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Original Article

STUDY OF NATURE OF SUPRAORBITAL FORAMEN IN DRY HUMAN NORTH INDIAN SKULLS

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ABSTRACT

Introduction: Supraorbital foramina are important passage for neurovascular bundles. Their nature should be known for Ocular and facial surgeries. The aim of study was to document topographical anatomical nature of Supraorbital foramen, which is necessary for procedures which are performed in supraorbital region.

Materials and methods: A total of 72 dry human skulls of unknown age and gender from North India, were studied. In each skull, nature of supraorbital foramen was observed on both sides.

Results: It was observed that the supraorbital foramen was complete in33,3% on left side and in 47.2% skulls on right side, with overall bilaterality of 19.44%. It was incomplete in 18.1% skulls on left and 4.2% skulls on right side. Supraorbital notch was present bilaterally in 36.12% skulls.

Conclusions: Precise knowledge about nature of Supraorbital foramen may have important implication on Orbital and periorbital procedures. It may provide guidance for anaesthetists and surgeons.

Keywords: Supraorbital foramen, Nature, North Indian Human skull.

INTRODUCTION

The accurate identification of Supra Orbital Foramen (SOF)/Supra Orbital Notch (SON), and Infra Orbital foramen (IOF) are important for both diagnostic and clinical procedures. Clinically, nerve bundles emerging from these foramina could probably be injured during surgical procedures, resulting in paraesthesia or anaesthesia. An understanding of the anatomical location of important maxillofacial foramina is of increased importance with the rising popularity of endoscopic procedures with limited visibility [1]. The facial foramina, which transmit nerves and blood vessels between the facial structures and the cranium, show positional and metric features at variance with standard descriptions in anatomy textbooks [2,3]. There are data that show variations with age, sex and ethnic groupings [4]. In adults, there are no absolute landmarks and, in some cases, the facial foramina may not be palpable [5].

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Ashwini LS et al [6] in their study of adult skulls revealed that the SON (69.87%) was found more frequently than the SOF (28.91%). Of all the cases, 56.62% had bilateral SON, while 14.45% had bilateral SOF. Notches were mostly observed on the right side and foramina were mostly seen on the left side. Londhe SR et al [7] found in their study that percentages of combinations on right and left side in adult and foetal skulls were as Incomplete Foramen (IF) in 29.7%, Complete Foramen (F) in 30.7%, Notch (N) in 39.6% on right side; and on left side it was Notch in 47.52%, Complete Foramen in 18.81%, Incomplete Foramen in 33.66% adult skulls.

In case of foetal skulls, the observations were as Incomplete Foramen in 18.64%, Absent (A) in 10.16%, Notch in 71.18% on right side; and Notch in 66.10%, Complete Foramen in 15.25%, absent in 18.64% on left side. Based on their study they showed various combinations in adult skulls as bilateral notch in 28.71%, bilateral complete foramina in 13.86%, bilateral incomplete foramina in 16.83%, left notch and right Incomplete Foramen in 7.92%, left notch right Complete Foramen in 2.97%, left Complete Foramen and right notch in 7.92%, left Complete Foramen and right Incomplete Foramen in 8.9%, left Incomplete Foramen and right notch in 10.89%, left Incomplete Foramen and right Complete Foramen in 1.98%. In case of foetal skulls, they showed the various combinations as bilateral notch in 50.84%, bilateral Incomplete Foramen in 3.38%, and bilaterally absent in 6.67%. Other combinations were as left notch and right Incomplete Foramen in 11.86%, left notch and right absent in 8.87%, left Incomplete Foramen and right notch in 11.86%, left Incomplete Foramen and right absent in 3.38%, left absent and right notch in 3.38% of foetal skulls.

Jha AK et al [8] determined after their study that of the supraorbital foramina 78.6 % were notches and remaining 21.4% were foramina. Trivedi DJ et al [9] observed different type of combinations of supra orbital foramen and notch as bilateral notch in 35.62%, right notch and left foramen in 7.72%, right notch and left incomplete foramen in 3.43%, right side notch and left side absent features in 0.85%, right foramen and left notch in 9.01%. Foramen were present bilaterally in 21.45%, whereas right foramen and left incomplete foramen in 5.15%, right foramen and left no features in 0.85%, left notch and right incomplete foramen in 5.15%, left foramen and right incomplete foramen in 3.43% were found. Their further observations were bilaterally incomplete foramen in 6.43%, left foramen with no features on right side in 0.42%, and bilateral absence of any features in 0.42% skulls.

Yukio DODO et al [10] found the incidence of complete SOF in Assam and Sikkim to be 44.6%, in East India 46.8, in South India 44.6% as and in Northwest India as 39.4%. Ongeti K et al [11] observed that the right and left supraorbital passages were present in 93.3% and 94.2% of the skulls respectively. The percentage of skulls with right and left supraorbital notches was 67% and 64.3%, respectively. Supraorbital notches ranged from mere dents on the superior surface of the orbit to near-circular notches. Funda AKSU et al [12] found in their study that Supraorbital foramen were found in 27.7% on right side and in 24.8% on left side; supraorbital notch were found in 66.3% on right side and in 67.3% on left side.

The rate of unilateral supraorbital notch and supraorbital foramen on the other side was found as 20%. There was no foramen or notch on 3% of skulls.

Apinhasmit W et al [13] observed that the SON (66.5%) was found more frequently than the SOF (33.5%). Of all cases, 50.0% had bilateral SON, 17.0% had bilateral SOF and 33.0% had a notch on one side and a foramen on the other. Among the available reports, the highest frequency (92.5%) of SON was observed by Cutright et al [1] in a study conducted on 40 black and 40 white cadaveric heads. Chung MS et al [4] found that supraorbital notches (69.9%) were more frequent than supraorbital foramina (28.9%). In their study, they showed that bilateral notches in 35.62% of skulls and bilateral foramina in 21.45 % of skulls and 16.73 % of skulls demonstrated a notch on one side and a contralateral foramen.

Similarly, an earlier study conducted by Berry and Berry also reported markedly low frequency of SOF (12.3%) in North Indian skulls [14] However, a study conducted on a North-West Indian population has revealed a much-balanced frequency of SOF and SON, which was 45.6% of SOF and 54.4% of SON [15]. An almost equal ratio of SOF (41%) and SON (49%) was observed by Kazkayasi M et al [16]. They also found 10% of cases with the groove. The frequency of SOF was reported to be more in North East Asians and North American populations from an arctic region than the other populations [17]. In another cross racial study, the frequency of SOF ranged from 8% to 51% depending upon the study population; it was lowest in a Burmese population and highest in Mexican populations [14]. Hollinshed WH [18] had described a total incidence of supraorbital foramina as 25% but has not given the side difference. Williams and Warwick [3] did not mention the absence of all the three (notch, foramen and incomplete foramen) features at supraorbital margin of human skull as also seen in our study.

The incidence of supra orbital foramina as reported by Duke Elder SS [19] was 25% of total adult skulls while Rao et al [20] reported 6.5% in South Indian studies. Bilodi Arun Kumar S and Sanikop MB [21] had shown incidence of supra orbital foramina of 39% on right side and 43.3% on left side, while study by Sinha DN [22] had shown the incidence to be 34.25% on right side and 28.5% on left side. Berry AC et al [14] had found equal incidences of supra orbital notches and foramina in Mexican crania. Sinha DN [22] observed incidence of supra orbital notch in 44.25% of skulls (14.25% on right side and 25.5% on left side). Rao et al [20] showed the presence of supra orbital notch in 38.5% adult skulls, while incidence of notch given by Bilodi Arun kumar S and Sanikop MB [21] was 47.38% on right side and 36.6% on left side.

Webster [23] observed that out of 108 skulls studied, 49.07% demonstrated bilateral supraorbital notching, 25.93% demonstrated bilateral supraorbital foramina, and 25% demonstrated a notch on one side and a contralateral foramen. Sinha D N et al [22] observed that out of 400 skulls studied, 44.25% demonstrated bilateral supraorbital notches, 18.25% demonstrated bilateral supraorbital foramina, and 38.50% demonstrated a notch on one side and contralateral foramen. Berry AC et al [14] observed that the incidence of complete supra orbital foramen in Indian Punjabis to be as 12.3%. Webster et al [23] observed that

49.07% of skulls demonstrated bilateral supraorbital notching, 25.93% demonstrated bilateral supraorbital foramina, whereas 25% demonstrated a notch on one side and a contralateral foramen. Sinha DN [22] observed that out of 400 skulls studied, 44.25% demonstrated bilateral supraorbital notches, 18.25% demonstrated bilateral supraorbital foramina, and 12.55% demonstrated a notch on one side and contralateral foramen. Chung M.S et al [4] found that supraorbital notches (69.9%) were more frequent than supraorbital foramina (28.9%).

Since modern surgical procedures, anaesthesia and acupressure techniques require a more precise understanding of surrounding anatomy, the aim of this study was to examine the different Anatomical variations of Supra Orbital foramen (SOF)/ Supra Orbital Notch (SON) related to side. This data would provide important information for local anaesthesia during Rhinoplasty and about Maxillo-facial area during Plastic surgery. An effort was made to provide reliable data for comparison of previous studies data and to provide the same for future studies.

MATERIALS AND METHODS

A total of Seventy-two dry human Indian adult skulls of unknown age and gender were utilized for this study. These dry skulls were obtained from the Museum of Department of Anatomy, Varun Arjun Medical College, Uttar Pradesh, India. Child skulls and skulls in which the openings were damaged, either unilaterally or bilaterally, which would hamper observations were excluded. In each skull, both sides of the SOF/SON were observed by single observer. The variables of age and gender were not considered. Presence of bilateralism (i.e., similar characteristics on both sides of same skull) was also studied.

Morphometric measurements were recorded regarding the nature of Supra Orbital foramen on left (LT) side as Complete Foramen, Incomplete Foramen, or Notch.

The information was tabulated and from these measurements means and standard deviations (mean ± SD) were calculated. Basic descriptive statistics were employed to analyse the data obtained using standard software (Excel 2007, Microsoft Corp.) and SPSS software (version 16, SPSS, USA 2007), on the basis of left and right sides.

RESULTS

In our study it was found that Supra Orbital Foramen showed different nature of presentation. It was complete foramen (CSOF) in 24 (33.3%) skulls on left side and in 34 (47.2%) on right side; and as incomplete foramen (INCSOF) in 13 (18.1%) on left side and in 3 (4.2%) on right side. Notch form (SON) was most prevalent form of SOF; in 35 (48.65%) skulls on both (left and right) side (Table 1(A)& 1(B)).

Overall, it was found that CSOF had frequency of 40.28%, INCSOF had frequency of 11.1%, whereas SON had maximum frequency (48.6%) as shown in Table 2. When bilateralism was compared, it was found that complete foramen was present bilaterally (B/LCSOF) in 19.44% skulls and notch was seen bilaterally (B/LSON) in 36.11% skulls. Maximum (44.44%) had bilaterally mixed presentation as shown in Table 3.

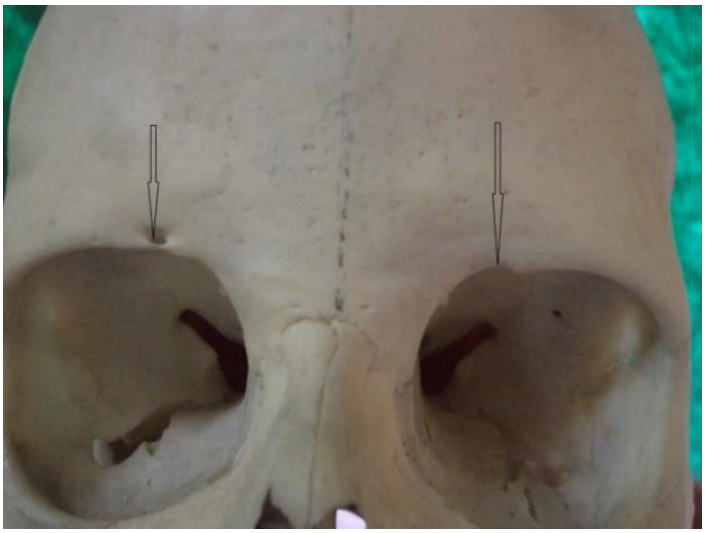

Fig. 1. Supra Orbital Foramen on Right side and Supra Orbital Notch (SON) on Left side

Table 1(A). Nature of Supra Orbital foramen on left (LT) side

	NATURE OF SOF (LT) ↓	FREQUENCY	PERCENT	VALID PERCENT	CUMULATIVE PERCENT
Valid	CSOF	24	33.3	33.3	33.3
	INCSOF	13	18.1	18.1	51.4
	SON	35	48.6	48.6	100.0
	Total	72	100.0	100.0	

Table 1(B). Nature of Supra Orbital foramen on right (RT) side

	NATURE OF SOF (RT)↓	FREQUENCY	PERCENT	VALID PERCENT	CUMULATIVE PERCENT
Valid	CSOF	34	47.2	47.2	47.2
	INCSOF	3	4.2	4.2	51.4
	SON	35	48.6	48.6	100.0
	Total	72	100.0	100.0	

Table 2. Overall nature of Supra Orbital foramen

PARAMETER↓	LEFT	RIGHT	TOTAL	PERCENT
CSOF	24	34	58	40.28
INCSOF	13	3	16	11.11
SON	35	35	70	48.61

Complete Foramen (CSOF) Incomplete Foramen (INCSOF), and Notch (SON)

Table 3. Bilateralism of nature of Supra Orbital foramen

B/L NATURE OF SOF PARAMETER ↓	FREQUENCY	PERCENT
B/L CSOF	14	19.44
B/L SON	26	36.11
MIXED	32	44.44
B/L INCSOF	00	

Bilateral Complete Foramen (B/L CSOF), Bilateral Incomplete Foramen (B/L INCSOF), and Bilateral Notch (B/L SON)

Table 4. Overall nature of Supra Orbital foramen

PARAMETER→ (NATURE OF SOF) STUDY ↓	COMPLETE FORAMEN (%)	INCOMPLETE FORAMEN (%)	NOTCH (%)
Our Study	40.28 (33.3-L; 47.2-R)	11.11 (18.1-l;4.2-R)	48.61(L ; R)
Ashwini LS et al …. 2012	28.91		69.87
Londhe SR et al …. 2011	30.7-R; 18.81-L	29.7-R; 33.66-L	39.6-R; 47.52-L
Jha AK et al ……...2011	21.4		78.6
Charconovic C et al.2011			47.50
Yukio D et al…….. 2009	39.4 to 46.8		
Gupta T…….2008	45.6		54.4
Ongeti K et al.....… 2008			67-R; 64.3-L
Funda AKSU et al.. 2007	27.7-R; 24.8-L		66.3-R; 67.3-L
Apinhasmit W et al..2006	33.5		66.5
Cutright C et al.… .2003			92.5
Kazkayasi M et al…2003	41		49
Bilodi AKS et al.…2002.	39-R, 43.3-L		47.38-R, 36.6-L
Rao et al……...1997	6.5		38.5
Chung MS et al…. 1995	28.9		69.9
Sinha DN et al .….1978	34.25-R; 28.5-L		44.25
Berry AC et al .….1967	12.3		
Duke Elder et al ...1961	25		

Table 5. Bilateralism of nature of Supra Orbital foramen

PARAMETER→ (NATURE OF SOF) STUDY ↓	B/L COMPLETE FORAMEN (%)	B/L NOTCH (%)	B/L INCOMPLETE FORAMEN (%)	MIXED %
Our Study	19.44	36.12	00	44.44
AshwiniLS et al …. 2012	14.45	56.62		
Londhe SR et al…. 2011	13.86	28.71	16.83	40.60
Trivedi DJ et al…..2010	21.45	35.62	6.43	36.50
Funda AKSU et al. 2007				20
ApinhasmitW et al 2006	17	50		33
Cutright C et al.… 2003		92.5		
Aziz SR et al ……..2000		70		
Webster et al……..1986	25.93	49.07		25
Sinha DN et al….. 1978	18.25	44.25		38.50
Chung MS et al…. 1995	21.45	35.62		16.73

DISCUSSION

There is a wide range of reports available regarding the frequency of the supraorbital foramen and supraorbital notch. Generally, the notches are considered to be more frequent than the foramina [24]. In the present study, the SON was observed in 48.61% of cases and the SOF was observed in 40.28% of cases, whereas the incidence of incomplete foramen was 11.11% in adult skulls. Charcanovic BR et al [25] demonstrated that 47.50% of the supraorbital foramina were in fact notches, not foramen Another study conducted on Indian skulls also showed similar results where SON was more frequent compared to the SOF [23]. Similarly, an earlier study reported markedly low frequency of SOF (12.3%) in North Indian skulls [14]. However, a study conducted on a North-West Indian population has revealed a much-balanced frequency of SOF and SON, which was 45.6% of SOF and 54.4% of SON [15].

An almost equal ratio of SOF (41%) and SON (49%) was observed by Kazkayasi et al [16]. They also found 10% of cases with the groove. The frequency of SOF was reported to be more in North East Asians and North American populations from an arctic region than the other populations [17]. In another cross racial study, the frequency of SOF ranged from 8% to 51% depending upon the study population; it was lowest in a Burmese population and highest in Mexican populations [14]. Among the available reports, the highest frequency (92.5%) of SON was observed by Cutright C et al [1] in a study conducted on 40 black and 40 white cadaveric heads. Chung et al in a study conducted on 124 Korean skulls, reported 69.9% cases of SON and 28.9% cases of SOF. Hollinshed WH [18] had described a total incidence of supraorbital foramina as 25% but has not given the side difference. Williams and Warwick [3] did not mention the absence of all the three (notch, foramen and incomplete foramen) features at supraorbital margin of human skull, as it was also seen in our study. The incidence of supra orbital foramina as reported by Duke Elder SS [19] was 25% of total adult skulls while Rao et al [20] reported 6.5% in South Indian studies. Bilodi AKS & Sanikop MB [21] had shown incidence of supra orbital foramina of 39% on right side and 43.3% on left side, while study by Sinha DN et al [22] had shown the incidence to be 34.25% on right side and 28.5% on left side. Berry AC et al [14] had found equal incidences of supra orbital notches and foramina in Mexican crania. Sinha DN et al [22] observed incidence of supra orbital notch in 44.25% of skulls. It was 14.25% on right side and 25.5% on left side. Rao et al [20] showed the presence of supra orbital notch in 38.5% adult skulls, while incidence of notch by Bilodi AKS & Sanikop MB [21] was 47.38% on right side and 36.6% on left side. According to Cheng et al [17] the supraorbital neurovascular bundle is relatively fixed in position in the supraorbital foramen. Hence, the neurovascular bundle is in great danger during surgical dissection; since during retraction, it is more likely to be stretched. Surgeons must take additional precautions during the reflection of scalp flaps in populations with a higher incidence of supraorbital foramina. It is evident by these reports that while performing forehead, coronal, brow or temple lift surgeries; palpating SON alone is not sufficient in locating the supraorbital neurovascular bundle.

Therefore, surgeons should also be aware of the frequency of occurrence of SOF and their location well above the supraorbital margin [23].

Bilodi AKS, Sanikop MB [21] concluded that in the absence of supra orbital foramina and notches, supra orbital vessels and nerves are more prone for injury due to sharp supraorbital margin at orbital rim. Webster et al [23] observed in their study that 49.07% of skulls demonstrated bilateral supraorbital notching, 25.93% demonstrated bilateral supraorbital foramina, and whereas 25% demonstrated a notch on one side and a contralateral foramen. Sinha DN et al [22] observed that out of 400 skulls studied, 44.25% demonstrated bilateral supraorbital notches, 18.25% demonstrated bilateral supraorbital foramina, and 12.55% demonstrated a notch on one side and contralateral foramen. Chung M.S et al [4] found that supraorbital notches (69.9%) were more frequent than supraorbital foramina (28.9%). Present study showed, bilateral notches in 36.12% of skulls and bilateral foramina in 19.44% of skulls whereas 44.44 % of skulls demonstrated a notch on one side and a contra lateral foramen (i.e., mixed variety). Apinhasmit W et al [13] demonstrated 50.0% bilateral notching, 17.0% bilateral foramina and 33.0% a notch on one side and a contralateral foramen. It showed poor symmetrical relation between the sides. Webster RC et al [23] reported the distributions of 49.1% for bilateral SON, 25.9% for bilateral SOF and 25.0% for one notch and one foramen. In other study, bilateral SON was reported at 70% in white, black and Hispanic subjects [26] and 92.5% in white and black subjects [1]. Table No 4 &5 shows a comparative analysis of different studies.

CONCLUSION

Most of the data in the available literature was based on studies that were carried out in the foreign samples. Our study, on the other hand, represented the Indian population which differs in physical build from Western populations.

Comparison of results from previous studies makes the large variation of the anatomical characteristics of the infraorbital and supra orbital foramen evident, not only due to the diversity of the used parameters, but also due to the distinct investigated populations. With a possibility of these characteristics being dependent on population groups, this study makes the morphometric study of these foramen in the population of India relevant. The results showed a large dispersion and variability in the various distances pertaining to the location of the infraorbital foramen and supra orbital foramen/ notch because we analysed skulls from different geographical areas; individual's precision in measurements; and varying osteoblastic and osteoclastic activity in different individuals. The various mean distances along with standard deviation as elaborated in tables determine the exact position of infraorbital foramen, SOF/SON in Indian population and may be first hand vital information to the concerned clinicians to avoid complications during surgical procedures and nerve block. Besides, these results can play a role in the performance of surgical procedures in the periorbital area in order to prevent the involvement of neurovascular structures which cross these foramina.

All these findings are important for performing local nerve block and surgery in the forehead and the periorbital regions in order to avoid the neurovascular structures passing through these two foramina. As per the measurements in this study, the best site for local anaesthetic block for the infraorbital nerve would be about 8.15

mm inferior to the inferior orbital rim (at the point where one can palpate the zygomatic-maxillary suture), about 27.58 mm from the midline, and about 40.86 mm below the SON/F in the same vertical line. Extra care should be taken during surgical dissection in the superior orbital region especially in the middle aspect of the superior orbital rim. Some intra-ethnic and interethnic variations in the position of the SOF and IOF may exist, and thus these mean distances found may vary from population to population

Overall, it can also be stated that the position of the SOF/SON is not constant and it varies between different races and people of different regions. SON is observed more frequently compared to the SOF, though there is a slight difference in the frequency rate among the studies conducted in different regions and race groups. . It can be either a notch or a foramen. It may be an incomplete foramen. 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 the sharp supraorbital margin. Because of the numerous variations of the exit points on the supraorbital rim, all surgical approaches to the supraorbital nerve on the supraorbital rim, especially the endoscopic ones, always have to be done under vision and with the necessary care of the nerves. The occurrence of accessory supraorbital foramina is very common and is more frequently seen lateral to the main SOF/SON. This should be kept in mind while performing these procedures.

The skew values found in present study alert the surgeons to avoid anaesthetic failures and other procedures involving infraorbital and supra orbital foramen. Therefore, the risks associated with facial surgery may be reduced for the Indian population if the anatomic morphometry is taken into consideration. The data are of direct relevance to clinical practice and teaching.

Our sincere effort by present study was to add information to the literature concerning the morphology of the SON/SON, and IOF especially in an Indian population. Also, we tried to provide some information about Infra orbital groove and canal, but to clarify the morphological characteristics of them, it will be necessary to carry out a correlation study concerning the size of skull, total length of the infraorbital canal, and data obtained by this study.

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