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Original Research Article

Detailed Assessment of the Anatomical Location and Variations of IOF in Human Dry Skull: A Morphometric Analysis

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Abstract

Aim: The purpose of the study was to obtain detailed knowledge of the anatomical location and variations of IOF in human dry skull of Bihar population which is imminent for successful regional anaesthesia and endoscopic surgeries of the maxillary region.

Methods: 60 Human skull bones of unknown gender were selected from the Department of Anatomy, Nalanda medical College, Patna, Bihar, India for 12 months. Human adult skull bones without any deformity were included in the study.

Results: The mean distance between ANS to inferior margin of IOF 34.22+0.55 mm on right side & 34.77+0.3 mm on left side. Mean vertical diameter of IOF 3.76 mm on right side & 3.94 mm on left side. Minimum vertical diameter of IOF is 2 mm on both sides. Maximum vertical diameter of IOF is 7 mm on both sides. Mean transverse diameter of IOF 4.18 mm on right side 4.32+15 mm on the left side. Minimum transverse diameter on right side is 3mm& 2mm on left side. Maximum transverse diameter 5mm on right side & 7mm on left side. Accessory IOF were present in 6% of skulls bilaterally. They lie medial to the IOF with mean distance between them as 5 mm on right side & 3 mm on left side.

Conclusion: Thus, the data obtained in this study is at par with studies conducted by different authors of various geographical areas. So the information derived here in identifying the precise location IOF will help surgeons to reduce the adverse outcome of the surgeries centered on IOF in patients of Bihar.

Keywords: Anterior nasal spine (ANS), Infraorbital foramen (IOF), Infraorbital margin (IOM), Infraorbital nerve (ION), Pyriform aperture (PA)

Introduction

Infraorbital foramen is located in the maxilla of the skull bone. The skull is the most complex bony structure in the body. It consists of cranium, facial skeleton, mandible. The vicero cranium (facial skeleton) hangs down from the front of neurocranium (calvaria and basi cranium) and houses the organ of sight, smell, taste as well as openings to the respiratory and digestive systems via nose and mouth respectively. The Upper part of the face is occupied by and the bridge of the nose. Each orbital opening is roughly quadrangular in shape. The, upper, supraorbital margin is formed entirely by the frontal bone. Infraorbital margin is formed by zygomatic bone laterally and maxilla medially. Infraorbital margins are sharp and palpable. The anterior nasal aperture is pyriform in shape, wider below than the above. The upper boundary of aperture is formed by nasal bone while the remainder is formed by maxillae. The anterior nasal spine marks the upper limit of the inter maxillary suture at the lower margin of anterior nasal aperture and is palpable in the nasal septum.

Infraorbital foramen (IOF) is an important anatomical landmark situated bilaterally on the anterior surface of the maxilla below the infrorbital margin and it allows the passage of infraorbital nerve and vessels. [1] The Infra orbital nerve is a continuation of maxillary nerve. It is purely sensory in function. It comes out from IOF after traversing the infra orbital canal and emerges on the face. It ends by dividing into palpebral, nasal and labial branches which supply the skin over the lower eyelid, conjunctiva, lateral aspect of external surface of nose, upper lip, ala of the nose and the premolar teeth. Infra orbital vessels are branches of maxillary artery which supplies the area adjoining IOF. [2]

Infraorbital nerve block through IOF and canal is used to anesthetize the lower eyelid, upper lip, lateral nose, upper teeth and related gingivae. The infraorbital nerve block is used to accomplish regional anesthesia in the maxillo-facial region for diagnostic, surgical and other invasive procedures. [3]

Therapeutic infraorbital nerve blocks are used in intractable and pharmacologically unresponsive trigeminal neuralgia. [4] Knowledge of exact location, shape, and direction of IOF is of paramount importance to decrease anesthetic complication. Infraorbital nerve can also be damaged during zygomatic complex fractures which are one of the most common facial injuries. [5] The key factor which prevents the dentists from using the infraorbital nerve block is the damage to the patient's eye. [6]

Infraorbital margin is formed by zygomatic bone laterally and maxilla medially. Infraorbital margins are sharp and palpable. The anterior nasal aperture is pyriform in shape, wider below than the above. The upper boundary of aperture is formed by nasal bone while the remainder is formed by maxillae. The anterior nasal spine marks the upper limit of the inter-maxillary suture at the lower margin of anterior nasal aperture and is palpable in the nasal septum. The infraorbital foramen transmits the infra orbital vessels and nerve, and lies about 1cm below the middle of the infraorbital margin in maxillary bone. It commonly aligns with a vertical axis passing through maxillary tooth 5 and sits an average of 2.5 cm from the midline face with difference noted between genders and side. The infra orbital nerve, the continuation of maxillary division of trigeminal nerve is a sensory nerve. It supplies skin of the lower eye lid, skin of the side of nose, movable part of nasal septum, skin of anterior part of cheek and upper lip. The branches of the infraorbital nerve joined from the branches of the facial nerve to form the infraorbital plexus. The infraorbital nerve is commonly implicated in trigeminal neuralgia and amenable to cryotherapy when medical therapy fails. [7]

The purpose of the study was to obtain detailed knowledge of the anatomical location and variations of IOF in human dry skull of Bihar population which is imminent for successful regional anaesthesia and endoscopic surgeries of the maxillary region.

Methods

60 Human skull bones of unknown gender were selected from the Department of Anatomy, Nalanda medical College, Patna, Bihar, India for 12 months. Human adult skull bones without any deformity were included in the study.

Foetal skulls and skulls with facial fractures were excluded from the study. Both side of skulls were visually observed for shape, direction of the infraorbital foramen and presence of accessory infraorbital foramina. [8]

1. Sagittal Distance between the infraorbital margin to upper margin of infraorbital foramen were measured.

2. Transverse diameter from lateral margin of pyriform aperture to medial margin of IOF were measured.

3. Oblique distance from anterior nasal spine to inferior margin of IOF, were measured.

4. Vertical and transverse diameter of the IOF were measured. [9]

All the measurements were done on both side of the skull by using sliding vernier calliper{lab world} with the accuracy of 0.1 mm. Software used is SPSS (Trial Version)-23.

Results

Table 1: Number of accessory infraorbital foramen

	Right	Left
Single Infraorbital Foramen	57	57
Accessory Infraorbital Foramen	3	3

Table 2: Mean distance between accessory infraorbital foramen and nearby anatomical landmarks

Infra orbital foramen accessory infraorbital foramen Mean		**Infraorbital margin – Accessory infraorbital foramen Mean**		**Pyriform aperture – Accessory infraorbital foramen Mean**		**Anterior nasal spine – Accessory infraorbital foramen Mean**	
Right	Left	Right	Left	Right	Left	Right	Left
5 mm	3 mm	3 mm	3 mm	18 mm	19 mm	35mm	34 mm

The mean distance between ANS to inferior margin of IOF 34.22+0.55 mm on right side & 34.77+0.3 mm on left side. Mean vertical diameter of IOF 3.76 mm on right side & 3.94 mm on left side. Minimum vertical diameter of IOF is 2 mm on both sides. Maximum vertical diameter of IOF is 7 mm on both sides. Mean transverse diameter of IOF 4.18 mm on right side 4.32+15 mm on the left side. Minimum transverse diameter on right side is 3mm& 2mm on left side. Maximum transverse diameter 5mm on right side & 7mm on left side. Accessory IOF were present in 6% of skulls bilaterally. They lie medial to the IOF with mean distance between them as 5 mm on right side & 3 mm on left side. (Tables 1 and 2)

Table 3: Statistical analysis of IOF regarding its location

DIMENSIONS	Mean ±SD			Median		Mode		Range	
	Right	Left	P value	Right	Left	Right	Left	Right	Left
IOF-IOM	7.09 ± 1.83	6.95±1.76	0.015	7.09	7.0	6.0	7.0	3.5-14	4-12.5
IOF-PA	18.39±2.23	17.89±2.52	0.025	18.0	18.0	18.0	18.0	13 -23	12-24
IOF-LAM	27.88±4.25	27.31±4.45	0.035	28.0	27.0	30.0	25.0	20-36	17-38
VD	3.78± 0.35	3.48 ± 1.12	0.048	3.5	3.0	4.0	03.0	1-5	1-6.5
HD	3.50± 0.91	3.35± 0.85	0.012	3.5	3.0	4.0	03.0	1.5 -6	1-5.5

The mean, standard deviation, median, mode, range and p value of all the measured parameter for infraorbital foramen on both right and left side is discussed in table 1. The range provides an indication of the location of the infraorbital foramen depending upon sample space and the dispersion of values. The mean distance is indicative of the infraorbital foramen location. The standard deviation provides variability in the position of the foramen around mean position. This is very vital information for rapidly locating this foramen during surgical procedures. The mode is the dimension which helps us to know the value which is found in most of the subjects of same racial group. All parameters measured of the IOF displayed significant results while comparing both sides as the p value was <0.05.

Table 4: Location of infraorbital foramen along upper teeth

Location of infraorbital foramen	Frequency n (%)
Between first and second premolar	15 (25)
In line with second premolar	40 (66.66)
Between second premolar and first molar	3 (5)
In line with first molar	2 (3.34)

The locational relationship of the infraorbital foramen in relation to the upper teeth either in line with the longitudinal axis of the upper second premolar or first molar tooth or as lying between the adjacent upper first and second premolars or between second premolar and first molar tooth is shown in table 4.

Discussion

The infraorbital nerve and vessels pass through the infraorbital foramen therefore, knowledge of its location is very essential to surgeons and anesthetists for various surgical procedures in the Indian population. Varshney R, Sharma N found that the mean vertical and horizontal diameters of IOF on the right side are 3.94 and 3.31 mm, while those on the left side are 3.89 and 3.25 mm, while singh R found it as 3.39, 3.19 mm and 3.75, 3.52 mm. The values in the present study the values are 3.78, 3.50 and 3.48, 3.45mm which were almost similar to the results found by varshney R, Sharma N and singh R. [10-12]

In our study, the most common site of IOF in Bihar skulls was found to be in line with the

second premolar tooth (66.66%), followed by its position between the first and second premolar tooth (25%). Sharma et al found that the majority of IOF were oriented to second premolar teeth on the right side and between second premolar and first molar on the left side. [11] Aziz et unobserved the location of IOF in line with the first premolar tooth in White, Black, and Hispanics skulls, verifying the racial differences among these. In the present study IOF was observed at the first molar tooth (5% of Bihar skulls) this advocates a possibility of either a complicating or failed infraorbital nerve block during regional anesthesia.

The mode of the distances of the infraorbital foramen and the infraorbital margin on both sides of the skull was 6mm on right side and 7 mm on left side. The mode of infraorbital foramen and piriform aperture distances on both sides was 18mm. Mode is the value which provides the most frequent distances to be used when locating the infraorbital foramen precisely in relation to piriform aperture or the infraorbital margin.

Infraorbital nerve (ION) is one of the important nerves of facial skeleton which is commonly used for local anaesthetic block during maxillofacial surgeries, dental procedures, used for local anaesthetic block during maxillofacial surgeries, dental procedures, maxillary sinus exploration and endoscopic surgeries involving zygomatic-maxillary region. Any inadvertent injury to the Infra orbital nerve will result in neurological disturbances involving lower lid, lateral side of nose, upper lip affecting the day-to-day activities of the patients. Because of its utmost importance plastic and ENT surgeons try to preserve this nerve during maxillofacial surgeries for which knowledge of the exact location of IOF with reference to the nearby

anatomical landmarks is mandatory for the expert surgeons & anaesthetists.

However surgeons should consider the skew values to prevent surgical complications in the head and neck region and the anesthetist should consider these values for anesthetic failures of nerve block. Skew values are very rare values but their incidences cannot be ruled out. Although the skew values of these distances in data set influence the mean making the analysis more subjective, the results of this analysis will be very useful to surgeons and anesthetist. Information regarding the size and symmetry of the skull foramina is helpful for radiologists when diagnosing difficult pathologies of the skull foramina by using computed tomography/magnetic resonance imaging.[10]

Accessory branch of infraorbital nerve passes via the AIOF implies exact site of AIOF to be known to take the adequate precautions prior to any surgical intervention of this region to preserve the accessory infraorbital nerve. The knowledge of anatomical location and number of accessory foramen is mandatory, to give adequate dosage anaesthetic agents to block the accessory branches of infraorbital nerve, during of midfacies, maxillary and or orbital floor surgical procedures.[8]

Conclusion

Thus, the data obtained in this study is at par with studies conducted by different authors of various geographical areas. So the information derived here in identifying the precise location IOF will help surgeons to reduce the adverse outcome of the surgeries centered on IOF in patients of Bihar. This information is also useful for morphologists who conduct their research on people of different populations and geographical regions. So, the results of our study are another strong evidence of presence of anatomical variations (like accessory infraorbital foramen) in this region that will surely a great guide for general surgeons, ENT professionals, Plastic surgeons, Anaesthetists and dentists operating this region.

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