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RESEARCH ARTICLE

SUPRAORBITAL NOTCHES AND FORAMEN IN ADULT HUMAN SKULLS IN SOUTH INDIA-A MORPHOLOGICAL AND MORPHOMETRIC ANALYSIS

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ABSTRACT

Background: The supraorbital nerve is one of the main cutaneous nerves supplying the forehead and scalp region. It exits through the supra-orbital foramen/notch to innervate the skin and may be injured during various surgical and anesthetic procedures. The exact location, morphology and morphometry of these foramen show variations which had great clinical impact. This study focuses on such variations. **Materials and methods:** The study is done in 106 human dry crania from the department of Anatomy, Yenepoya Medical College. Eight different bilateral combination patterns of the notches/foramen are determined and percentage of incidence calculated. The distance of the foramen/notch from 2 reference points namely, the nasion and fronto-zygomatic suture is calculated andthe dimensions of the foraminaor notch is measured using vernier calipers and the mean value as well as range is analysed. The number of accessory foramen/notches are determined bilaterally and their relation to the main SOF/SON is established. **Results:** The most common pattern is determined to be bilateral notches with 41.51% incidence. The mean distance of the SOF/SON from nasion was23.65mm on right side and24.17mm on left side and from fronto-zygomatic suture was 27.83mm on right side and 28.41mm on left side. The mean horizontal length of the notch was 3.76mm on right side and 3.66mm on left side and that of SOF was 2.96mm on right side and 3.27mm on left side. The vertical length of SOF was calculated to be 1.55mm on right side and 1.61mm on left side. The number of accessory foramen were found to be more on right side and accessory notches more on left side. These accessory openings are found to be more associated with the main notch than the foramen. **Conclusion:** There is a difference in the position and dimensions of SOF /SON and thorough anatomical knowledge of SON /SOF is important in various procedures in surgery and anesthesia.

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INTRODUCTION

The bony exit located above the orbit under the eyebrow; transmitting supra orbital nerve and vessels may present as a foramen or as a notch called supra-orbital foramen / notch. When the opening is completely surrounded by bone, it is known as the supraorbital foramen and if it is partially covered by bone, it is known as the supraorbital notch (Moore, 2006). Knowledge of exact location of supraorbital notch/foramen is important in various surgical procedures. Subsequently, it was noticed by surgeons that the exit point was repeatedly not at the site where anticipated. With this background, a study was done on 120 adult human skulls in South Indian region to determine the location and dimensions of the supraorbital notch (SON) or the supraorbital foramen (SOF). Data obtained were compared with those from other races and regions.

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The supraorbital nerve is one of the major cutaneous nerves supplying the forehead and scalp area. It exits through its foramen/notch to innervate the skin and may be injured during various surgical and anesthetic procedures (Gupta, 2008). The supraorbital nerve blocks (Pareja, 2006) are commonly performed in the region of supraorbital foramen during surgical closure of facial wounds, biopsies, scarrevisions and other cosmetic surgical procedures. Knowledge of the exact location of the foramen is important while diagnosing conditions like supraorbital neuralgia, as it is normally characterized by pain and tenderness over the SON/SOF and the treatment of this condition includes supra-orbital nerve blocks at the foramen 5. Irritation, entrapment or compression of the supraorbital nerve have been considered as one of the causes for migraine headaches (Guyuron, 2000 and Guyuron, 2005). This knowledge is also important in cosmetic procedures like face-lift, forehead lift, blepharoplasty, Botox injections etc. Excessive dissection and retraction during surgical procedures, close to the neurovascular bundles can cause scarring, which may lead to entrapment neuropathies and

Table 1. Incidence of bilateral combination patterns of supra-orbital notches/foramen

Serial number	Types of combination		Number of skulls	Percentage
	RIGHT	LEFT		
1	N	N	44	41.51%
2	F	N	10	9.43%
3	N	F	16	15.09%
4	F	F	26	24.53%
5	F	X	1	.94%
6	N	X	2	1.89%
7	X	N	5	4.72%
8	X	X	2	1.89%

Table 2. Mean distance of sof/n from nasion and frontozygomatic suture.

Serial number	Value	Distance from nasion		Distance from fronto-zygomatic suture	
		Right	Left	Right	Left
1	No: of observations	98	104	98	104
2	Mean distance	23.65	24.17	27.83	28.41
3	Range	11.82-13.71	13.61-36.92	20.45-33.52	17.22-35.84

Table 3. Measurement of Dimensions of Supra Orbital Foramen/Notches

Serial number	Value	Horizontal length of supra orbital notch		Horizontal length of supra orbital foramen		Vertical length of supra orbital foramen	
		Right	Left	Right	Left	Right	Left
1	No: of observations	61	62	37	42	37	42
2	Mean	3.76	3.65	2.96	3.27	1.55	1.61
3	Range	.44-8.94	.36-8.72	1.29-5.24	1.14-4.98	.76-3.24	.68-3.95

Table 4. Accessory supraorbital foramen and notches and their associations

Serial no:	Value	No: of accessory foramen		No: of accessory notches	
		Right	Left	Right	Left
1	No: of observations	37	32	5	7
2	Associated with sof	14	7	2	3
3	Associated with son	23	25	3	4

painful neuralgias (Caputi, 1997 and Beer *et al.,* 1998). Planning of the surgical flaps also need good knowledge about the anatomy of supra-orbital foramen. The injury of supraorbital vessels and nerve in procedures may lead to complications such as: hematoma formation, sensory disturbances of the skin of forehead; flap necrosis and hair loss (Webster, 1986). It is also important during procedures involving the superior orbital wall such as; orbital decompression, frontal sinus obliteration and fractures explorations and orbital exenteration. The supraorbital notch/foramen is also a convenient landmark for the probing procedure for nasolacrimal canal in nasolacrimal duct atresia/stenosis in children.

MATERIALS AND METHODS

The study was conducted in Department of Anatomy of Yenepoya Medical College, Mangalore, Karnataka and Believers Church Medical College, Kerala. .106 dry human skulls of unknown sex were used in this study. Defective and damaged skulls were excluded from the study. The supra-orbital bony passages were studied bilaterally in these skulls. The presence as well as absence of supra-orbital foramen or notch is appreciated and the bilateral pattern is recorded. The presence of accessory notches/foramina and their association with notches/foramen are also looked for. The horizontal and transverse length of the foramen and the transverse length of the notch is measured using vernier calipers.

The distance between supra-orbital foramen /notch with the fronto-zygomatic suture and the nasion was recorded using verniercalipers. The mean distance is calculated statistically and range is determined. The mean transverse as well as vertical diameters of the foramen and the transverse diameter of the notches are established. These values are compared bilaterally. The number of accessory foramen and notches are calculated and their relationship with the main exit studied and compared bilaterally. The results were analyzed statistically.

Figure 1. Skull showing double SOF

Observations

Eight different combination patterns are observed with the presence and absence of the notches and foramen which were tabulated in Table 1 with their incidences. The mean distance of the SON/SOF from the nasion and fronto-zygomatic suture

were tabulated in Table 2. The dimensions of SON/SOF are calculated and mean value is recorded in Table 3. No: of accessory foramen and notches are determined and their incidence with the main foramen or notch is studied bilaterally and compared in Table 4. Interesting observations of double and triple supraorbital foramen were made during this study-Fig.1 and Fig.2

Figure 2. Skull showing triple SOF

DISCUSSION

It has been believed that the point of emergence of the supraorbital nerve is through a notch or a foramen at the junction of the inner third and the middle third of the supraorbital rim. In contrast to several anatomic textbooks, it was noticed that this point of exit was repeatedly not at the site anticipated which inspired this study. In the present study 8 different combination patterns of the notches and foramen were seen which were depicted in table 1.the most common pattern was bilateral notches (41.51%).whereas the least common was foramen on right side and absence of a major exit on left side (.94%). 2 skulls (1.89%)showed total absence of any major foramina/notch. Complete absence of notch or foramen may deprive the supraorbital nerves and vessels the protection given by these and make them more vulnerable to injuries at sharp supraorbital margins (Emeka Anthony, ?). Webster (Webster, 1986) observed that out of 108 skulls studied, 49.07% demonstrated bilateral supraorbital notching, 25.93% demonstrated bilateral supraorbital foramina, 25% demonstrated a notch on one side and a contralateral foramen. Sinha D. N. (Sinha, 1978), observed that out of 400 skulls studied, 44.25% demonstrated bilateral supraorbital notches, 18.25% demonstrated bilateral supraorbital foramina, 12.55% demonstrated a notch on one side and contralateral foramen.
Yenepoya Medical College, Manglore and Believers Church Medical College, Thiruvalla. Supraorbital notch or foramen transmits the supraorbital nerve and vessels. Supraorbital nerve is the larger terminal branch of the frontal nerve, which is a branch of ophthalmic division of trigeminal nerve. It traverses through the notch/foramen and divides into medial and lateral branches to supply the upper eyelid, conjunctiva and skin of the scalp up to the lambdoid suture. Supraorbital artery is a branch from the ophthalmic artery which in turn is a branch of internal carotid artery. It leaves the orbit through the notch /foramen and divides into superficial and deep branches and supplies the skin and muscles of the upper eyelid, forehead and the scalp. The supraorbital vein unites with the supratrochlear vein near the medial angle of the eye and forms the facial vein (Standring, 2005). In this study, the supra-orbital bony exit was measured using two reference points-the nasion and fronto-zygomatic suture which are relatively constant and easily identifiable landmarks. The fronto-zygomatic suture is easily palpable on the skin along the lateral orbital margin at the level of the lateral end of palpebral fissure which makes it more convenient for the surgeons to locate the SOF/SON from this point. The mean distance of the foramen/notch from the nasion was calculated to be 23.65 mm on the right side and 24.17 mm on the left side with a range of observations varying from 11.8mm-13.71mm on the right and 13.6-36.9mm on the left sides respectively. Gertrude M. Beer (Gertude, 1998), observed average distance ofsupraorbital notch/foramen to nasion was 31mm. Chung M.S.[12] calculated the average distance from nasion to the supraorbital notch/foramen was 22.7 mm. The mean distance of the foramen/notch from the fronto-zygomatic suture was calculated to be 27.83mm on right side and 28.41mm on left side with the range of observations varying between 20.45-33.52mm on right and 17.2-35.8 mm on left side. Liu et al (2011), 2011 observed this average distance to be 20.55 mm where as Smith et al (2010), 2010 measured it to be 26.2mm. In most of the reports available regarding the frequency of the supraorbital foramen and supraorbital notch, the notches are found to be more frequent than theforamina (Turhan-Haktanir, 2008). In the present study, the SON was observed in 58.17% of cases and the SOF was observed in 37.98% of cases.

Anearlier study conducted by Berry and Berry also reported markedly low frequency of SOF (12.3%) in North Indian skulls (Carolineberry, 1967), However, a recent study conducted on a North-West Indian population had showed a much balanced frequency of SOF and SON, which was45.6% of SOF and 54.4% of SON.[1] A ratio of SOF (41%) and SON (49%) was observed by Kazkayasi et al (Kazkayasi, 2008).Among the available reports, the highest frequency (92.5%) of SON was observed by Cutright et al. in a study conducted on 40 white and 40 black cadaveric heads (Cutright, 2009). An observation made by Chung et al. in a study conducted on 124 Korean skulls, were 69.9% cases of SON and 28.9% cases of SOF (Chung, 1995). The size of the SOF/SON reflects the thickness of the supraorbital nerve and the caliber of the supraorbital vessels. Hence the dimensions of the supra –orbital notches/foramen are taken. In the present study, it was found that the mean height of SOF was1.58 mm on the right side and 1.62mm on the left side; while the mean transverse diameter of SOF was 2.96 mm on the right side and 3.27 mm on the left side. The mean transverse length of the SON was found to be 3.76mm on right side and 3.66 mm on left side. Gupta reported only the width of the SOF/SON in the study, which was 4.8 mm on the right side and 4.5 mm on the left side (Gupta, 2008). A study on Thai skulls has also revealed similar results, where they observed the SOF to be 2.81 mm and the SON 4.31 mm wide[17] Webster et al. have reported the height of SOF as 2.02 mm, width of the SON as 5.7 mm and the width of the SOF as 3.78 mm (Webster, 1986). The occurrence of accessory supraorbital foramina is a common and well documented finding. The accessory foramina transmit the minor twigs of the supraorbital nerve which arise within the orbit and are responsible for incomplete analgesia following nerve blocks at SOF/SON. In this study, the accessory foramen and notches and their incidence with the main SOF/SON is studied and compared bilaterally .The findings are tabulated in Table 4.

The no: of accessory foramen are found to be more than accessory notches and majority of these foramen were on the right side and are interestingly associated with supra-orbital notches than SOF. The no: of accessory notches were seen more on left side and these are also associated more with

supra-orbital notches than SOF. It has been observed that the supraorbital notches which were less than 5 mm in width showed at least one accessory foramen indicating the early division of the supraorbital nerve and their exit through theseaccessory foramina (Ashwini, 2012). The accurate anatomical location of SOF/SON is vital for both diagnostic and surgical procedures in this area. From this study, it is evident that a wide variation in anatomy is associated with the location of SON/SOF and hence greater caution is required while performing procedures and deep dissection around the same.

Conclusion

This study points out that the exit points of the supraorbital nerve are not at all constant. It can be either a notch or a foramen or absence of both. 8 different combination patterns are established in this study. SON is observed more frequently compared to the SOF. The occurrence of accessory supraorbital foramina is very common and is more frequently associated with the main SON. The average distance of the SOF/SON from two bony landmarks-the nasion and fronto-zygomatic suture were recorded. The mean dimensions of the foramen as well as the notch are measured and documented. The data obtained in this study will be of great help to the surgeons and anesthetists to avoid injury to the neurovascular bundle and also assist anthropologists and forensic scientists in the localization and characterization of these foramina and notches.

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