

Original Research Article

Morphometric Analysis of Infra Orbital Foramen by A Cone Beam Computed Tomography

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Abstract

Infraorbital foramen conveys infraorbital nerve and vessel, and knowledge about is mandatory. The present study was designed to assess the infraorbital foramen location in Kurdistan population in relation to side and gender. Fortyone beams computed tomographies of adult Kurdistan patients were selected. Axial, sagittal, coronal views and three dimensional reconstruction models were analyzed to achive all informations. The distances of infraorbital foramen from facial midline, infraorbital rim, and piriform aperture were assessed. The locational relationship to upper teeth and supraorbital foramen was also recorded. The mean distance of medial margin of infra orbital foramen from facial midline was 24.09 ± 2.62 mm, and the mean distance of its superior margin from infraorbital rim was 7.53 ± 1.46 mm. Non-significant difference present between the sides and between gender son right side, but it was significant on left side. The mean distance between its medial border and the piriform aperture of the nose was 17.83 ± 2.28 mm. No significant difference present between sides, but it was significant between genders on both sides. The most common position of the infraorbital foramen was found in position between the upper first and second premolars (40%), and the most common position in relation to the supraorbital foramen/notch was lateral to its lateral margin (55%). No statistically significant difference was noted between sides and genders. The results of the present study may assist dentists and surgeons to localize infraorbital foramen to facilitatelocal anesthetic and surgical procedure.

Key Words:Infra orbital foramen, maxillary bone, cone beam computed tomography, infra orbital rim, infra orbital neurovascular bundles, supra orbital foramen/notch.

الخلاصة

الثقبية تحت محجر العين تنقل العصب والأوعية التي تحت المحجر ، والمعرفة بها هي إلزامية. الهدف من هذه الدراسة لتقييم موقع الثقبية تحت محجر العين في سكان كردستان فيما يتعلق بالجانب والجنس. أربعون تصوير مقطعي شعاعي مخروطي لمرضى كردستان البالغين تم اختيارهم. ، وقد تم تحليل الوجه المحوري، السهمي، الاكليلي والنماذج التركيبية ذو ثلاثة ابعاد لتحقيق جميع المعلومات. المسافة من الثقبية تحت المحجر من خط الوسط الوجه، حافه تحت المحجر، والفتحة الكمثرية تم تقييمها. العلاقة المكانية لها مع الأسنان العلوية والثقبية فوق المحجر سجلت ايضا. كانت متوسط المسافة بين الحافه الوسطية للثقبية تحت المحجر وخط الوسط للوجه هي 24.09 ± 2.62 ملم، وكان متوسط المسافة بين الحافة العلوية لها وحافة تحت المحجر هي 7.53 ± 1.46 ملم. أظهرت النتائج عدم وجود فرق معنوي بين الجانب الأيمن والأيسر، وبين الجنسين على الجانب الأيمن، لكن الفرق كان معنويا على الجانب الأيسر. كانت متوسطة المسافة بين الحافة الوسطية والفتحة الكمثرية الأنف هي 17.83 ± 2.28 ملم. لا يوجد فرق معنوي بين الجانبين، ولكنه كان معنوي بين الجنسين في كلا الجانبين. الموقع الأكثر شيوعا لثقبية تحت المحجر بالنسبة إلى الأسنان العلوية هو موقع بين الضواحك الأولى والثانية (40٪)، وكان الموقع الأكثر شيوعا فيما يتعلق بالثقبية فوق المحجر / الحز هو هامشي للحافة الجانبية (55٪). لا يوجد اختلاف معنوي تم ملاحظته بين الجانبين وبين الأجناس. إن نتائج هذه الدراسة قد تساعد اطباء الاسنان والجراحين في تحديد الثقبية تحت المحجر لتسهيل التخدير الموضعي والعمليات الجراحية.

Introduction

Infra orbital foramen (IOF) is an significant anatomical landmark, located bilaterally in the maxilla below the inferior orbital rim and assist the passage of the infra orbital artery (IOA), vein (IOV), and nerve (ION) [1]. Evidences showed a variation in the morphology and relative position of the IOF among different populations [2], inhabitants of the same geographic environment [3], and in its relation to the maxillary teeth [4].

Good localization of IOF is very important to allow effective ION block and helps to prevent in any injury to the ION during facial operations, as infacial fracture surgery and cosmetic operations [5, 6].

Cone beam computed tomography (CBCT) is one of the most important developments in dental radiology which gained great popularity in dentistry [7]. CBCT has short exposure time and less image distortion, in addition to the multiplanar screening and the decreased patient dose. It helps to localize the anatomic structures of the maxillofacial region and the adjacent important structures which can be visualized in various planes [8].

The objective of this study was to elucidate the location of IOF in relation to facial midline, infraorbital rim (IOR), piriform aperture (PA) of the nose, maxillary premolars and first molar tooth, and with the supraorbital foramen (SOF) /notch (SON).

Materials and Methods

Forty CBCT scans of adult Kurdish patients, (20) males and (20) females were selected and their ages were over 18 years. They were visited the Radiological Department/ College of Dentistry, Hawler Medical University (HMU), and DENTA private center in Erbil/ Iraq in the periods from 2013 to June 2016. These patients have undergone CBCT scans for various medical reasons. Within each CBCT, maxillary first and second premolars, and maxillary first molar should be present. CBCT with

multiple IOF or SOF/N, and CBCT of any patients had undergone a previous maxillofacial surgery, or had maxilla of acial pathology, mid face fracture or maxillary dental irregularity were excluded from the study.

New tom Giano CBCT 3D imaging- QR Sr- via silvestrini, 20- 37135 Verona, Italy- was used in the study. All scans were performed by using a patient-positioning protocol and a standard exposure. The axial, sagittal and coronal views and three dimensional (3D) reconstruction models, were studied and analyzed to achieve various distance measurements from the IOF.

The slices at an interval of 0.5mm were viewed for localization and morphometric analysis of IOF. New tom Giano software NNT viewer (version 6.1) software was used to assist in the measurements between the IOF and the all anatomical landmarks mentioned. All the analysis were studied bilaterally and compared between the sides and the genders.

The locational relation of IOF to the following anatomical landmarks was assessed:

A). Transverse distance between the medial borders of IOF and the facial midline for both sides in coronal view (Figure-1A). The midline is a line which is drawn between the crista galli and the midpoint of the fusion of the hard palate [9].

B). Vertical distance between the superior border of IOF and IOR in sagittal view (Figure-1B).

C). Transverse distance between medial border of IOF and PA of the nose in axial view (Figure-1C).

D). The locational relationship of the IOF in relation to the upper teeth was recorded as: in line with the longitudinal axis of the upper second premolar (PM) or first molar (M) tooth or as lying between the upper first and second PMs or between second PM and first M tooth by 3- dimensional reconstruction model (Figure-2A).

E).The location of IOF in relation with the SOF (lateral, in line, medial to SOF) was recorded by 3- dimensional reconstruction model (Figure-2B).

Statistical Package for Social Sciences (SPSS) was used to statistically analyze the

data. Chi-square test and t test were used to analyze the differences for each measurement regarding the gender and side. P-value less or equal to 0.05 was considered statistically significant.

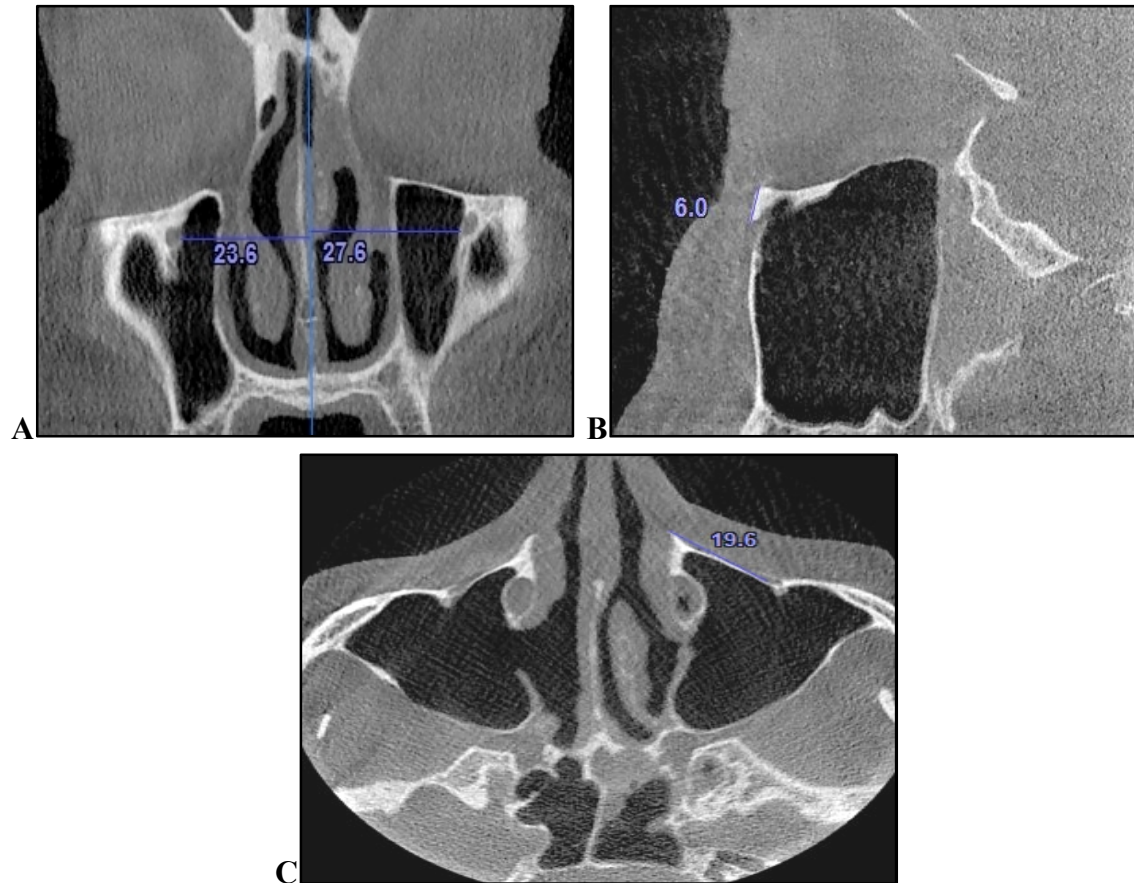


Figure 1-(A): The transverse distance measurement between medial borders of (IOF) and facial midline in coronal view.(B) Vertical distance between superior border of (IOF) and (IOR) in sagittal view.(C) Transverse distance between medial border of the (IOF) and (PA) of nose in sagittal view.

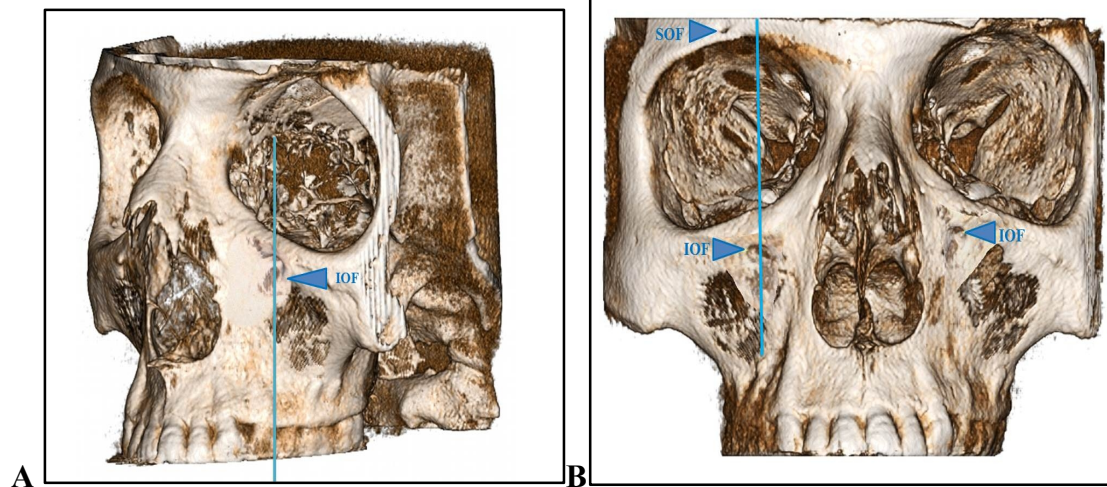


Figure 2-(A): The locational relationship of the (IOF) in relation to the upper teeth, and(B) in relation with the (SOF) by 3-dimensional reconstruction model.

Results

The total sample size was 40 subjects (20 males and 20 females), and their ages ranged from 19 to 55 years, with a mean age of (37.35 ± 12.39) years for the total sample. The male's ages ranged from 22 to 53 years with a mean age of (36.8 ± 12) years. The female's ages ranged from 19 to 55 years with a mean age of (37.9 ± 13.1) years. All the CBCT scans studied showed an IOF on both sides.

The transverse distance between medial borders of IOF and facial midline

The mean distance between the medial margin of IOF and the facial midline in present study was 24.09 ± 2.62 mm (the maximum distance was 31 mm, and the minimum distance was 20.6 mm). The total mean distance on the right side was (24.22 ± 2.67) mm and while the total mean distance on the left side was (23.95 ± 2.59) mm. Statistically a non-significant difference in distances present ($p=0.387$) between the right or the left side from the facial midline.

The mean distances of IOF from the facial midline on right side for males was (24.89 ± 2.12) mm, while for females was (23.55 ± 3.03) mm. Statistically a non-significant difference present ($p=0.115$) between males and females regarding this distance from the facial midline on right side.

The mean distances of IOF from facial midline on left side for males was (25.11 ± 2.27) mm, while for females was (22.70 ± 2.31) mm. Statistically a significant difference present ($p=0.002$) between males and females regarding this distance from the facial midline on left side.

The vertical distance between the superior border of IOF and IOR

The mean distance of superior margin of IOF from IOR was 7.53 ± 1.46 mm (the maximum distance was 11 mm, and the minimum distance was 4.2 mm). The total mean distance on the right side was (7.47 ± 1.60) mm and while the total mean distance on the left side was (7.58 ± 1.33) mm. Statistically a non-significant difference in distances present ($p=0.545$) between the right or the left side from the IOR.

The mean distance of IOF from the IOR on right side for males was (7.88 ± 1.54) mm, while for females was (7.06 ± 1.60) mm. Statistically a non-significant difference present ($p=0.106$) between males and females regarding this distance from the IOR on right side.

The mean distances of IOF from IOR on left side for males was (8.20 ± 1.44) mm, while for females was (6.96 ± 0.87) mm. Statistically a significant difference present ($p=0.002$) between males and females regarding this distance from the IOR on left side.

The transverse distance between medial border of IOF and PA

The mean distance between medial border of IOF and the PA was 17.83 ± 2.28 mm (the maximum distance was 23.1 mm, and the minimum distance was 13.4 mm). The total mean distance on the right side was (17.69 ± 2.10 mm) and while the total mean distance on the left side was (17.97 ± 2.46 mm). Statistically a nonsignificant difference in distances present ($p=0.249$) between the right or the left side from the PA.

The mean distances of IOF from the PA on right side for males was (19.20 ± 1.67 mm), while for females was (16.17 ± 1.19 mm). Statistically a significant difference present ($p= 0.000$) between males and females regarding this distance from the PA on right side.

The mean distances of IOF from PA on left side for males was (19.48 ± 2.05 mm), while for females was (16.46 ± 1.84 mm). Statistically a significant difference present ($p=0.000$) between males and females regarding this distance from the PA on left side.

The locational relationship of the IOF in relation to the upper posterior teeth

The most common position for the IOF in relation to the upper teeth was found in a position between first and second PMs (40%). The IOF was located in line with second PM in 30% of the cases, followed by the interval between the second PM and the first M in 22.50% of the cases and it was

located in line with the first M in 7.50% of the study subjects. In the right side, most of the cases were found in a position between first and second PMs (40%), in line with second PM in 30% of the cases, between 2nd PM and 1st M in 20% of the cases, and in line with 1st M in 10% of the cases studied. Most of the cases in the left side were found in a position between first and second PMs (40%) or in line with second PM in 30% of the cases, between 2nd PM and 1st M in 25% of the cases, and in line with 1st M in 5% of the cases. No statistically significant difference was noted ($p= 0.828$) between sides.

In right side, (40%) of the cases in males, the IOF seen in line between the first and second PM and (30%) of the cases seen in position between second PM and first M. While in females, most of the cases seen in line between the first and second PMs (40%) and in line with the second PM (40%). Statistical analysis showed non- significant differences present ($p=0.343$) between male and female for right side (Table-1).

In left side, (40%) of the cases in males, the IOF seen in line between the first and second PMs and (30%) of the cases seen in position between second PM and first M. While in females, most of the cases seen in line between the first and second PMs (40%) and in line with the second PM (40%). No cases seen in line with the first M. Statistical analysis showed non- significant differences present ($p=0.435$) between male and female for left side (Table-1).

Table 1: IOF position in relation to upper posterior teeth for both sides in relation to gender

Side	Gender	No	Between first and second PM	In line with second PM	Between second PM and first M	In line with first M	P- value
Right	Male	20	40.00%	20.00%	30.00%	10.00%	0.343
	Female	20	40.00%	40.00%	10.00%	10.00%	
Left	Male	20	40.00%	20.00%	30.00%	10.00%	0.435
	Female	20	40.00%	40.00%	20.00%	0.00%	

Location of IOF in relation with SOF

The most common position for the IOF in relation to the SOF/N was lateral to the lateral margin of the SOF/N in (55%). The IOF and SOF/N were lying in the same sagittal plane only in 28.75 % of the subjects, and in 16.25% of subjects it was

located medial to the medial margin of SOF/N. In both sides, most of cases were found lateral to the lateral margin of the SOF/N. No statistically significant difference was noted ($p=0.756$) between right and left side (Table-2).

Table 2: Position of IOF in relation to SOF/N between sides

Side	Lateral to SOF/N	In line with SOF/N	Medial to SOF/N	P- value
Right	52.50%	32.50%	15.00%	0.756
Left	57.50%	25.00%	17.50%	

In right side, most of the cases in males, the IOF seen in line which was lateral to SOF/N in (55%) of cases followed by the position in line with SOF/N in (30%). While in females, the IOF seen in line lateral to SOF/N in (55%) of cases followed by the position in line with SOF/N in (35%). The rest of cases (15%), the IOF seen medial to SOF/N in males and females for the right side. Statistical analysis showed non- significant differences present ($p=0.939$) between male and female for right side (Table-3).

In left side most of the cases in males, the IOF seen in line which was lateral to SOF/N in (60%) of cases followed by the position in line or medial to SOF/N in (20%) of cases. While in females, the IOF seen in line lateral to SOF/N in (55%) of cases followed by the position in line with SOF/N in (30%). The rest of cases (15%), the IOF seen medial to SOF/N in females for the left side. Statistically no significant differences present ($p=0.746$) between male and female for left side (Table-3).

Table 3: Position of IOF in relation to SOF/N between genders on both sides

Side	Gender	No	Lateral to SOF/N	In line with SOF/N	Medial to SOF/N	P-value
Right	Male	20	55.00%	30.00%	15.00%	0.939
	Female	20	50.00%	35.00%	15.00%	
Left	Male	20	60.00%	20.00%	20.00%	0.746
	Female	20	55.00%	30.00%	15.00%	

Discussion

The present study showed that the total mean distance of medial margin of IOF from facial midline was (24.09 ± 2.62 mm), which is lower than Indian[10] and Kenyan populations[11], which were 27.20mm, 28.5mm and 28.65mm, respectively. These studies used the center of IOF in dry skulls as a point for taking measurements. Such a point is difficult to locate and define, and

when using this point, there is a chance to giving error measurements. That's why the distance between IOF and facial midline of those studies were somewhat higher than the same distance of present study.

The total mean distance on right side was (24.22 ± 2.67 mm), while the total mean distance on the left side was (23.95 ± 2.59 mm). Statistically, no significant difference present between the sides in the distances from the FM ($p=0.387$). This result agrees with others[11,12]. Non-significant

difference in this distance present between males and females on right side ($p= 0.115$), but it was significant on left side ($p=0.002$), unlike to other study reported non-significant differences were found when comparing mean distances between males and females on both sides [11].

Our results showed that the total mean distance of superior margin of IOF from IOR was to be ($7.53 \pm 1.46\text{mm}$), which is nearly equal to other findings (7.13 mm)[13]. These results is less than the data informed in Korean[14]and in American[15] which are 9.60 mm and 8.53mm respectively, but higher than other results seen in Indian which are 6.78 mm and 6.77mm respectively[5,16].

The total mean distance on the right side was ($7.47 \pm 1.60\text{mm}$), while the total mean distance on the left side was ($7.58 \pm 1.33\text{mm}$). Statistically a non- significant difference in distances present ($p=0.545$) between the right and the left side from the IOR. This comes in agreement with others [17], whereas, disagreement with some authors who reported a significant difference present between sides in distances from upper border of IOF to IOR [5,18,19]. Non-significant difference in this distance present between males and females on right side ($p=0.106$), but a significant difference between genders on left side ($p=0.002$) was seen, unlike to the studies[15, 20], where they reported that non- significant difference was seen when comparing between males and females of the same side.

The present study revealed that the total mean distance between medial border of IOF and the PA was ($17.83 \pm 2.28\text{mm}$), which was nearly similar to the results found in Brazilian and in Indian, which were 17.69 mm and 18.13mm respectively[13, 18]. However these results were higher than that seen by others in Indian who's reported a distance of 16.01mm [5].

The total mean distance on the right side was ($17.69 \pm 2.10\text{mm}$), while the total mean distance on the left side was (17.97 ± 2.46

mm). Statistically a non-significant difference in the distances present ($p=0.249$) between the right and the left side from the PA. These result agree with some studies[5,18], and disagree with others[19].

Our results found significant gender differences in the distance between medial border of the IOF and the PA on both right and left sides ($P= 0.000$). From the present results, these measurements are shorter in females than in males, which was similar to other study [15]. Therefore professionals should be aware about these variations, and also gender should be taken in to account when IOF is to be located, as the distance from IOF to the PA may be longer in males than in females.

In the present study the interval between 1st PM and 2nd PM had the most common vertical orientation with IOF (40%). This percentage was higher than the reports by others, which were 31.60%, 29.63%, 23.30% and 31%, respectively[3, 19, 20, 21]. However, the majority of studies reported that the most common tooth which is located to the same vertical line with the IOF was 2nd PM[3, 4, 5, 21].

According to the results of present study, the most common position of IOF was found to be lateral to the sagittal plane passing through the SOF/N in (55%) of total subjects. The results are in accordance with those reported by others [4] which was (53.20%), and are lower than the studies described by others which were 63.60%, 68.52%, 69.2% and 88% of total subjects, respectively[3,10,17,21]. Information regarding locational relationship between SOF/N and IOF is of great help to determine clinically the location of the IOF as SOF/N can be easily palpated[21].

The present study about the localization of IOF may provide guidance to the maxillofacial surgeons and dentists to localize IOF in Kurdish population to prevent and avoid injury to the neuromuscular bundles and the local anesthetic procedures become very easy.

Conclusions

1. The total mean distance of medial margin of IOF from the facial midline was 24.09 ± 2.62 mm. Non-significant difference in this distances present between sides or between genders on right side ($p=0.115$), but it was significant on left side ($p=0.002$).

2. The total mean distance of superior margin of IOF from IOR was 7.53 ± 1.46 mm. Non-significant difference in this distances present between sides ($p=0.545$) or between genders on right side ($p=0.106$), but it was significant on left side ($p=0.002$).

3. The total mean distance between medial border of IOF and the PA was 17.83 ± 2.28 mm. Non-significant difference in this distances present between the sides ($p=0.249$), but a significant difference was found between genders on the right and left side ($p=0.000$).

4. The most common position for the IOF relative to the upper teeth was found in a position between first and second PMs (40%). No statistically significant difference was noted between the sides ($p=0.828$), and between genders for the right ($p=0.343$) and left ($p=0.435$) side.

5. The most common position for the IOF in relation to the SOF/N was lateral to the lateral margin of the SOF in (55%). No statistically significant difference was noted between the sides ($p=0.756$), and between genders for the right ($p=0.939$) and left side ($p=0.746$).

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