Computed tomographic localization of infraorbital foramen position and correlation with the age and gender of Iraqi subjects

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ABSTRACT

Background: The Infraorbital foramen is an anatomical structure with an important location in the maxilla, position of foramen in maxillofacial area is necessary in clinical situation requiring regional nerve blocks that are performed in children undergoing facial surgeries to avoid injury to corresponding nerve. The aim of study was to determine the position of the Infraorbital foramen and to correlate Infraorbital foramen position with age and gender using computed tomography.

Subjects, Materials, and Methods: The sample consist of prospective study for 50 Iraqi subjects (21 male and 29 female) with age ranged from (5-17) years. The examination was performed on Multi – Slice Spiral Tomography scanner in Al-Karakh General Hospital. Using sagittal and coronal sections including right and left sides and the following measurements were done:

1. The distance from crista galli to the midpoint of fusion of hard palate(Midline of the patient) in the coronal section.
2. The distance from mid line to the infraorbital foramen, in the coronal section for both sides right and left.
3. The distance from sella turcica to the infraorbital foramen, in sagittal section for both sides right and left.
4. The distance from nasion to the infraorbital foramen, in coronal section for both sides right and left.

Results: The partial regression coefficient for each year increase in age the linear measurements (midline-infraorbital foramen) (nasion-infraorbital foramen) and (vertical distance from nasion meeting the horizontal line from infraorbital foramen to midline) are expected to significantly increase after adjusting for confounding effect of gender. From multiple linear regression model designed in this study two mathematical formulae were derived for correlation of infraorbital foramen position with the age and gender:-

Y1 [Linear measurement (Midline-Infraorbital foramen) mm] = 19.56 + (1.02 x gender) + (0.53x age in years).

Y2 [Linear measurement (vertical distance from nasion meeting the horizontal line from Infraorbital foramen to midline)] = 28.42 + (2.5 x gender) + (0.30 x age in years).

Conclusions: Computed tomography scan information facilitates the localization of infraorbital foramen position for successful access of the needle in infraorbital nerve block in children of different age and gender.

Key words: Infraorbital foramen position, Computed Tomographic, Infraorbital nerve block. (J Bagh Coll Dentistry 2013; 25(Special Issue 1):30-35).

INTRODUCTION

Infraorbital foramen (IOF) is located in the maxillae which are the largest bones of the face, above the canine fossa, the end of the infraorbital canal (IOC); it transmits the infraorbital vessels and nerve [(1-3)]. Anatomically the maxillary nerve has several branches that can be blocked by the use of local anesthetic solution. In infraorbital canal, the nerve gives rise to 2 branches: the anterior superior alveolar nerve and the middle superior alveolar nerve. These sensory nerves supply the mucous membrane of the anterior portion of inferior meatus and the floor of the nasal cavity. As the nerve exits the infraorbital foramen, it gives rise to 3 branches: [(4-6)]

1. Inferior palpebral, which supplies the skin and conductive of the lower eyelid.
2. External nasal, which supplies the side of nose and the nasal septum and joins the terminal twigs of the naso ciliary nerve.
3. Superior labial which supplies the sensory innervations of the upper lip, the mucous membrane of the mouth and the labial glands they are joined immediately below the orbit by filaments of the facial nerve & form the infra orbital plexus.

A sensory block of the infraorbital nerve (ION) can be performed and the access by use of an intra oral route or an extra oral route (atranscutaneous). For these approaches, recognition of the location of the IOF is crucial, once the location of the infra orbital foramen is determined, a needle is advanced either through the skin directly toward the IOF or through mouth at the level of the incisor at alveolar-buccal mucosal margin in the subsulcal plane. In our study CT localization of IOF position in children of varying age groups to facilitate successful placement of ION block required for different maxillofacial surgeries [(8, 9)].

MATERIALS AND METHODES

The study sample consist of 50 Iraqi subjects (21 male and 29 female) with age ranged from

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(5-17) years , attending the maxillofacial department at al-Gerahat Specialist and Al-karakh General Hospitals in Baghdad from September 2011 to march 2012, for various maxillofacial surgeries. The examination was performed on multi – slice spiral tomography scanner (The Philips Brilliance CT-64) in (AL-KARKH GENERAL HOSPITAL) To identify the exact position of IOF for both sides (right and left) using coronal and sagittal sections as shown in figure (2-4 and 2-5) and the following measurements were done:

1. C-M The distance from crista galli to the midpoint of fusion of hard palate (mid line of the patient), in the coronal section.
2. Midline-IOF The distance from mid line to the IOF, in the coronal section for both sides right and left .
3. N-IOF The distance from nasion to the IOF, in coronal section for both sides right and left .
4. S-IOF The distance from sella turcica to the IOF, in sagittal section for both sides right and left.

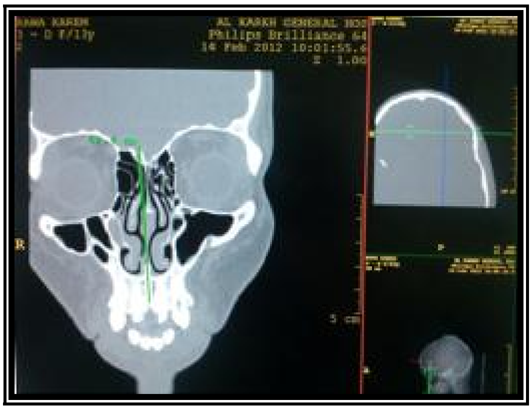

Figure 1: Measurement of C-M in coronal section.

Figure 2: Measurement of Midline-IOF in coronal section.

Figure 3: Measurement of N-IOF (right and left) in coronal section.

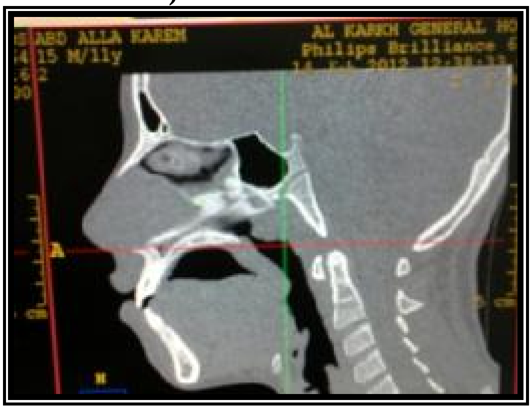

Figure 4: Sagittal section without manipulation of image

Figure 5: Measurement of S-IOF in sagital section with manipulation of image

Statistical data analysis

The multiple linear regression model was used to assess the predictive power of age and gender on each specific measurement. The model provide the following parameters:

1. P model: for the model to be generalized to the population it must be statistically significant.
2. B (partial regression coefficient):

The amount of change in outcome (response) variable for each unit increase in the independent (explanatory) variable after adjusting for other explanatory variables included in the model.

1. P value for regression coefficient
2. Determination coefficient (R2):
3. Means the amount of explained variation in the dependent variable.

Asymmetry index (laterality dimorphism) measure magnitude of a difference between right and left side as a percentage of a reference side (either right or left) in the current study since the right side measurement was larger than the left side, the formula used referred to the left side measurement as reference. Therefore apposition value for the index means that the right side is larger while a negative index indicates that the right side is smaller than the left. [10]

Asymmetry Index = $\frac{\text{RIGHT SIDE} - \text{LEFT SIDE X100}}{\text{LEFT SIDE}}$

RESULTS

This study included 50 Iraqi subjects age ranged from (5-17) years .The distribution of gender in the total sample was 21 males 42% and 29 females 58%.

A multiple linear regression model was used to calculate the net and independent effect of age and gender on of each of the selected linear measurements magnitude.

As shown in the table (1):-

1- For each year increase in age the linear measurement (C to M) the partial regression coefficient is expected to significantly increase by 1.120 mm after adjusting for confounding effect of gender.

2-Male gender is associated with a higher mean by an average of 4.400 mm compared to females this effect reaches the level of statistical significant after adjusting for age. The model was statistically significant and able to explain 46.2%is observed variation in measurement.

Table 1: Multiple linear regression model with (linear measurement Crista galli to midpalate) as the dependent (response) variable in addition to gender and age as independent (explanatory) variables.

Linear measurement (C to M) mm	Partial regression coefficient	P
(Constant)	44.320	<0.001
Gender	4.400	0.003
Age in years	1.120	<0.001

R2 = 0.462
P (model) < 0.001

As shown in the table (2):-

1- For each year increase in age the linear measurement (N-IOF) the partial regression coefficient is expected to significantly increase by 0.59mm after adjusting for confounding effect of gender.

2-Male gender is associated with a higher mean by an average of 7.87 mm compared to females this effect reaches the level of statistical significant after adjusting for age. The model was statistically significant and able to explain 28.1%is observed variation in measurement.

Table 2: Multiple linear regression model with (linear measurement N to IOF) as the dependent (response) variable in addition to gender and age as independent (explanatory) variables

Linear measurement (N-IOF) mm	Partial regression coefficient	P
(Constant)	34.39	<0.001
Gender	7.87	<0.001
Age in years	0.59	<0.001

R2 = 0.281
P (model) < 0.001

As shown in the table (3):-

1-For each year increase in age the linear measurement (Midline-IOF) the partial regression coefficient is expected to significantly increase by 0.53 mm after adjusting for confounding effect of gender.

2-Male gender is associated with a higher mean by an average of 1.02 mm compared to females this effect fail to reach the level of statistical significant after adjusting for age. The model was statistically significant and able to explain 13%is observed variation in measurement.

Table 3: Multiple linear regression model with (linear measurement Midline to IOF) as the dependent (response) variable in addition to gender and age as independent (explanatory) variables

Linear measurement (Midline-IOF) mm	Partial regression coefficient	P
(Constant)	19.56	<0.001
Gender	1.02	0.31[NS]
Age in years	0.53	<0.001

R2 = 0.13
P (model) = 0.001

A mathematic formula can be derived from the above multiple linear regression model to localize the exact position of IOF in relation to the age and gender for each patient:

Y1 [Linear measurement (Midline-IOF) mm] = 19.56 + (1.02 × gender) + (0.53× age in years).

As shown in the table (4):-

1-For each year increases in age the linear measurement (Vertical distance from N meeting the horizontal line from IOF to midline) the partial regression coefficient is expected to significantly increase by 0.30 mm after adjusting for confounding effect of gender.

2-Male gender is associated with a higher mean by an average of 2.50mm compared to females. This effect reaches the level of statistical significant after adjusting for age. The model was statistically significant and able to explain 8.5%is observed variation in measurement.

Table 4: Multiple linear regression model with (linear measurement vertical distance from N to IOF horizontal line) as the dependent (response) variable in addition to gender and age as independent (explanatory) variables

Linear measurement (Vertical distance from N meeting the horizontal line from IOF to midline)	Partial regression coefficient	P
(Constant)	28.42	<0.001
Gender	2.50	0.021
Age in years	0.30	0.048

R^2 = 0.085
P (model) = 0.014

A mathematic formula can be derived from the above multiple linear regression model to localize the exact position of IOF in relation to the age and gender for each patient:

Y2 [Linear measurement (vertical distance from N meeting the horizontal line from IOF to midline)] = 28.42 + (2.5 × gender) + (0.30 × age in years).

As shown in the table (5):-

1-For each year increase in age the linear measurement (S-IOF) the partial regression coefficient is expected to significantly increase by0.66mm after adjusting for confounding effect of gender.

2-Male gender is associated with a higher mean by an average of 1.23mm compared to females. This effect fails to reach the level of statistical significant after adjusting for age. The model was statistically significant and able to explain 24.2 %is observed variation in measurement.

Table 5: Multiple linear regression model with (linear measurement S to IOF) as the dependent (response) variable in addition to gender and age as independent (explanatory) variables

Linear measurement (S to IOF) mm	Partial regression coefficient	P
(Constant)	47.76	<0.001
Gender	1.23	0.15[NS]
Age in years	0.66	<0.001

R^2 = 0.242
P (model) < 0.001

As shown in the table (6):-

1-For each year increase in age the angle measurement (N-IOF-Midline) the partial regression coefficient is expected to obviously increase by -0.28 mm degree after adjusting for confounding effect of gender.

2-Male gender is associated with a higher mean by an average of 1.42mm degree compared to females. These effects fail to reach the level of statistical significant after adjusting for age and gender. The model no statistically significant and able to explain 2.5 % is observed variation in measurement.

Table 6: Multiple linear regression model with (angle degree measurement) as the dependent (response) variable in addition to gender and age as independent (explanatory) variables.

Angle degree N-IOF-Midline)	Partial regression coefficient	P
(Constant)	54.15	<0.001
Gender	1.42	0.37[NS]
Age in years	-0.28	0.22[NS]

R^2 = 0.025
P (model) = 0.3[NS]

The mean of linear measurement (N-IOF) was significantly higher in the right side by an average of 1.6 mm compared to left side.

While the effect of laterality (R VS L)side show the right side increase in this linear measurement by an average of 3.8% of its reference left side as shown in the table (7).

Table 7: The differences in mean measurements of (N-IOF) between right and left side.

Linear measurement (N-IOF) mm	Left side	Right side	Difference between right and left side	Laterality-dimorphism %	P (paired t-test)
Range	(31.2 to 58)	(35.6 to 59.1)	(-1.8 to 7)		
Mean	42.6	44.2	1.6	3.8 %	<0.001
SD	4.7	4.4	1.6		
SE	0.66	0.62	0.23		
N	50	50	50		

Table 8: The differences in mean measurements of (Midline-IOF) between right and left side.

Linear measurement (Midline-IOF) mm	Left side	Right side	Difference between right and left side	Laterality-dimorphism %	P (paired t-test)
Range	(18.1 to 50.1)	(20.5 to 51.9)	(-7.5 to 7.2)		
Mean	26.5	27.5	1	3.8 %	<0.001
SD	5.3	5.1	3.1		
SE	0.75	0.72	0.43		
N	50	50	50		

The mean of linear measurement (Midline-IOF) was significantly higher in the right side by an average of 1 mm compared to left side.

While the effect of laterality (R VS L)side show the right side increase in this linear measurement by an average of 3.8% of its reference left side as shown in the table (8).

The mean of linear measurement (Vertical distance from N meeting the horizontal line from IOF to midline) was significantly higher in the right side by an average of 1.2 mm compared to left side. While the effect of laterality (R VS L)side show the right side increase in this linear measurement by an average of 3.6% of its reference left side as shown in the table (9).

This proportional right vs. left pattern is made more obvious by an almost stable (N-IOF-Midline) angle (-0.2%) included by the IOF triangle formed by the previous 3 lines in both right and left as shown in table (10).

The mean of linear measurement (S to IOF) was significantly higher in the right side by an average of 1.6 mm compared to left side. While the effect of laterality (R VS L) side show the right side increase in this linear measurement by an average of 2.8% of its references left side as shown in the table (11).

Table 9: The differences in mean measurements of Vertical distance from nasion meeting the horizontal line from IOF to midline between right and left side.

Linear measurement (Vertical distance from N meeting the horizontal line from IOF to midline)	Left side	Right side	Difference between right and left side	Laterality-dimorphism %	P (paired t-test)
Range	(17.7 to 43.8)	(18.7 to 46.3)	(-5.3 to 8.7)		
Mean	32.9	34.1	1.2	3.6 %	0.005
SD	5.2	5.6	2.9		
SE	0.74	0.79	0.41		
N	50	50	50		

The three linear measurements (Vertical distance from N meeting the horizontal line from IOF to midline), (N-IOF), and (Midline-IOF) associated with IOF in the coronal plane showed comparable laterality dimorphism magnitude (ranging between 3.6 to 3.8% of left side reference value) (table 7-9).

Table 10: The differences in mean measurements of Angle (N-IOF-Midline) between right and left side.

Angle degree (N-IOF-Midline)	Left side	Right side	Difference between right and left side	Laterality-dimorphism %	P (paired t-test)
Range	(30.3 to 62.8)	(28.6 to 60.1)	(-12.7 to 14.7)		
Mean	51.1	50.9	-0.1	-0.2 %	0.87[NS]
SD	7.7	7.9	5.2		
SE	1.09	1.12	0.74		
N	50	50	50		

Table 11: The differences in mean measurements of (S-IOF) between right and left side.

Linear measurement (S to IOF) mm	Left side	Right side	Difference between right and left side	Lateraliy-dimorphism %	P (paired t-test)
Range	(46.7 to 65.5)	(44.9 to 68)	(-4.5 to 6.5)		
Mean	56.2	57.8	1.6	2.8 %	0.027
SD	4.6	4.7	2.5		
SE	0.65	0.67	0.36		
N	50	50	50		

DISCUSSION

The accurate identification of IOF position is important for both diagnostic and clinical procedures. Clinicaly, nerves emerging from this foramen, could probably be injured during surgical procedures, resulting in parasthesia or anesthesia. An understanding of the anatomical location of this important maxillofacial foramen is of increased importance with the rising popularity of endoscopic procedures with limited visibility. (7) The current study provided an easy method for correlation of IOF position with the age and gender. This method done by recording the age and gender of the pediatric patients, then using these values in mathematic formulae derived from multiple linear regression model for correlation of these two variables with IOF position as shown in table (1, 2)

Suresh et al (7) study sample of 48 CT scans of children and derived a linear regression formula based on age only, distance of the infraorbital foramen (in mm) from midline =21.3+0.5 × age (in years). Using this formula in currently study gave comparable results to those calculated using age and gender. The formula used in current study is however more accurate since it adjusted for the effect of gender.

In the current study all the linear measurements (C-M, N-IOF, midline-IOF, vertical distance from N to horizontal line from IOF to midline, S-IOF evaluated showed a statistically significant positive linear association of IOF linear measurements with age after adjusting the effect of gender with mean of partial regression coefficient respectively (1.120 and p value<0.001, 0.59and p value <0.001, 0.53 and p value <0.001, 0.30and p value <0.048, and0.66 and p value 0.001).

Suresh et al (7) reported positive linear correlation between age and linear measurement midline to IOF.

The relation between the linear measurements and the gender after adjusting age:

In the current study the linear measurements (C-M, N-IOF, vertical distance from N to horizontal line from IOF to midline) evaluated showed a statistically significant positive linear association of IOF linear measurements with gender after adjusting the effect of age with mean of partial regression coefficient respectively (4.400 and p value 0.003, 7.87and p value <0.001, 5.50and p value 0.021) as shown in tables (3-12, 3-13, 3-15).

The linear measurements of S-IOF and Midline-IOF failed to reach statistical significant due to small sample size

Lopes et al (4) reported the significant differences in the measurements of the distance from IOF to the IOM and from ANS to IOF between the male and female (P<0.005).

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