The Measurements of Maxillary Alveolar Bone Density at 13-15 Years Age by Using Spiral Computerized Tomography

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ABSTRACT

Background: Bone density is a major factor that affect mini implant primarily stability; no Iraqi studies have evaluated bone density related to mini-implant placement for orthodontic anchorage at age 13 -15 years. The present research aims to evaluate gender, side and site differences in the bone density at various orthodontic implant sites for the maxillary alveolar bone.

Materials and methods: Twenty nine individuals (16 males and 13 females) had subjected to clinical examination, then 64-multislice computed tomography scan data were evaluated and bone density was measured in Hounsfield unit at 21 points (9 points for each side and 3 points between the right and left central incisors) .

Results: The results obtained showed that there are no significant differences in bone density between males and females and between the left and right sides were found. There was no significant differences in bone density between the maxillary buccal cortical bone and the palatal cortical bone were generally except that at lateral incisor and canine point where the palatal side had higher bone density than buccal side. The mean bone density of the cancellous bone in the anterior part was higher than that in the posterior of the maxilla.

Conclusions: When orthodontic, mini implant are indicated, no gender and side difference affect the success rate regarding bone density.

Keyword: Bone density, mini-implant, computerized tomography. (J Bagh Coll Dentistry 2016; 28(2):103-107).

INTRUDUCTION

The orthodontist always constructs an appliance to produce certain desired tooth movements. For every action, there is an equal and opposite reaction. Inevitably, reaction forces can move other teeth if the appliance contacts them. Anchorage, then, is resistance to reaction forces that is provided by other teeth. Anchorage control is an important factor directly affecting the results of orthodontic treatment, mainly when maximum anchorage is necessary [1].

Although traditional systems to provide tooth movement with enhanced anchorage have been developed, limitations due to the need for patient cooperation, operator skill, and precision in determining the ideal force to perform the movement make the control of posterior anchorage a challenge [2].

To overcome problems associated with anchorage loss, skeletal anchorage methods such as dental miniplates and miniscrews. Mini-implants are a valuable alternative to extraoral anchorage, which need cooperative patient [3]. Microscrew implants have many benefits, including easy placement and removal, immediate loading, minimal anatomical limitations thanks to their small size, and low cost, as compared with other skeletal options. Many reports have dealt with various clinical situations, such as en-masse retraction of the anterior or posterior teeth, retraction of the whole dentition, molar distalization, molar up righting, protraction of molars, and forced eruption of the canines [4,5].

Several sites have been proposed for the placement of miniscrews or microscrew implants. Most frequently recommended sites were the midpalatine area; Inter-radicular spaces are generally the site of choice for mini implant placement for their ease of access, simplicity of procedure, and less traumatic placement [6]. The alveolar bone between the maxillary second premolars and first molars, and the mandibular first and second molars [7].Three main factors affect the success of dental implants: host, implant, and surgical method. Density of bone is a host factor that is known to play a crucial role in mini implant stability. A close relationship was shown between bone density and the success of dental implants. During early stages, bone density appears to be the key determinant for stationary anchorage of miniimplants in the sites with inadequate cortical bone thickness because primary retention of mini-implants achieved by mechanical means rather than through osseointegration [8].

Characteristic of all bones are a dense outer sheet of compact bone and a central cancellous bone. The cancellous bone forms a trabecular network, surrounds marrow spaces that may contain either fatty or hematopoietic tissue, lies subjacent to the cortical bone, and makes up the main portion of a bone. The maxilla has a thin compact bone and fine trabecular bone supporting the teeth [9]. Mini implant stability is primarily related to local bone density. TADs are also

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known to be frequently associated with higher failure rates among adolescents when compared with adults, which suggests that age may be a contributing factor. It has been speculated that it may be due to thinner cortical layers coupled with immature bone qualities in adolescents [10].

The demonstration of bone density by means of CT scanning directly depends on the quantity of inorganic crystals contained in the bone tissue keeping in mind that bone is not uniform in structure but composed of several layers of different materials.

One method for measuring bone density appropriately is CT. CT has expediency and nondestructive nature and its images in DICOM format contain data of bone density so that the software program can measure it. Misch [11] mentioned that the bone density measurements using CT provide more accurate results than radiographic assessment.

MATERIALS AND METHODS

The sample

The sample of this study consisted of CT images for patient who were attending Al. Shaheed Ghazi Al-Hariri Hospital/the Computerized Tomography department. Only 29 subjects (16 male and 13 female, age range 13-15 years).Subject Selection criteria included:

1) All subjects are Iraqi in origin.
2) The age ranged between 13-15 years.
3) They have full set of permanent teeth in both jaws “excluding the 3rd molar”.
4) They have bilateral class I molar and canine relationships, with normal over jet ranging between 2-4 mm and normal overbite ranging between 1-2 mm.
5) Clinically skeletal class I was determined by two-finger method.
6) Subjects should have no large metal restorations that cause streak artifacts and affect the density of the adjacent bone tissue.
7) No history of dentofacial deformities and pathologic lesions in the jaws.
8) No history of chronic regular use of medication affects the bone density such as steroids, barbiturates, anticonvulsants, and thyroid hormone replacements.
9) None of the subjects had received previous orthodontic and orthopedic treatment.

Materials and equipment

1. Disposable dental mirrors and probes and sliding caliper
2. 64-multi-detecter CT scanner (SOMATOM Definition AS, Siemens AG, Germany, Z-UHR(Ultra HighResolution).
3. Seimens work station computer.
4. Syngo VX2009B, image fusion (Siemens AG imaging software multimodality reading, Germany).

Method

The mean bone density was measured using software (Syngo 2009B) that had already been incorporated into the CT machine. The points were selected using 3D, axial, coronal and sagittal planes. With the "Three Dimensional " mode, the intended points could be seen in three planes of space at the same time to determine the specific location since all the slices in the 3 planes will be changed at the same time and each slice can be matched by the slice serial number to be opened on the"viewing"mode for the maxillary alveolar bone 21 points was measured, 9 points for each side between each two teeth (lateral inciser and canine,second premolar and first molar and between first molar and second molar), and 3 points between the right and left central incisors.

For buccal and palatal cortical bone distal to the distal most surface of the tooth of interest was chosen apically 5 to 7 mm from the alveolar crest, the density of the cancellous bone was measured at the trabeculae, located halfway buccopalataly between the buccal and palatal cortical plates of each tooth.

RESULTS

Bone density assessed and the results were expressed by descriptive statistics including the mean and standard deviation of the mean.

According to t-test, there was no significant difference in the maxillary alveolar bone density between the right and left sides in different areas in male (table1) and female group (table 2).Then matching measurements of the right and left sides combined for further analysis.

Table 1: Comparison of the bone density between the right and left sides in different areas in male group (N=16)

Areas	Sides	Right		Left		Comparison	
		Mean	S.D.	Mean	S.D.	t-test	p-value
7-6	Buccal	989.27	131.18	1046.40	182.48	-2.085	0.056
	Cancellous	482.60	63.96	494.60	97.27	-0.473	0.644
	Palatal	1018.73	136.75	1022.67	129.28	-0.114	0.911
6-5	Buccal	1026.00	106.96	1006.40	169.92	0.583	0.569
	Cancellous	532.33	91.09	484.60	145.44	1.342	0.201
	Palatal	1007.07	137.34	1030.07	166.46	-0.773	0.452
3-2	Buccal	983.13	152.63	1002.07	180.36	-0.572	0.576
	Cancellous	616.07	140.50	556.80	188.52	1.271	0.225
	Palatal	1030.53	120.29	1055.67	159.58	-0.735	0.474

Table 2: Comparison of the bone density between the right and left sides in different areas in female group (N=13)

Areas	Sides	Right		Left		Comparison	
		Mean	S.D.	Mean	S.D.	t-test	p-value
7-6	Buccal	1019.27	91.44	1003.13	126.18	0.505	0.621
	Cancellous	478.87	49.37	470.40	52.98	0.428	0.675
	Palatal	1014.87	63.57	1044.60	121.60	-1.315	0.210
6-5	Buccal	1008.87	105.21	1047.93	106.30	-1.875	0.082
	Cancellous	500.60	108.77	487.80	79.46	0.736	0.474
	Palatal	1029.13	89.31	1063.73	133.23	-0.874	0.397
3-2	Buccal	1016.53	105.20	1005.80	131.50	0.370	0.717
	Cancellous	524.00	144.19	521.13	106.55	0.073	0.943
	Palatal	1063.93	83.26	1030.27	139.79	1.031	0.320

Descriptive statistics of the bone density for the male, the alveolar the buccal cortical bone density ranged approximately from (992±164 HU) at lateral incisor\canine point to (1021±119 HU) at the central incisor\ central incisor point.

For, alveolar palatal cortical bone density ranged approximately from (997± 145HU) at central incisor\ central incisor point to (1043±139 HU) at lateral incisor \ canine point. Thedensity of the alveolar cancellous bone of the maxilla ranged approximately from (488±81 HU) at the first molar / second molar point to (638±136 HU) at the central incisor/central incisors point (table 1).

Descriptive statistics of the bone density for the female, the alveolar buccal cortical bone density ranged approximately from (1002±140HU) at central incisor\ central incisor point to (1028±105 HU) at the second premolar/ first molar point. For, alveolar palatal cortical bone density ranged approximately from (1025±117HU) at central incisor\ central incisor point to (1047±114 HU) at lateral incisor \ canine point The density of the alveolar cancellous bone of the maxilla ranged approximately from (474±50 HU) at the first molar / second molar point to (570±140 HU) at the central incisor/central incisors point.(table 2).

According to t-test, there was no significant difference in the maxillary alveolar cortical and cancellous bone density between males and females in most points (Table 3).

Descriptive statistics of the bone density for total sample after combined male and female, the alveolar buccal cortical bone density ranged approximately from (1001±141HU) at lateral incisor\canine point to (1022±123 HU) at the second premolar/ first molar point. For, alveolar palatal cortical bone density ranged approximately from (1011±117HU) at central incisor\ central incisor point to (1045±126 HU) at lateral incisor \ canine point. The density of the alveolar cancellous bone of the maxilla ranged approximately from (481±67 HU) at the first molar / second molar point to (604±141 HU) at the central incisor/central incisors point (table 5).

Table 3: Descriptive statistics and genders difference of the bone density in different areas (N=29)

Area	Side	Descriptive Statistics				Genders difference	
		Males		Females			
		Mean	S.D.	Mean	S.D.	t-test	p-value
7-6	Buccal	1017.83	158.83	1011.20	108.58	0.189	0.851
	Cancellous	488.60	81.11	474.63	50.50	0.801	0.427
	Palatal	1020.70	130.77	1029.73	96.53	-0.304	0.762
6-5	Buccal	1016.20	139.86	1028.40	105.80	-0.381	0.705
	Cancellous	508.47	121.68	494.20	93.82	0.509	0.613
	Palatal	1018.57	150.40	1046.43	112.82	-0.812	0.420
3-2	Buccal	992.60	164.45	1011.17	117.13	-0.504	0.616
	Cancellous	586.43	166.12	522.57	124.58	1.685	0.097
	Palatal	1043.10	139.43	1047.10	114.34	-0.122	0.904
1-1	Buccal	1021.93	119.29	1002.73	140.64	0.403	0.690
	Cancellous	638.13	136.99	570.87	142.69	1.317	0.198
	Palatal	997.13	145.65	1025.00	83.30	-0.643	0.525

Table 4: Comparison of the bone density between the right and left sides in different areas for total sample (N=29)

Areas	Sides	Right		Left		Comparison	
		Mean	S.D.	Mean	S.D.	t-test	p-value
7-6	Buccal	1004.27	112.14	1024.77	155.71	-0.942	0.354
	Cancellous	480.73	56.17	482.50	77.93	-0.111	0.921
	Palatal	1016.80	104.80	1033.63	123.82	-0.823	0.417
6-5	Buccal	1017.43	104.61	1027.17	140.85	-0.482	0.633
	Cancellous	516.47	99.89	486.20	115.16	1.534	0.136
	Palatal	1018.10	114.38	1046.90	149.13	-1.183	0.247
3-2	Buccal	999.83	129.91	1003.93	155.10	-0.188	0.852
	Cancellous	570.03	147.51	538.97	151.55	1.020	0.316
	Palatal	1047.23	103.05	1042.97	147.97	0.179	0.859

Table 5: Descriptive statistics of the bone density in different areas for total sample(N=29)

Area	Side	Mean	S.D.
6-7	Buccal	1014.52	134.93
	Cancellous	481.62	67.05
	Palatal	1025.22	114.05
5-6	Buccal	1022.30	123.10
	Cancellous	501.33	107.52
	Palatal	1032.50	132.56
2-3	Buccal	1001.88	141.86
	Cancellous	554.50	149.53
	Palatal	1045.10	126.44
1-1	Buccal	1021.93	128.50
	Cancellous	604.50	141.63
	Palatal	1011.07	117.43

DISCUSSION

In the present study, the inter-radicular spaces were the areas of interest since they are generally the site of choice for mini implant placement for their ease of access, simplicity of procedure, and less traumatic placement [6,12].

The results of the present study indicate that there were no significant differences between both sides for all measured variables for both genders. Human studies showed no difference in bone densities between left and right sides [3,8,13,14-17]. This investigation found no significant gender differences in buccal and palatal cortical bone density which is in accordance with others [3,8,13,16 17]. This non-significant gender difference can be reflected clinically by previous studies that found no differences in the success rate and stability of mini implants between male and female subjects [18,19]. The lack of gender differences in this study can be explained by the presence of estrogen

hormone in higher levels in the female subjects compared to the male subjects, which is compensated by the exercises exerted by the males and the different chewing patterns.

On the other hand, other studies reported significant differences in mean bone densities between males and females human subjects (age range 12-50) [20], which are inconsistent with the present study. This inconsistency may be related to subject age differences between two studies, as age range in the present study was 13-15 years.

However other studies [10,14,20] showed that adult females had significantly greater palatal cortical bone density than adult males did, this is in conflict with the finding of the present study suggesting that the presence of gender difference may be depend on the different specific sites being examined in the palate or due to ethnic variation or the CT scanning machine setting being used.

Clinicians should remember that the reported data are only guides, each patient is unique, and the density variability among patients is high. In high-risk cases, such as patients with systemic or severe craniofacial problems, each site should be evaluated before mini-implant placement. It remains to be aware of the risk of computed tomography, which continues to impart a higher radiation dosage compared to conventional radiographs, but to weigh this against the power of the diagnostic information that it can provide.

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