Morphometric Study Of Infraorbital Foramen In Dry Human Skulls

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Abstract : Background & Objectives:To study the most precise location, shape and direction of infraorbital foramen in dry human skulls, in relation to Infraorbital Margin, Piriform Aperture(PA) and Upper Alveolar Margin(AM). Method: A total of one hundred dry human skulls of unknown gender were measured using digital calliper with Infraorbital Margin, Piriform Margin and Alveolar Margin as reference points. The location, shape, size, direction and number of accessory foramina were observed. Results: The mean distance between the Infraorbital Margin(IOM) and Infraorbital foramen(IOF) was 7.82mm. There was a statically significant difference on right and left sides. The mean distance between the IOF and the piriform aperture(PA) was 16.01mm. The overall vertical diameter of the IOF was 3.23±0.98mm (right) and 3.25±1.03mm (left). The overall horizontal diameter of IOF was 3±0.76mm(right) and 3.28±0.99mm (left).The majority of IOF were directed inferiomedially on both the right (51%) and left (50%) side. There was a superiomedially directed IOF in 1% of skulls, which was not mentioned in the previous literatures. Accessory foramina were found in 20% skulls. Interpretation & Conclusion: Infraorbital foramen is located close to important anatomical structures like orbit, nose, oromaxillary sinuses and upper teeth. The knowledge of anatomical characteristics of the location ,dimension, shapes, directions and number of accessory foramina have clinical implications in the infraorbital nerve block. This information should be kept in mind during local anaesthetic planning for surgeries in the field of Dentistry, ENT, Anaesthesia, Ophthalmology and Surgery. [Bharti B et al NJIRM 2013; 4(3) : 43-49]

KEY Words: Infraorbital foramen, Infraorbital margin , Piriform aperture ,Alveolar margin.

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Introduction: Facial skeleton on the anterior view of the human skull is formed by a frontal bone in the upper part, two maxillae in the central part and a mandible in the lower part.

The central part of the face is occupied by two maxillae separated by the anterior nasal aperture. Each maxilla contributes to the upper jaw, floor of the orbital cavity, the lateral wall of the nose, the floor of the nasal aperture and the bone of the cheek. Medially the maxilla forms the nasal notch. The prominent anterior nasal spine, which surmounts intermaxillary suture at the lower margin of the anterior nasal aperture, is palpable in the nasal septum. The infraorbital foramen, which transmits the infraorbital vessels and nerve, lies about 1 cm below the infraorbital margin[1]. It is a continuation of infraorbital canal, which is present on the orbital surface of the maxilla. This canal opens just below the margin of the orbit. It transmits the infraorbital nerves and infraorbital artery, both of which enter this canal at the infraorbital groove, courses through the maxillary sinus and exits via infraorbital foramen.

The infraorbital nerve is a terminal branch of maxillary nerve[1]. It divides into three groups of branches- the palpabral, the nasal and the superior labial. The palpabral branches supply the skin in the lower eyelid. The nasal branches supply the skin of the side of the nose and of the movable part of the nasal septum. The superior labial branches supply the skin of the anterior part of the cheek and the upper lip .The teeth in the upper jaw are supplied by the three superior alveolar (dental) nerves. The posterior superior alveolar nerve arises from maxillary nerve. The middle superior and anterior superior alveolar nerves arise from infraorbital nerve. The middle superior nerve runs in the lateral wall of maxillary sinus and ends in small branches forming superior dental nerve plexus which supply the upper premolar tooth. The anterior superior alveolar nerve traverses the anterior wall of maxillary sinus, passes towards the nose, divides into branches supplying upper incisors and canine teeth.

The infraorbital artery arises from third part of the maxillary artery. It emerges from the infraorbital foramen on the face to supply the lower eyelid,

lateral aspect of the nose and the upper lip. The upper jaw is supplied by dental arteries which are posterior, middle and anterior superior arteries. The middle and anterior superior alveolar arteries are branches of infraorbital artery. The anterior superior alveolar artery supplies the upper incisors, canine and mucous membrane in the maxillary sinus. It follows the rim of anterior nasal aperture and ends near nasal septum giving its terminal branches.

The infraorbital foramen is located near important anatomical structures like orbit, nose and oral cavity. It finds clinical significance because of its neurovascular contents. The infraorbital nerve block is the local analgesic technique of choice for the regional anaesthesia of the face[2]. The procedure offers several advantages over local tissue infiltration. The infraorbital nerve block achieves anaesthesia with a smaller amount of anaesthetic drug than is required for local infiltration. It can also provide anaesthesia without causing tissue distortion. The infraorbital nerve block is a convenient alternative for situations such as facial lacerations in which tissue distortion would be unacceptable[3]. The infraorbital nerve supplies sensory innervations to the lower eyelid, the side of nose and the upper lip. This nerve is a prime candidate for a regional nerve block on account of this large area of innervation[4].

An infraorbital nerve block is essential during surgical procedures around the orbit, nose and buccal regions. Therefore the location of the infraorbital foramen assumes great importance. This study was conducted for morphometric measurements of the infraorbital foramen in 100 dry human skulls, irrespective of their gender. The aim of this study was to find out the incidence of variations in number, location, shape, dimension and direction of the infraorbital foramen on both the sides of the same skull. The findings of this study were also compared with the findings of other authors.

Material and Methods: One hundred adult dry macerated human skulls of unknown gender were obtained from department of anatomy of various medical colleges in Maharashtra, with prior permission of the concerned authorities. Both sides of each skull were assessed by direct inspection. The location, dimension and direction of infraorbital foramen (IOF) were observed. Skulls with fractures in the supraorbital margin, piriform aperture, infraorbital foramen, infraorbital margin and at the upper alveolar margin , adult skulls in which one side is destroyed, edentulous skulls, foetal and child skulls were excluded from this study. All the measurements were taken on both the sides with the help of digital vernier caliper and noted in millimetre by a single observer. The distances from the upper and lower margins of the infraorbital foramen to the supraorbital margin (lateral to supraorbital notch) and infraorbital margin (where zygomaticomaxillary suture intersects the infraorbital margin) were measured. The distances from the medial margin of the infraorbital foramen to the piriform aperture along the transverse plane that passes through the centre of the infraorbital foramen were measured. The vertical distances from the lower margin of the infraorbital foramen to the upper alveolar margin were measured. The tooth to which this vertical line corresponds was also noted. Vertical and horizontal dimensions of the foramen were also taken with double tipped compass. The compass opening was transferred to calliper and measuring scales to measure the dimensions.The direction of the infraorbital foramen was determined by using a probe in the direction of opening of IOF.

Result: The sample size is of 100 skulls in each group. Various mean distances were documented and compared on right and left sides using Z-test. Statistical significance of the differences in various parameters on right and left side were established on the basis of p value. The level of significance was 5%.The range for various measurements were calculated. Standard deviation in various measurements were calculated. The mean distance of upper margin of infraorbital foramen to supraorbital notch on right side is 38.21 mm (SD ±3.91) and on left side is 38.55 mm (SD ±4.66). This distance lies in the range of 17.59 mm (minimum) and 48.00 mm (maximum). Statistically there is no significant difference between mean distance on

right and left sides of the skull, the calculated p-value = 0.569 > 0.025 (Standard p-value). The mean values of distance of lower margin of infraorbital foramen to supraorbital notch on right side is 39.46mm (SD ±5.93) and on left side is 40.49mm (SD ±5.92). This distance ranges from 16.53mm (Minimum) to 48.87 mm (Maximum) .The overall mean distance between the infraorbital foramen and the supraorbital notch is 39.18 mm .

The mean values of distance of upper margin of infraorbital foramen to infraorbital margin on right side is 6.54 mm (SD ±1.28) on left side is 7.02 mm (SD ±1.42) .The distance ranges from 4.17mm (minimum) to 10.21mm (maximum) .The mean distance of upper margin of infraorbital foramen from infraorbital margin on the right side differ significantly (0.48mm ±0.14) from that on the left side of the skulls with a calculated p-value = 0.014 < 0.025. The mean values of distance of lower margin of infraorbital foramen to infraorbital margin on right side is 8.62mm (SD ±1.23) and on left side is 9.11mm (SD ±1.70).This distance lies in the range of 5.94 mm minimum to 13.7 mm (maximum).Statistically there is a significant difference (0.49mm±0.47) between mean distance of IOM to lower margin of IOF on right and left sides of skull (calculated p-value = 0.021 <0.025). The overall mean distance between the infraorbital foramen and the infraorbital margin is 7.82mm.

The mean values of distance from medial margin of infraorbital foramen to piriform aperture on right side is 16.20mm (SD ±2.72) and on left side is 15.82mm (SD ±2.75). The overall combined mean distance between IOF and PA is 16.01 mm (SD±2.73), with a range of 9.56 mm(min) and 24.24 mm (max). Statistically there is no significant difference (0.37mm±0.02) between mean transverse distance of IOF from PA on right and left sides of skull (calculated p-value = 0.33 > 0.025).

The mean vertical distance from lower margin of infraorbital foramen to upper alveolar margin on right side is 28.93 mm (SD ±4.11) and on left side is 28.42 mm (SD ±4.43). The overall combined mean vertical distance between lower margin of IOF and upper alveolar margin 28.68 mm (SD±4.27). This ranges from 16.99 mm (min) to 42.32 mm (max). Statistically, there is no significant difference (0.5mm±0.31) between lower margin of IOF and upper AM on right and left sides of the skull (calculated p-value = 0.392 > 0.025).

The mean horizontal distance between medial and lateral margin of infraorbital foramen (H) on right side is 3.00 mm (SD ±0.76)and on left side is 3.28 mm (SD ±0.99). Statistically, there is a significant difference (0.28mm±0.23) between mean horizontal dimension of right and left sides of the skull (calculated p-value = 0.024 > 0.025).The mean combined horizontal distance between lateral and medial margins of IOF is 3.14 mm (SD±0.89).The range of this horizontal distance is 0.55 mm (min) to 5.48 mm (max).

The mean vertical distance between upper and lower margins of infraorbital foramen (V) on right side is 3.23mm (SD ±0.98) and on left side is 3.25mm (SD ±1.03).Statistically, there is a significant difference (0.02mm±0.05) between mean vertical dimension of IOF on right and left sides of the skull (p-value = 0.896 > 0.025).The overall combined mean vertical dimension is 3.24mm (SD±1.00), with a range of 0.96 mm (min) to 5.71 mm (max).

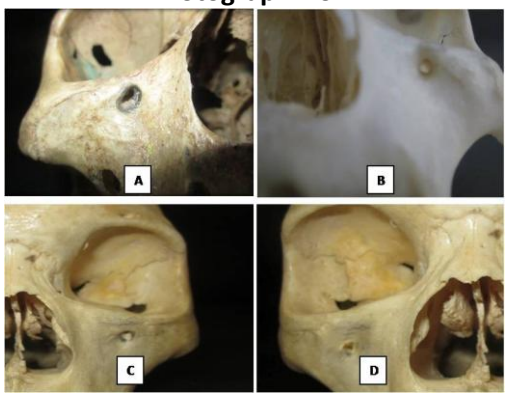
Four different directions of openings of the infraorbital foramen (Photograph No.3) were observed.They were: 1) Inferiomedially directed foramen - in 51% skulls on right side and 50% skulls on left side of the same skull. 2) Inferiorly directed foramen- in 22% skulls on right side and 22% skulls on left side of the same skull. 3) Medially directed foramen - in 26% skulls on right side and in 27% skulls on left side of the same skull. 4) Superiomedially directed foramen (Photograph No.2, 3) – in 1% skull on right side and in 1% skull on left side of the same skull. There is one skull showing openings of infraorbital foramen on right side being inferiomedially and on left side being medially (Photograph no.4). There is no such variant finding reported in the previous literatures. Statistically there is no significant difference in the

direction of opening of infraorbital foramen on the right and left side of the same skull.

Photograph No.1

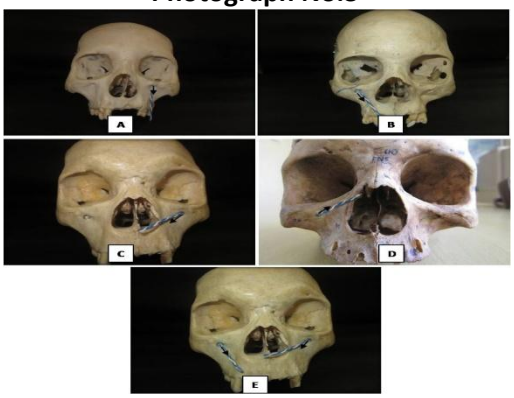
IOF – Infraorbital foramen, IOM-Infraorbital margin, PA-Piriform aperture, AM-Alveolar margin(upper), 1-Distance between IOM and IOF, 2-Transverse Distance between IOFand PA , 3-Vertical Distance between IOF and upper AM.

Photograph No.2



A-OVAL, , B- ROUND, C-SEMILUNAR , D- TRIANGULAR

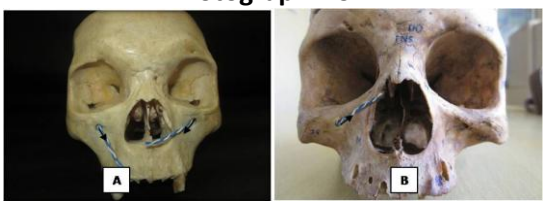
Photograph No.3



A-INFERIORLY , B- INFERIOMEDIALLY, C- MEDIALLY, D-SUPERIOMEDIALLY, E-MEDIALLY (LEFT) AND INFERIOMEDIALLY (RIGHT)

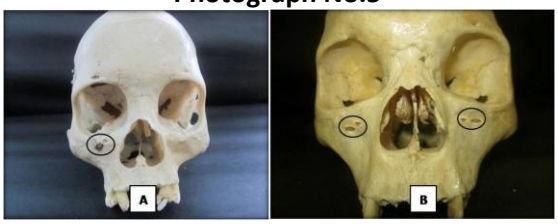
Discussion: The mean distance between the infraorbital foramen and the supraorbital notch is 39.18 mm ,which is very close to the average distance of the center of the supraorbital notch/foramen to the center of the infraorbital foramen by Aziz SR[6] (42.75mm), followed by Apinhasmit[7] (44.95mm) and Ilayperuma[10]

Photograph No.4



A- MEDIALLY (LEFT)AND INFERIOMEDIALLY(RIGHT),
B- SUPERIOMEDIALLY

Photograph No.5



A-UNILATERAL ACCESSORY FORAMEN
B-BILATERAL ACCESSORY FORAMEN

(44.06mm). The position of the infraorbital foramen in relation to the infraorbital margin has been variably reported to lie between 6 mm and 10 mm in previous studies which is corresponding with the result of present study. We can find that the mean distance between the infraorbital foramen and the infraorbital margin ,in the present study, is 7.82 mm, which is very close to that of Agthong et al[13] (7.9mm), Gupta[15] (7.8 mm) and Aziz et al[6] (8.3). However, it is lower than that by Ilayperuma[10] and higher than Cutright B[11], Macedo[5], Elias[12], Hindy[14], Sarala[9], Rajani[5] and Boopathy[8]. The mean distance of lower margin of infraorbital foramen from infraorbital margin on the right side differ significantly (0.49mm±0.47) from that on the left side of the skulls. The distance of the IOF from the IOM on the left side is more than the distance of IOF from the IOM on the right side .This difference in the position of IOF on both the sides is an important information for the surgeons and anaesthetists ,during extraoral and intraoral approach to IOF while performing infraorbital nerve block.

The mean distance of the infraorbital foramen from the piriform aperture in the present study is 16.01 mm which is close to the study by Rajani Singh[4] (15.56 mm). The mean distance of medial

margin of infraorbital foramen from piriform aperture (in a transverse plane) on the right side is almost equal to that on the left side of skulls.The mean vertical distance of lower margin of infraorbital foramen from the alveolar margin, on the right side is almost equal to that on the left side of the skulls.

The dimensions of the left IOF is more than the right IOF .There is a significant difference (0.28mm±0.23) between mean horizontal dimension of right and left sides of the skull (p-value = 0.024 > 0.025). There is a significant difference (0.02mm±0.05) between mean vertical dimension of right and left sides of the skull (p-value = 0.896 > 0.025). The vertical and horizontal dimensions are seen to be closely related to that in the study by Apinhasmit[7] and Rajani Singh[4]. The variation in the dimension on both right and left sides can be because of the difference in the thickness of the infraorbital artery emerging from the infraorbital foramen.

The distance of the IOF from the IOM on the left side is more than the distance of IOF from the IOM on the right side. The size of the left IOF is larger than the size of the right IOF These measurements are in few millimetres (3mm-9mm) and even a minor difference of approximately 0.5mm becomes a significant feature for comparison on both right and left side in a population.

The distance of the IOF from the AM on the right side is more than the distance of IOF from the AM on the left side. This distance is measured in mm (28mm - 29mm) which is close to 1 cm and a difference of approximately 0.5 mm is hardly significant for comparison on both right and left side in a population. Therefore, while palpating the IOF extraorally professionals have to be careful about the variation in its position from different anatomical landmarks.

On the basis of the present study, professionals dealing with the operative and anaesthetic procedure in and around infraorbital foramen should keep in mind that this foramen on left side may be slightly lower than the infraorbital margin (IOM) on the right side. This foramen may be slightly higher on the right side from the alveolar margin (AM) than on left side.

In the present study, the tooth most commonly corresponding to the same vertical line with the infraorbital foramen was 2nd maxillary (upper) premolar tooth which was similar to that found by Apinhashmit[7], A.T. Bosenberg[2] and Gupta[15]. the second most commonly corresponding tooth to the same vertical line with the infraorbital foramen was 1st maxillary (upper) premolar tooth which was also found in the study by Aziz SR[6] .In the present study this finding is further followed by the vertical line passing behind the second upper premolar and least commonly by line passing between the first and second maxillary premolars.There is a significant difference between the proportion on the right side and left side for 1st and 2nd PM (p value=0.009<0.05). In the remaining skulls the difference between the proportion on the right side and left side for the vertical line corresponding with the other tooth is not statistically significant . The second most commonly corresponding tooth to the same vertical line with the infraorbital foramen was 1st maxillary (upper) premolar tooth which was also found in the study by Aziz SR[6] .In the present study this finding is further followed by the vertical line passing behind the second upper premolar and least commonly by line passing between the first and second maxillary premolars.This vertical relation of IOF with the tooth in upper alveolar margin is an important guide to the anaesthetists during intraoral approach of infraorbital nerve block.

In the present study, majority of IOF was directed inferiomedially (51% on right side and 50% on left side).This was close to the findings by Boopathy S[8](55% on right side and 52.50% on left side).The inferiorly directed infraorbital foramen (22% right and 22% left side)which was similar to the observation by Boopathy S[8] (38.75% right and 43.75% left) and Apinhashmit[7] (12.3%) which they termed as vertically directed and downward directed respectively.Medially directed infraorbital foramen (26% on right and 27% left side) , which

was higher than the result by Boopathy[8] (6.25% on right and 3.75% on left side). Apinhashmit[7] observed medially directed infraorbital foramen in 87.7% of the skulls, which was higher than that in the present study.

The incidence of the superiomedially directed infraorbital foramen is 1% on right and left sides of the same skull in the present finding.There was no reference in the literature related to the superiomedially directed infraorbital foramen. This may be due to the atrophy in the aging skull of maxillary sinus. The normally directed infraorbital foramen may have undergone change in direction to give a variant form of direction of opening of infraorbital foramen as superomedial.

There was one skull showing openings of infraorbital foramen on right side being inferomedially and on left side being medially (Photograph no.3). There is no such variant finding reported in the previous literatures.Statistically there is no significant difference in the direction of opening of infraorbital foramen on the right and the left side of the same skull.

The variation on both the sides may be because of facial asymmetry. There may be difference in the dimension of IOF because of effect of climate. The requirement of blood supply on face to keep it warm in colder climate is more and hence blood vessels become thickened and lead to larger size of IOF while emerging out of this foramen.

Conclusion: The infraorbital foramen is an important site of regional anaesthesia. Infraorbital nerve is the nerve of choice for regional nerve block by the professionals performing surgeries in the orbital, buccal and nasal areas .The distance of infraorbital foramen from the infraorbital margin was significantly different on both right and left side. The IOF was lying 7-8mm below the infraorbital margin. It was lower on the left side than the right side. The dimensions (size) of infraorbital foramen differ significantly on both right and left side. It was larger on the left side than the right side. Four different shapes of the infraorbital foramen were observed – oval, round, triangular and semilunar. The observed shape of the infraorbital foramen was same on both the sides.

Four different directions of the openings of foramina were observed. They were directed inferiorly, inferomedially, medially and superomedially. All skulls had same directions of opening on both the sides of same skull with the exception of one skull. One skull had different directions of opening of the foramen - inferomedially on right side and medially on left side. Only one skull had superomedially directed foramen on both the side of same skull. This may be a variation from normal direction of opening of the foramen or a result of some pathology. From the piriform aperture the IOF was located almost 16-17mm laterally. The vertical distance of IOF from the alveolar margin was 28mm.

Out of 100 skulls, 20 skulls showed accessory foramen. The knowledge of the location, shapes, direction, number ,difference between right and left side and its variations will help the professionals in the field of Surgery, ENT, Ophthalmology, Acupuncture and Dentistry to assess the infraorbital foramen for regional nerve block which is an important procedure during operative and invasive procedures performed in this region.

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