Effect of gender, age and tooth loss on the dimensions of incisive canal, and buccal bone anterior to the canal (Computed Tomography study)

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ABSTRACT

Background: The incisive canal is an anatomical structure with an important location in the anterior maxilla, analyzing this canal and its relation to the bone anterior to the canal is necessary during dental implant. Aim of this study is evaluated effect of gender, age and tooth loss in area of maxillary central incisors teeth on the dimensions of incisive canal and buccal bone anterior to the canal using spiral computed tomography.

Materials and Methods: Sample consists of prospective study for 156 subjects for both gender, they divided into two groups, 120 dentate group (60 male and 60 female) with age ranging from (20-70) and 36 edentate group (with missing maxillary central incisors) (18 male and 18 female) with age ranging from (50-70). All subjects attended to Baquba teaching general hospital in Diyala for computed tomography scan investigation for different diagnostic purposes. The following were measured and recorded from sagittal section of CT for analysis 1-diameter and length of incisive canal.2- distance and length of buccal bone anterior to canal.

Result: Gender had effect on the dimensions of incisive canal and buccal bones anterior to this canal, the mean values begin higher in male as compared to female. Dental status had effect on incisive canal length and buccal bone dimensions, mean values is higher in dentate than in edentate group, canal diameter remain unchanged with dental status. Age had no effect on all selected measurements in study sample. Duration of maxillary central incisors teeth loss had effect on canal length and buccal bone dimensions mean values begin lower in long duration than that in short duration while it had weak effect on incisive canal diameter.

Conclusion: Gender and dental status are important factors that can affect incisive canal and amount of bone anterior to canal.

Keywords: Incisive canal; buccal bone; computed tomography. (J Bagh Coll Dentistry 2015; 27(2):79-85).

INTRODUCTION

Anterior segments of the jaws in maxillary and mandibular locations are often considered as safer areas when compared with posterior jaws during surgeries [(1,2)]. Incisive canal (IC), located at the midline, posterior to the central incisor teeth, is an important anatomic structure of the anterior maxillary area [(3)]. The canal commences towards the front of the floor of each nasal cavity. It opens into median plane of the palatine process of the maxilla, posterior to the central incisors and transmits naso-palatine vessels and nerves, branches of the maxillary division of the trigeminal nerve and the maxillary artery [(4)]. It is important to know the anatomic features in this area when performing surgeries (e.g., implant, bone augmentation and apicoectomy) [(3)].

According to the presence or absence of teeth in the anterior maxilla, dimensional changes of anterior jaw bones and incisive canal were reported [(5,6)].The gender influenced on buccal bone dimensions and incisive canal [(7)],men had higher level than women [(6)],women have less dense bone than men and over the years an equal loss of bone usually leaves women with a lesser bone mass [(8)].

Dental esthetics has become an important issue in implant dentistry in the anterior maxilla, patients consider the esthetic outcome to be an essential factor, often surpassing even functional aspects of the dental implant therapy [(9)]. Among all the teeth, the upper incisors demand the greatest attention in implant treatment, from both an esthetic and functional viewpoint. Two anatomical limitations exist in the anterior maxilla. One is the absorption of the alveolar bone following loss of the incisors, and the other is the location of the incisive canal at the palatal zone of the incisor region [(10)].The computed tomography (CT) scan is an imaging method that uses X-rays to create cross-sectional pictures of the body. A computer crates separate image of body area, called slices, were can be stored, viewed on monitor or printed on film. [(11)].

Innovations in imaging systems and increased usage of preoperative CT evaluation have allowed us to get a more accurate and close look at the incisive canal and surrounding bone [(12)].In the present study spiral computed tomography used for determination the effect of gender, age and central incisors loss on incisive canal and buccal bone anterior to canal.

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MATERIALS AND METHODS

The sample composed of 156 patients, age ranged between (20-70) years old, the total sample included patients attended to the Baquba teaching general hospital in Diyala for CT scan investigations for different diagnostic purposes. Those subjects were divided into 2 groups:

1-Dentate group: included 120 dentate subject (60 male and 60 female) with age ranging from (20-70).

2-Edentate group: included 36 subjects (18 male and 18 female) with age ranging from (50-70), all the edentate group with missing both maxillary central incisors. Edentate group divided into two group according to the duration of maxillary central incisor teeth loss, long duration (5+) years which consists 26 subjects and short duration (<5 years) which consists of 10 subjects.

The CT machine used in the present study was (Toshiba, Aquillion 64) with a helical scan to acquire the image. The image were generated at 120kv and 500 mA x-ray, the slice thickness of the image was 0.5mm,the image matrix size was 512× 512,window level(WL) =35,window width(WW) =85,exposure time =2.5 sec. and imaging zoom =1.00.

The following measurements were taken on sagittal section of CT according to protocol [3].

A- The diameter of (IC) were measured, the following points were selected for standardized measurement as shown in **figure 1**
   1. The diameter of crestal part of IC (at incisive foramen).
   2. The diameter of middle part of IC (at the middle length of the IC).
   3. The diameter at the most apical part of IC.
   4. The mean of the total IC dimensions.

B- The length of IC which was measured from nasal fossa to the incisive foramen (palatal border of incisive foramen). **Figure 1**

C- The distance of the buccal bone anterior to the IC including the following points for standardized measurements as shown in **Figure 2**
   1. The distance of the crestal part of the buccal bone (at alveolar crest)
   2. The distance of middle part of the buccal bone (from the buccal wall of the IC to the facial aspect of the bone wall using a horizontal line from the palatal border of the incisive foramen).
   3. The distance of the most apical part of the buccal bone (from the buccal wall of the IC to the facial aspect of the buccal bone wall (ANS) using a horizontal line from the palatal border of the nasal foramen).
   4. The mean of the total buccal bone distances.

D- The length of the buccal bone anterior to the IC (from the apical measurement of the buccal bone to the alveolar crest).**Figure 2**

Statistical analysis

Statistical analyses were done using SPSS version 21 computer software (Statistical Package for Social Sciences). Quantitative variables are described by mean, SD. The statistical significance, strength and direction of linear correlation between 2 quantitative normally distributed variables were assessed by Pearson's linear correlation coefficient. Cohen's d is a standardized measure of effect size for difference between 2 means, which can be compared across different variables and studies, since it has no unit of measurement. A multiple linear regression model was used to study the net and independent effect of a set of explanatory variable (gender, age and duration of edentulous central incisor) on a quantitative outcome (dependent) variable.

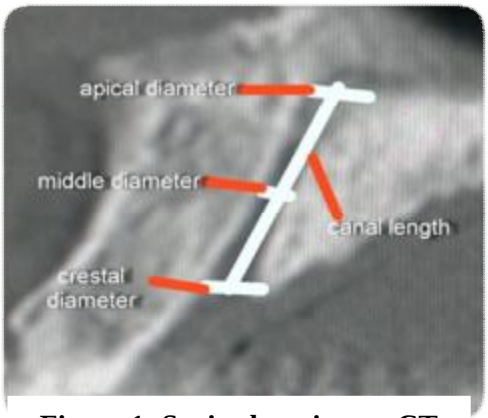

Figure 1: Sagittal section on CT showing Measurements of incisive canal diameter and

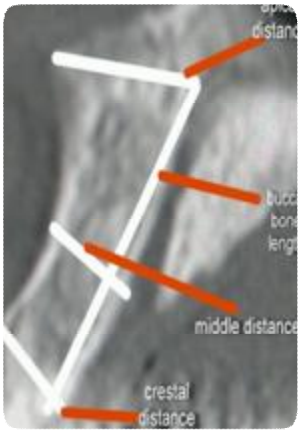

Figure 2: Sagittal section on CT showing measurements of buccal bone distances and length

RESULTS

Incisive canal dimensions (length and diameter) for dentate subjects differed according to gender. Mean values showed that male had longer and wider canals in dentate subjects ,for testing the effect of gender on these measurements by cohen's d , the effect seem to be moderately strong (0.46, 0.55). buccal bone dimensions (length and distance of bone anterior to the canal) were different between genders, where male had greater mean values than female, for testing the effect of gender on these measurements by cohen's d, the effect seem to be moderately strong (0.37, 0.42) **(Table 1).**

Edentate group shows similar results. Length, diameter of the canal and length, distance of buccal bone anterior to the canal were greater in mean value for male subjects compared with female subjects, for testing the effect of gender on these parameters by cohen's d, the effect seem to be moderately strong for both gender (0.44, 0.57, 0.61, 0.77) **(Table 2)**.

Absence of maxillary central incisors cause a decrease at incisive canal length and buccal bone dimensions(length and distance) for both genders, for testing the effect of tooth loss on these parameters by cohen's d, the effect seem to be strong for male (-0.89, -1.17, -1.4) and for female (-1.37, -1.44,-1.62) while canal diameter was not change according to dental status and there was no effect of tooth loss on this parameter for both gender (cohen's d=0) **(Table3)**.

Mean value of canal length and buccal bone dimensions(length and distance)begin higher in short duration (<5years) as compared to long duration (5+) years for both genders, for testing the effect of the duration of maxillary central incisors teeth loss on these parameters by cohen's d, the effect seem to be moderately strong to strong for male (-0.8,-0.43, -0.92)and strong for female (-1.14, -1.13, -1.22)while canal diameter show weak effect with duration for both male (-0.18) and female (-0.17) **(Table 12)**.

Age shows very weak indirect relationship and non significant correlation with all selected measurements in current study. In the linear regression model, gender shows a statistically significant difference on all selected measurements in the study sample after adjusting for age and duration of maxillary central incisors teeth loss, age shows a non statistically significant difference on all selected measurements after adjusting for gender and duration of maxillary central incisors teeth loss, duration of maxillary central incisors teeth loss shows a statistically significant difference on canal length and buccal bone dimensions while it shows a no statistically significant difference on mean canal diameter after adjusting for age and gender **(Tables 4-11)**.

Table 1: Effect of the gender on the IC and buccal bone dimensions for dentate group

Variables	Gender	Mean	SD	Cohen's d
Canal diameter				
(crestal)	**Male**	3.1	0.6	0.62
	Female	2.7	0.7	
(middle)	**Male**	1.5	0.6	0.55
	Female	1.2	0.5	
(apical)	**Male**	2.1	0.7	0.31
	Female	1.9	0.6	
Mean	**Male**	2.2	0.6	0.55
	Female	1.9	0.5	
Canal length	**Male**	10.9	2.3	0.46
	Female	9.8	2.5	
Buccal bone distance				
(crestal)	**Male**	6.2	0.8	0.55
	Female	5.7	1	
(middle)	**Male**	7.4	1.1	0.61
	Female	6.7	1.2	
(apical)	**Male**	11.2	1.7	0.44
	Female	10.6	1	
mean	**Male**	8.2	1.3	0.42
	Female	7.7	1.1	
Buccal bone length	**Male**	20	2	0.37
	Female	19.1	2.8	

Table 2: Gender difference for IC and buccal bone dimensions in edentate group

Variables	Gender	Mean	SD	Cohen's d
Canal diameter				
(crestal)	**Male**	3	0.4	1
	Female	2.6	0.4	
(middle)	**Male**	1.4	0.5	0.36
	Female	1.2	0.6	
(apical)	**Male**	1.9	0.6	0.33
	Female	1.7	0.6	
Mean	**Male**	2.1	0.3	0.57
	Female	1.9	0.4	
Canal length	**Male**	9.2	1.9	0.44
	Female	8.5	1.2	
Buccal bone distance				
(crestal)	**Male**	3.8	1.4	0.66
	Female	3	1	
(middle)	**Male**	5.5	1.5	0.51
	Female	4.8	1.2	
(apical)	**Male**	10	1.5	0.82
	Female	8.4	2.3	
Mean	**Male**	6.4	1.3	0.77
	Female	5.4	1.3	
Buccal bone length	**Male**	16.5	1.1	0.61
	Female	15.4	2.3	

Table 3: Effect of the teeth loss on the IC and buccal bone dimensions compared to dentate group

Variables	Study group	Mean	SD	Cohen's d	Study group	Mean	SD	Cohen'sd
Canal diameter								
(crestal)	**Dentate**	2.7	0.7	-0.14	**Dentate**	3.1	0.4	-0.2
	Edentate	2.6	0.7		**Edentate**	3	0.5	
(middle)	**Dentate**	1.2	0.5	0	**Dentate**	1.4	0.7	0
	Edentate	1.2	0.6		**Edentate**	1.4	0.5	
(apical)	**Dentate**	1.7	0.6	0	**Dentate**	2	0.8	-0.14
	Edentate	1.7	0.6		**Edentate**	1.9	0.6	
Mean	**Dentate**	1.9	0.5	0	**Dentate**	2.1	0.6	0
	Edentate	1.9	0.6		**Edentate**	2.1	0.4	
Canal length	**Dentate**	10.5	2	-1.37	**Dentate**	11	2.1	-0.89
	Case s	8.5	0.9		**Edentate**	9.2	1.9	
Buccal bone distance								
(crestal)	**Dentate**	5.5	1.1	-2.36	**Dentate**	6.1	0.7	-2.17
	Edentate	3	1		**Edentate**	3.8	1.4	
(middle)	**Dentate**	6.5	1.3	-1.35	**Dentate**	7.3	1	-1.45
	Edentate	4.8	1.2		**Edentate**	5.5	1.5	
(apical)	**Dentate**	10.7	2.4	-0.97	**Dentate**	11.4	3	-0.56
	Edentate	8.4	2.3		**Edentate**	10	1.5	
Mean	**Dentate**	7.6	1.4	-1.62	**Dentate**	8.3	1.4	-1.4
	Edentate	5.4	1.3		**Edentate**	6.4	1.3	
Buccal bone length	**Dentate**	18.5	3	-1.44	**Dentate**	19.5	3	-1.17
	Edentate	15.4	1.3		**Edentate**	16.5	2.1	

Table 4: Multiple linear regression model with canal diameter-mean as the dependent (response) variable and age, gender in addition to duration as the explanatory (independent) variables among dentate group.

	Partial regression coefficient	P
(Constant)	2.136	<0.001
Age (years)	-0.005	0.18[NS]
Gender	0.278	0.005

R^2=0.18, P (Model) = 0.007

Table 5: Multiple linear regression model with canal diameter-mean as the dependent (response) variable and age, gender in addition to duration as the explanatory (independent) variables among edentate group.

	Partial regression coefficient	P
Constant	2.727	0.037
Age (years)	-0.012	0.52[NS]
Gender	0.334	0.04
Duration of edentulous (5+ years)	-0.092	0.64[NS]

R^2=0.115, P (Model) = 0.027

Table 6: Multiple linear regression model with buccal bone diameter-mean as the dependent (response) variable and age, gender in addition to duration as the explanatory (independent) variables among dentate group.

	Partial regression coefficient	P
(Constant)	7.636	<0.001
Age (years)	0.001	0.92[NS]
Gender	0.577	0.011

R^2=0.255,P (Model) = 0.037

Table 7: Multiple linear regression model with buccal bone diameter-mean as the dependent (response) variable and age, gender in addition to duration as the explanatory (independent) variables among edentate group.

	Partial regression coefficient	P
Constant	9.831	<0.001
Age (years)	-0.053	0.2[NS]
Gender	1.055	0.008
Duration of edentulous (5+ years)	-1.446	0.001

R^2=0.402, P (Model) = 0.001

Table 8: Multiple linear regression model with canal length as the dependent (response) variable and age, gender in addition to duration as the explanatory (independent) variables among dentate group.

	Partial regression coefficient	P
(Constant)	9.508	<0.001
Age (years)	0.006	0.68[NS]
Gender	1.068	0.016

R^2=0.25, P (Model) = 0.049

Table 9: Multiple linear regression model with canal length as the dependent (response) variable and age, gender in addition to duration as the explanatory (independent) variables among edentate group.

	Partial regression coefficient	P
Constant	12.778	0.002
Age (years)	-0.062	0.29[NS]
Gender	0.660	0.02
Duration of edentulous (5+ years)	-0.397	0.04

R^2=0.386, P (Model) = 0.03

Table 10: Multiple linear regression model with buccal bone length as the dependent (response) variable and age, gender in addition to duration as the explanatory (independent) variables among dentate group.

	Partial regression coefficient	P
(Constant)	19.935	<0.001
Age (years)	-0.019	0.23[NS]
Gender	0.875	0.03

R^2=0.244, P (Model) = 0.04

Table 11: Multiple linear regression model with buccal bone length as the dependent (response) variable and age, gender in addition to duration as the explanatory (independent) variables among edentate group.

	Partial regression coefficient	P
(Constant)	18.844	<0.001
Age (years)	-0.037	0.55[NS]
Gender	1.106	0.02
Duration of edentulous (5+ years)	-1.573	0.018

R^2=0.243, P (Model) = 0.029

Table 12: Effect of the duration of the teeth loss on IC and buccal bone dimensions in edentate group.

Measure-ments	Duration of teeth loss	Mean	SD	Cohen'sd	Duration of teeth loss	Mean	SD	Cohen's d
Canal diameter								
(crestal)	**Long**	2.3	0.6	-0.14	**Long**	2.9	0.8	-0.11
	Short	2.4	0.8		**Short**	3	0.9	
(middle)	**Long**	1.2	0.6	-0.17	**Long**	1.5	1.1	-0.18
	Short	1.3	0.5		**Short**	1.7	1.1	
(apical)	**Long**	1.7	0.7	-0.15	**Long**	2.3	0.9	-0.11
	short	1.8	0.6		**Short**	2.4	0.9	
Mean	**Long**	1.7	0.6	-0.17	**Long**	2.2	1.1	-0.18
	Short	1.8	0.6		**Short**	2.4	1.1	
canal length	**Long**	8.2	1.1	-1.14	**Long**	8.8	1.1	-0.8
	Short	9.4	0.9		**Short**	9.9	1.6	
Buccal bone distance								
(crestal)	**Long**	2.6	0.5	-1.89	**Long**	3.4	1.1	-1.07
	Short	4	1.2		**Short**	4.8	1.8	
(middle)	**Long**	4.4	0.8	-1.32	**Long**	5.1	1.4	-0.96
	Short	5.8	1.6		**Short**	6.4	1.3	
(apical)	**Long**	8	1.3	-1.07	**Long**	9.6	1.1	-0.92
	Short	9.4	1.3		**Short**	10.9	2.1	
Mean	**Long**	5	1.1	-1.22	**Long**	6	1.1	-0.92
	Short	6.4	1.3		**Short**	7.3	1.7	
Buccal bone length	**Long**	13.6	2.6	-1.13	**Long**	16.3	1.1	-0.43
	Short	16.1	1.8		**Short**	16.8	1.3	

DISCUSSION

The present study showed gender and loss of maxillary central incisors influenced the incisive canal and buccal bone dimensions anterior to this canal. When dentate subjects were classified according to gender, male had greater canal and buccal bone dimensions. Edentate subjects (with missing maxillary central incisors) showed the same results when gender was considered. Our result agreed with the study made by **Liang et al** [6] who examined incisive canal length and diameter on 120 CT scans and found higher values in male.

Bornstein et al [7] examined 44 male and 56 female, they measured canal dimensions and buccal bone width and reported statistically higher buccal bone width and canal length values in male and this seem to be closes to our result. **Guncu et al** [3] and **Tozum et al** [13] examined 417 males and 516 females, they reported that the gender had significant influence on canal and buccal bone dimensions for both dentate and edentulous patients. The effect of tooth loss on the canal and buccal bone dimensions in male and female were examined. When central incisors were not present, both incisive canal length and buccal bone dimensions decreased; however, canal diameter did not change with dental status in both genders. Our study come in agreement with the study made by **liang et al** [6],they reported longer canals in dentate patients with no statistical difference noted for the canal diameter.

Song et al [14] examined canal length in 56 maxilla and found that the canal length decrease in edentulous subjects and this correlate with the present study. Our result are in agreement with

the study made by **Guncu et al** [3] and **Tozum et al** [13],they reported that the canal length and buccal bone dimensions decrease in edentulous patients while canal diameter did not change. Conversely to the present study results, **Mardinger et al** [5] examined canal dimensions on 207 CT scans and reported that the canal diameter enlarged with tooth loss and this could be attributed to different in canal morphology. In the present study, no significant correlation are detected between age and canal, buccal bone dimensions, such result correlate with the study made by **Guncu et al** [3]; **Mraiwa et al** [4]**; Tozum et al** [13] **.** In contrast to these finding **Bornstein et al** [7] reported that the age had significant influence on canal length which decrease with age, **Liang et al** [6] found that the canal enlarged by age and this disagreement with our study. Duration of maxillary central incisors teeth loss had significant difference on canal length and buccal bone dimensions with mean values begin higher in short duration as compared to long duration for both genders. These finding come accordance with the study made by **Bornstein et al** [7] who reported that the buccal bone width decreasing in values for patients with missing central incisors and long time span since tooth loss.

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