%, 42% and 44% in northwest, south and east India respectively.

The prevalence of bilateral supraorbital notch was higher than the prevalence of bilateral supraorbital foramen in the present, in accordance with the study of Webster et al. (1986) (Table 3).

In the present study, the mean distance of the supraorbital foramen/ notch from midline is higher on the left side than the right side. However, the difference between the sides was not found to be significant on comparing with paired ‘t’ test.

The mean distance of the supraorbital foramen/ notch from the midline in the present study showed no significant differences from the study of Apinhasmit et al. (2006) (25.14+/-4.29 mm), but it showed significant differences (p<0.05) from the study of Turhan et al (2008) (24.9+/-4.5 mm) on comparison by unpaired ‘t’ test.

The location of the supraorbital nerve exit is highly variable in all studied populations, and all surgical approaches to that area, especially the endoscopic ones, have to be done under vision and with the necessary care of the nerves. Effective and precise analgesia can be achieved only if one is aware of the most frequent type (notch or foramen), and the location of the exit of the nerve in this region. It may be suggested that preoperative imaging of the supraorbital nerve exit may be a good tool to avoid possible complications in endoscopic forehead surgery, especially when the palpation is inadequate. Palpating the supraorbital notch alone is not sufficient in locating the supraorbital neurovascular bundles in all cases. One should be aware that neurovascular bundles might exit through the supraorbital foramen well above the supraorbital rim, and that a combination of notches and foramina is possible in the same skull. The measurements of the supraorbital exit in relation to the midline and the frontozygomatic suture in the present study may help surgeons to locate this opening and avoid injuring the neurovascular bundles. The data concerning the distance from the frontozygomatic suture may be a better landmark and helpful for the surgeon

Table 3. Comparison of prevalence of the supraorbital foramen reported in previous studies

Population	South America*	North America*	Burma*	India (punjab)*	Nigeria*	Egypt*	Present study (North India)
Number of crania	53	50	51	53	56	250	71
Prevalence of supraorbital foramen	30.2%	53%	13.7%	12.3%	11.7%	11.2%	19.01%

*Berry and Berry (1967)

Table 4. Comparison of prevalence of the supraorbital foramen or notch reported in previous studies

Parameter	Webster et al. (1986)	Cheng et al. (2006)	Cutright et al. (2003)	Apinhasmit et al. (2006)	Present study
Population	N.A.*	Chinese	N.A.*	Thai	North India
supraorbital foramen	38.43%	45.9%	7.5%	33.5%	19.01%
bilateral supraorbital foramina	25.93%			17%	11.27%
unilateral supraorbital foramen	12.5%			16.5%	7.75%
supraorbital notch	61.57%	54.1%	92.5%	66.5%	80.99%
bilateral supraorbital notch	49.07%			50%	73.24%
unilateral supraorbital notch	12.5%			16.5%	7.75%

N.A.*-details not available in their study.

in anticipating the location of supraorbital foramina/notch, as it is difficult intraoperatively to exactly identify the midline of the skull.

As a conclusion, knowledge of variations of supraorbital foramina/notch during plastic and maxillofacial surgery provides accurate approach, lessens morbidity, facilitates the surgeon's intervention, and helps to get more satisfying results. An understanding of the exit of the nerve from supraorbital notch or foramen, and the exact position of the supraorbital notch or foramen, are of high importance with the rising popularity of endoscopic procedures with limited visibility. Hence, the current study provides valuable information regarding the supraorbital notch or the foramen from North Indian region, and compares the same with the data of different global regions. These data are of direct relevance to clinical practice and teaching, and would also contribute to epigenetic study of minor variations of the skull, as well as anthropological study.

REFERENCES

APINHASMIT W, CHOMPOOPONG S, METHATHRATHIP D, SANSUK R, PHETPHUNPHIPHAT W (2006) Supraorbital notch/foramen, infraorbital foramen and mental foramen in Thais: anthropometric measurements and surgical relevance. *J Med Assoc Thai,* 89: 675-682.

BERRY AC, BERRY RJ (1967) Epigenetic variation in the human cranium. *J Anat,* 101: 361-380.

CHENG AC, YUEN HK, LUCAS PW, LAM DS, SO KF (2006) Characterization and localization of the supraorbital and frontal exits of the supraorbital nerve in Chinese: an anatomic study. *Ophthal Plast Reconstr Surg,* 22: 209-213.

CUTRIGHT B, QUILLOPA N, SCHUBERT W (2003) An anthropometric analysis of the key foramina for maxillofacial surgery. *J Oral Maxillofac Surg,* 61: 354-357.

DODO Y (1987) Supraorbital foramen and hypoglossal canal bridging: the two most suggestive nonmetric cranial traits in discriminating major racial groupings of man. *J Anthropol Soc Nippon*, 95: 19-35.

DUKE ELDER SS (1961) System of Ophthalmology. Volume II. Henry Kimpton, London.

GRUNENBERG H (1952) Genetical studies on the skeleton of the mouse IV. Quasi-continuous variation. *J Genetics*, 51: 95-114.

HANIHARA T, ISHIDA H (2001) Frequency variations of discrete cranial traits in major human populations. IV. Vessel and nerve related variations. *J Anat,* 199: 273-287.

HAUSER G, DE STEFANO GF (1989) *Epigenetic Variants of the Human Skull.* Ed. Schweizerbart, Stuttgart.

HOLLENSHED W HENRY (1966*) Anatomy for surgeons*. Vol I. Hoeber-Harper, New York & London.

STANDRING S, BORLEY NR, COLLINS P, CROSSMAN AR, GATZOULIS MA, HEALY JC et al (2008) *Gray's Anatomy: The Anatomical Basis of Clinical Practice* 40th Edit. Elsevier, Churchill Livingstone, London.

TOMASZEWSKA A, TOMCZYK J, KWIATKOWSKA B (2013) Characterisation of the supraorbital foramen and notch as an exit route for the supraorbital nerve in populations from different climatic conditions. *Homo,* 64: 58-70.

TURHAN-HAKTANIR N, AYCICEK A, HAKTANIR A, DEMIR Y (2008) Variations of supraorbital foramina in living subjects evaluated with multidetector computed tomography. *Head Neck,* 30: 1211-1215.

WEBSTER RC, GAUNT JM, HAMDAN US, FULEIHAN NS, GIANDELLO PR, SMITH RC (1986) Supraorbital and supratrochlear notches and foramina: anatomical variations and surgical relevance. *Laryngoscope,* 96: 311-315.