Original Article

PRENATAL MORPHOMETRIC ANALYSIS OF SUPRAORBITAL, INFRAORBITAL AND MENTAL FORAMINA IN HUMAN FOETUSES AND THEIR CLINICAL CORRELATIONS TO ANAESTHESIA AND SURGICAL PROCEDURE

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ABSTRACT

Modern surgical procedures, anesthesia, acupuncture and other invasive procedures on the face require a more precise understanding of the anatomy of important landmarks to prevent subsequent neurovascular complications in the frontal region, upper jaw and lower jaw. Studies on bilateral locational relationship of SOF, IOF and mental foramen in foetal skull are still lacking, so aim of our study was 1) to examine the various morphometric variations (the location and shape) of SOF, IOF and mental foramina of the facial skeleton in human foetuses at different age of gestation 2) to establish whether or not, the location of these foramina get changed as the foetus matures and 3) to establish the pattern of growth of aforesaid foramina. For these 40 formalin-fixed foetuses between 17 and 32 weeks of gestation were studied for SOF, IOF and mental foramina. Foetuses were divided into two groups according to age. It was interesting to note that supra-orbital and mental foramina were placed in the same sagittal plane on both sides of the midline. Infra-orbital foramen was located lateral to sagittal plane for supra-orbital and mental foramina. The shape of SOF was recorded as a notch or rarely a foramen, whereas the shape of IOF and mental foramen were determined as a circular and an oval opening respectively.

KEYWORDS: Supraorbital notch/foramen, infraorbital foramen, mental foramen, surgical landmark, human foetuses.

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INTRODUCTION

The supraorbital, infraorbital and mental foramina are the important landmarks on the face. Modern surgical procedures, anesthesia and acupuncture require a more precise understanding of the surrounding anatomy [1]. Supraorbital notch/foramen is situated at the junction of lateral 2/3rd and medial1/3rd of the supraorbital margin. Infraorbital foramen is an opening located below the infraorbital margin bilaterally on the maxilla, giving passage to the infraorbital nerves and vessels. Infra orbital nerve block is used for intraoperative and post-operative analgesia in nasal and oral surgery procedures, as well as in chronic pain managements. Recent advancements in orthognathic surgery have increased surgical procedures in the mental region. Mental foramen is an important landmark as it is a determinant of the mental triangle to facilitate surgical, local anesthetic, and other invasive procedures and prevention of subsequent neurovascular complications in the region of lower jaw. Enormous literature is available providing information on locational relation ship of the supraorbital notch or foramen and infraorbital and mental foramina in adults [2, 3]. No study has been recorded on supraorbital foramen in foetuses till date. Few studies on infraorbital foramen were conducted in human foetal skull [4]. Studies on formation and early prenatal location of the human mental foramen [5] and horizontal migration of pre- and postnatal mental foramen [6] in human foetuses have also been studied in past. Studies on bilateral locational relationship of these foramina in foetal skull are still lacking. Such finding will be of great importance for forensic, anaesthetic and surgical procedures. In adults the SON or SOF is considered to be reliably constant in their location. SON/SOF transmits supraorbital nerve and vessels. The supraorbital nerve is one of the main cutaneous nerves supplying the forehead and scalp region, may be injured during various invasive procedures. This nerve is the larger terminal branch of the frontal nerve, and after exit through the SON/SOF divides into medial and lateral branches to supply the upper eyelid (as palpebral filaments), conjunctiva and skin of the scalp up to the lambdoid suture. The supraorbital nerve blocks are commonly performed in the region of supraorbital foramen during procedures like closure of facial wounds, biopsies, and scar revisions, as absolute but temporary treatment for supraorbital neuralgia and other cosmetic cutaneous procedures. Effective and precise analgesia can be achieved only if one is aware of the most frequent location of exit of the nerve in this region. Knowledge of the location of supraorbital nerve is also essential during various endoscopic procedures, which are increasingly being used for cosmetic facial surgery [7, 8]. However, cosmetic surgeons are generally reluctant to perform brow lifts and other open, as well as endoscopic surgical procedures in this region for fear of injuring the supraorbital nerve and subsequent sensory loss [9, 10]. Excessive dissection and retraction close to such neurovascular bundles can cause scarring, which may lead to entrapment neuropathies and painful neuralgias [11, 12]. Supraorbital artery, a branch of ophthalmic artery, leaves the orbit through the SON/SOF, divides into superficial and deep branches to supply the skin and muscles of the upper eyelid, forehead and scalp.

Aim of the study

1. To examine the various morphometric variations (the location and shape) of SOF, IOF and Mental foramina of the facial skeleton in human foetuses at different age of gestation.
2. To establish whether or not, the location of these foramina get changed as the foetus matures.
3. To establish the pattern of growth of aforesaid foramina.

MATERIALS AND METHODS

40 formalin-fixed foetuses between 17 and 32 weeks of gestation were investigated in this study and facial areas of skull were studied for SOF, IOF and Mental foramina. Foetuses were divided into two groups according to age (Table I). These foetuses were collected from the museum of Anatomy, faculty of medicine, AMU, Aligarh. Soft tissue and periosteum were removed carefully under magnifying glasses to visualize the supra-orbital, infra-orbital, and mental foramina. Measurements were taken to analyze the location and shape of these foramina. All measurements were made bilaterally by a single observer and variations were evaluated in two groups. Location of these foramina to certain reference points were measured by Vernier calliper. To find out the growth between adjacent foetal groups, Student's t' test was used. The following metric measurements were recorded:

1. Distance between SOF & MF
2. Distance between IOF & MF
3. Distance between SOF & IOF
4. Distance between lower border of mandible & MF
5. Distance between symphysis menti & MF
6. Distance of IOF from vertical line between SOF & MF
7. Distance of IOF from infraorbital margin

Following morphological observations were also made,

1. Shape of the SOF
2. Shape of the IOF
3. Shape of the MF

RESULTS

The supraorbital notch was frequently observed than the supraorbital foramen in group II foetuses, while the same was difficult to identify in group I foetuses. The mean distance between SOF and mental foramen were 24.85±5.93 and 32.25±1.07 in group I and group II respectively. The mean distance between IOF and mental foramen were 13.05±4.69 and 19.35±1.63 in two groups respectively. The mean distance of the IOF from the midline was 8.5±0.94 mm and 12.8±2.85 mm respectively. The average distance between SOF and IOF foramen were 12.35±0.93 and 15.45±2.74 in two foetal groups respectively. The average length from the inferior margin of mandible to the centre of the mental foramen was 3.95±0.604 and 6.80±0.95 in 1st and 2nd groups respectively.

The mean distance between symphysis menti and MF in group I and II fetuses were 6.9±0.94 mm and 9.8±2.85 mm respectively. It was interesting to note that supra-orbital and mental foramina were placed in the same sagittal plane on both sides of the midline. Infra-orbital foramen was located lateral to sagittal plane for supra-orbital and mental foramina.

The average lengths of infra-orbital foramina from aforementioned sagittal plane were 1.7±0.57 mm and 3.4±0.82mm in group I and group II fetuses on both sides. The mean distance of the IOF from the inferior orbital margin was about 2.47±0.547 mm in group I and 3.40±0.882 mm in group II. The shape of SOF was recorded as a notch or rarely a foramen, whereas the shape of IOF and mental foramen were determined as a circular and an oval opening respectively.

Table 1: Grouping of Human Foetuses.

Groups	Age in weeks	No. of foetuses
I	13-24 weeks (2nd trimester)	20
II	>24 week (3rd trimester)	20

Table 2: Right sided SOF, supra-orbital foramen; IOF, infra-orbital foramen; MF, mental foramen in human foetuses.

S.NO	Parameters	Group I		Group II		P Value
		No. of cases	Means ±SD (mm)	No. of cases	Means ±SD (mm)	
1	Distance between SOF & MF	20	24.85±5.93	20	32.25±1.07	0
2	Distance between IOF & MF	20	13.05±4.69	20	19.35±1.63	0
3	Distance between SOF & IOF	20	12.35±0.93	20	15.45±2.74	0
4	Distance between lower border of mandible & MF	20	3.95±0.60	20	6.80±0.951	0
5	Distance between symphysis menti & MF	20	8.40± 0.94	20	12.80±2.85	0
6	Distance of IOF from vertical line between SOF & MF	20	1.70±0.57	20	3.40±0.82	0
7	Distance of IOF from infraorbital margin	20	2.47±0.54	20	3.40± 0.88	0

Table 3: Left sided SOF, supra-orbital foramen; IOF, infra-orbital foramen; MF, mental foramen in human foetuses.

S.NO	Parameters	Group I		Group II		P Value
		No. of cases	Means±SD (mm)	No. of cases	Means±SD (mm)	
1	Distance between SOF & MF	20	24.85±5.93	20	32.6±1.04	0
2	Distance between IOF & MF	20	13.05±4.69	20	19.55±1.39	0
3	Distance between SOF & IOF	20	12.35±0.93	20	15.45±2.79	0
4	Distance between lower border of mandible & MF	20	3.95±0.60	20	6.80±0.951	0
5	Distance between symphysis menti & MF	20	8.40± 0.94	20	12.80±2.85	0
6	Distance of IOF from vertical line between SOF & MF	20	1.70±0.57	20	3.44±0.705	0
7	Distance of IOF from infraorbital margin	20	2.47±0.54	20	3.46±0.810	0

Table 4: Bilateral variations in distance between supraorbital foramen and mental foramen in human foetuses.

Groups	Right side		Left side		Per-cent difference
	No. of cases	Means±SD (mm)	No. of cases	Means±SD (mm)	
Group I	20	24.85±5.93	20	24.85±5.93	Nil
Group II	20	32.25±1.04	20	32.60±1.04	Nil

Table 5: Bilateral variations in distance between infraorbital foramen and mental foramen in human foetuses.

Groups	Right side		Left side		Per-cent difference
	No. of cases	Means±SD (mm)	No. of cases	Means±SD (mm)	
Group I	20	13.05±4.69	20	13.05±4.69	Nil
Group II	20	19.35±1.63	20	19.55±1.39	Nil

Table 6: Bilateral variations in distance between supraorbital foramen and infraorbital foramen in human foetuses.

Groups	Right side		Left side		Per-cent difference
	No. of cases	Means±SD (mm)	No. of cases	Means±SD (mm)	
Group I	20	12.35±0.93	20	12.35±0.93	Nil
Group II	20	15.45±2.79	20	15.45±2.79	Nil

Table 7: Bilateral variations in distance between lower border of mandible & MF in human foetuses.

Groups	Right side		Left side		Per-cent difference
	No. of cases	Means±SD (mm)	No. of cases	Means±SD (mm)	
Group I	20	3.95±0.604	20	3.95±0.604	Nil
Group II	20	6.80±0.95	20	6.80±0.95	Nil

Table 8: Bilateral variations in distance between symphysis menti &MF in human foetuses.

Groups	Right side		Left side		Per-cent difference
	No. of cases	Means±SD (mm)	No. of cases	Means±SD (mm)	
Group I	20	8.40±0.94	20	8.40±0.94	Nil
Group II	20	12.80±2.85	20	12.80±2.85	Nil

Table 9: Bilateral variations in distance of IOF from the vertical line between SOF & MF in human foetuses.

Groups	Right side		Left side		Per-cent difference
	No. of cases	Means±SD (mm)	No. of cases	Means±SD (mm)	
Group I	20	1.70±0.57	20	1.70±0.57	Nil
Group II	20	3.40±0.82	20	3.44±0.70	Nil

Table 10: Bilateral variations in distance of IOF from infraorbital margin in human foetuses.

Groups	Right side		Left side		Per-cent difference
	No. of cases	Means±SD (mm)	No. of cases	Means±SD (mm)	
Group I	20	2.47±0.54	20	2.47±0.54	Nil
Group II	20	3.40±0.88	20	3.46±0.81	Nil

Table 11: Shape of SOF/Notch, IOF & MF in human foetuses.

S. No	Foramen	Shape	
		Group I	Group II
1	Supraorbital foramen / Notch	Difficult to identify	Wide notch
2	Infraorbital foramen	Circular	Circular
3	Mental foramen	Oval	Oval

DISCUSSION

The positions of SON/F, IOF and MF vary among racial groups and genders [14-17]. Despite the significance of the SON/F, IOF and MF, little attention has been given to the study of the morphology, locations of these foramina and their associated anatomic characteristics in the human foetuses. Most of these studies are done in adult's human skull. The frequency of occurrence of a Supraorbital notch/foramen varies in different populations. Chung et al. (1995) reported that a SON (69.9%) was observed more frequently than a SOF (28.9%) whereas Saylam et al. (2003) [18] reported that the frequencies of a notch, foramen or double passage were 71.6%, 26.6%, and 1.8%, respectively. The frequency of SOF ranged from 8% to 51% depending upon the study samples. Study by Berry and Berry (1967) [19] in which skulls from Northern India (Punjab) showed SOF in only 12.3% of cases. Anatomical location of the supraorbital passages is a reliable landmark for the corresponding nerve exit. The supraorbital nerves are prone to injury during procedures involving dissection of the scalp. Many cosmetic surgeons may be reluctant in performing brow lifts and other open as well as endoscopic surgical procedures in this region for fear of injuring the supraorbital nerve and subsequent sensory loss (Rosenberg, 1998; Erdogmus and Govsa, 2007) [20, 21].

In adults the IOF has been variably reported to lie between 4 mm to 10 mm inferior to the inferior orbital margin (Zide and Swift, 1998; Aziz et al., 2000) [22, 23]. In this foetal study, the mean distance of the IOF from the inferior orbital margin was found to be between 2.47—3.40 mm.

Congenital abnormalities that can be repaired prenatally occur in a small percentage of full-term births. Surgical intervention is considered when a foetus presents with a congenital lesion that can compromise or disturb vital function or cause severe postnatal morbidity. Neonatal invasive congenital heart surgery has become an important area of interest [24]. After advances in imaging techniques like ultrasound, CT and MRI many congenital abnormalities such as hydrocephalus, meningomyelocoele, diaphragmatic hernia, facial hypoplasia and cleft palate that can be diagnosed in utero and are amenable to intervention. Plastic surgeon will be able to deal with various congenital deformities with reconstructive surgeries, aimed at restoring function, correcting disfigurement and to avoid further complications.

In our study all the SOF and MF are symmetrically located on both side of midline in same sagittal plane while the IOF is placed slightly lateral to aforementioned sagittal plane.

This locational relationship would be helpful clinically to determine the location of the infraorbital and mental foramina, by palpation of the supraorbital notch in foetal anaesthesia and in foetal surgery.

CONCLUSION

In this study, distances from the midline for both sides were similar for all foramina studied. In the majority of foetuses the SOF/SON, the IOF and the MF were in same sagittal plane with minor variation. There is a relatively narrow zone (width of about <0.5cm), which encompasses all three foramina in the majority of studied foetal skulls. We can ascertain that in our study this zone on average will extend from 8 mm to 12 mm from the midline and can be used for providing regional nerve blocks and performing foetal surgery.

Conflicts of Interests: None

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