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Reseacrh Article

Radiographic Assessment of Alveolar Bone and Tooth-supporting Tissue Changes Caused by Orthodontic Closing of Anterior Teeth Spaces on Maxilla and Mandible Using CBCT

Laila Abdel-Fattah Amer *[1], Hisham Mohamed Abozaid [2], Ebrahim Sabry El sayed [2]

1. Lecturer of Orthodontics, Faculty of Oral and Dental Medicine, MTI University, Cairo.

2. Assistant professor of Oral Medicine, Periodontology, Oral Diagnosis and Oral Radiology, Faculty of Dental Medicine (Boys-Cairo), Al-Azhar University, Egypt.

***Correspondence to**: **Laila Abdel-Fattah Amer**. Lecturer of Orthodontics, Faculty of Oral and Dental Medicine, MTI University, Cairo.

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Abstract

Background: *The basic knowledge is that orthodontic tooth movement resulted in alveolar bone changes in an equal ratio between bone remodeling and tooth movement; however, such ratio may not be valid for all kinds of tooth movement type or direction.*

Aim*: To detect the associated changes involving teeth supporting tissues and alveolar bone of both maxilla and mandible as a result of anterior tooth movement to close teeth spacing by orthodontic treatment.*

Patients and Method: *Twelve patients (7 Females & 5 Males) with age range between 18 and 26 years (mean was was16.66 ± 4.32) were included.*

Results: *Alveolar bone loss was noted in both jaws following the performing of teeth space closing with orthodontic treatment (T2) compared with that recorded prior to treatment (T2). Maxillary incisors showed greater alveolar bone loss compared with that of mandibular incisors; however, the difference did not reach the significance ($P > 0.05$); oral aspect of mandibular incisors showed less (non-significant) alveolar bone loss ($P > 0.05$) than maxillary incisors (0.57 ± 0.18 and 0.68 ± 0.16 respectively). There was significant greater bone loss ($P \leq 0.05$) at mesial side of maxillary incisors than in mandibular incisors (1.32 ± 0.32 and 1.16 ± 0.22 respectively). Bone loss was noted in buccal than in lingual side as well as decreased alveolar bone level in the distal side of maxillary and mandibular incisors. Significant loss of bone density involving both jaws after orthodontic tooth movement was noted; maxillary bone showed a greater bone density loss compared to mandibular alveolar bone. No significant bone height loss in each jaw bone after orthodontic closure of teeth spacing.*

Conclusions: *Maxillary incisors showed a greater amount of bone loss compared with that at mandibular incisors, in particular at the oral aspect. Greater bone loss was recorded at the buccal and palatal aspects of maxillary incisors compared with that at the buccal and lingual aspects of mandibular incisors. Bone density decreased, particularly in maxillary alveolar bone while no bone height loss in each jaw bone after orthodontic closure of teeth spacing.*

Key words: *alveolar bone, tooth remodeling, orthodontic tooth movement.*

Introduction

Space closure has been considered one of the challenging procedures in daily orthodontic practice as closing of teeth spaces, in particular those resulted from extraction require skill; application of closing teeth space mechanics without knowledge can result in failure to achieve an ideal occlusion.1 Various treatment procedures, depending on the etiology, were used to correct the anterior teeth spacing problems; if the spaces are due to protrusion or extrusion of the incisors, a change in the inclination or position of the teeth will be necessary.2 However, establishing an appropriate treatment plan for anterior spacing requires proper evaluation of the patient in the following order: tooth size, tooth inclination, and surrounding soft tissue function. If there are no problems with the size and inclination of the teeth and the function of the surrounding soft tissues is good, mesial movement of the molars may be necessary; caution should be exercised when changing the position of the anterior teeth to close space.3 It is crucial to understand the principles of space closure and master the biomechanical basis of space closure thus providing the clinicians with the ability to determine anchorage needs and treatment options, reaching prognosis of various alternatives, and the ability to decide specific adjustments that improve the treatment outcomes. Two basic biomechanical strategies can be used in closing of teeth spaces: frictionless (closing loop mechanics) and frictional (sliding mechanics).4 During orthodontic treatment, mechanical force applied on tooth will cause alveolar bone reaction; the applied force that move the tooth during the orthodontic treatment will result in alteration of alveolar bone function and its cellular component.5 Such alteration include bone formation on tension side and bone resorption on pressure side, thus the tooth will move to the new position. The resultant pressure exceeding the blood pressure level will induce collapsing of capillary blood vessel in periodontal ligament; thus inhibition of blood supply can occurs.6 On the contrary, if it was lower than blood pressure level, the capillary blood vessel will not collapse, and thus the optimal force used to move the tooth should not be higher than capillary blood vessel.5 Alveolar bone is a dynamic and unique organ system that is tooth dependent; it originates from dental follicle during embryogenesis, while basal/skeletal bone is more static and structural in function, and it develops de novo from neural crest cell migration and condensing mesenchyme interactions in conjunction with developing neuromuscular structures.7, 8

The alveolar bone changes associated with tooth movement may result from alveolar tooth remodeling as a response to various tooth movement; if movement area is limited, excessive orthodontic force will cause cortical bone resorption and root exposure will also occur because the tooth loses the supporting tissue (i.e. alveolar bone).9 Subjects with narrow and high alveolar process may have reduced bone support on labial and lingual aspects of their roots, and that both pronounced sagittal incisor movement and de-rotation contributed to a much higher risk for bone loss.10 Intraoral and or panoramic radiographs cannot show facial-lingual aspect of periodontium due to overlapping images on conventional radiographs.11, 12 Cone-Beam Computed Tomography (CBCT) overcomes this shortcoming by enabling us to evaluate teeth-supporting structures in lingual and facial regions without overlapping structures and within the 3 spatial planes. 13 The radiation dose of CBCT is less than one-fifteenth that of spiral CT and has a remarkable reproducibility of 0.1 mm voxel size. 14

Since its introduction in 1998, CBCT has become a popular modality in the evaluation of orthodontic diagnosis, treatment planning, and clinical outcomes.15 Although the detection of cortical bone thickness less than 0.5 mm or periodontal ligaments of less than 200 µm using CBCT may be relatively inaccurate, but due to its low radiation dose and acceptable resolution16, CBCT is still a preferred method to evaluate the alveolar process as it enables examination of shape and size of alveolar bone.17,18 In 1998, Tsunori et al introduced the use of CT to study correlation between facial type, mandibular cortical bone thickness, and bucco-lingual inclinations of the first and second molars.11,19,54It was reported that the cortical bone mineralization varies with vertical facial dimension.20, 21 The cortical bone follows orthodontic tooth movement in a 1:1 ratio, however this is not always the case; as it was found that this ratio changed by the movement direction.22 A study found that, retraction of mandibular incisors was associated with an increase in the bone volume in 58% of cases, while 42% had a decrease in bone volume.24 Additionally, when orthodontic tooth movement causes a root proximity with the cortical plate, fenestrations and dehiscence may occur;23 lingual defects of mandibular incisors with orthodontic tooth movement was reported.24,25 Marginal alveolar bone width and middle tooth root were considered equally important with apical alveolar bone, and remodeling bone is not always in the same quantity with number of tooth movement.26 Increasing the height of buccal alveolar bone was reported after retraction of mandibular central incisors; a study found that 58.8% had increased bone height in buccal region, while the rest showed decreased height. Increased bone height in that region may be attributed to angulations changes between mandibular plane and mandibular central incisor axis as well as to tooth intrusion.27,28

A systematic review and meta-analysis of alveolar bone changes in maxillary and mandibular anterior teeth during orthodontic treatment was conducted to analyze the effect of tooth movement on alveolar bone changes in maxillary and mandibular anterior teeth by CBCT55. Based on limited evidence, alveolar bone height and thickness, especially at the cervical level, decreased during both labial and lingual movement of anterior teeth. CBCT provided solutions to shortcomings of both traditional 2D radiography and traditional (CT) scan as it allows shorter imaging times and lower radiation exposure.29It seems likely that introduction of CBCT has drastically increased our understanding of relationship between the incisors and supporting bone. Due to its minimal distortion, CBCT allows accurate measures of bone changes (height and thickness) over time; 30-32 CBCT can be transferred into digital (DICOM) format files then with aid of computer-software a reconstruction of 3D models of craniofacial skeleton can be done including teeth and soft tissues.33,34 This study attempted to compare between alveolar bone loss as well as periodontal tissue changes that may be associated with the closing of spaces on maxillary and mandibular arches by orthodontic treatment, as identified by CBCT.

Patients and Method

Twelve patients (7 females & 5 males) with age ranging between 18 -26 years (mean 16.66 ± 4.32) indicated to have orthodontic closing of teeth spacing were included in this study; applying following inclusion criteria: a) permanent dentition exhibiting spacing between anterior teeth on both jaws; b) free from any systemic disease that may alter bone metabolism; c) not using steroid-based drugs; d) having natural six anterior teeth; e) have no history of tooth trauma, alveolar bone fracture or luxation in incisors; and f) exhibiting clinically / radiographically healthy periodontium. Study design was discussed and approved by the scientific research ethical committee, Faculty of Dental Medicine (Boys-Cairo), Al-Azhar University. All included patients were thoroughly examined clinically to assure the presence of healthy teeth supporting structures and they were free from any periodontal destruction prior to start the orthodontic teeth movement to close the spacing on both maxilla and mandible. This step was carried out applying the criteria of Gingival Index (GI),[36] Plaque Index (PlI),[37] and Periodontal Disease Index (PDI).[38]

Intra-oral periapical radiographs were taken at same intervals (T1, T2) to evaluate external root resorption around the incisors; L (Labial) and O (Oral; Palatal / Lingual) variables were obtained from long axis of the incisor and a point of reference (zero point) marked at the CEJ. From this reference point, 3 lines were traced in apical direction, with a 3 mm interval, up to the most external limit of Labial (L) and Lingual /Palatal (O) alveolar bone, perpendicular with tooth long axis (Fig.1). Degree of root resorption was analyzed through periapical radiographs, based on previously proposed score system; 39 its criteria as following: 0 = lack of root resorption; 1 = presence of apical irregularities; 2 = presence of root resorption up to 2 mm; 3 = presence of root resorption from 2 mm to one third of the root original length; 4 = presence of root resorption greater than one third of the original length of the root. Root length was obtained from measuring distance from root apex to ECJ, following incisor long axis (Fig. 2).

CBCT image acquisition and Measurements:

Following completion of the clinical examination, intraoral radiographs and CBCT (NewTom VG, Aperio Services, Italy) views were obtained prior to starting of orthodontic treatment (T1), 12 months (T2) after starting treatment. CBCT images were obtained from upper and lower anterior region to evaluate bone density and height. CBCT scan was carried out by a single technician and operated at 80 kV and 5 mA with a height of 30 mm, width of 40 mm. The acquired CBCT data were processed in Dolphin software (Dolphin 11.8, Chatsworth, CA, resolution 0.01 mm), and the incisors of each Jaw were chosen for measurements. Intra-examiner reliability was ensured by reading all images by the same examiner and repeating same measurement procedure after 3 weeks. The parameters (Fig.3) were the labial alveolar bone area (LABA), vertical alveolar bone level on the labial (B) and lingual (L) sides, root length (R), and upper (D1), middle (D2), and lower (D3) alveolar bone thicknesses on the labial side. The protocol of CBCT measurements was modified based on previous studies. 33, 35, 39

Multi-planar reconstructions from Digital Imaging and Communications in Medicine (DICOM); Image slices were oriented through axial, coronal, and sagittal views of 3D head rendering in any direction; bone density and height were calculated as following: Step 1 (Sagittal section): Adjusting long axis of middle incisor to vertical line; Step 2 (Transverse section): Positioning CEJ in axial view; locating the line connected with pulp cavity centers of adjacent incisors to horizon level; Step 3 (Coronal section): Consequently, longest and repeated images of inter-alveolar septum could be obtained and repeating steps for the other inter-alveolar septum (Fig. 1). Coronal, middle, and apical area of inter-alveolar septum were selected to measure bone density (Figure 2). Bone density of anterior area was evaluated through densitometry variations of grayscale, which varied from 0 to 255 (transparent to opaque). Alveolar bone height extending from apex to alveolar crest was measured in millimeters.

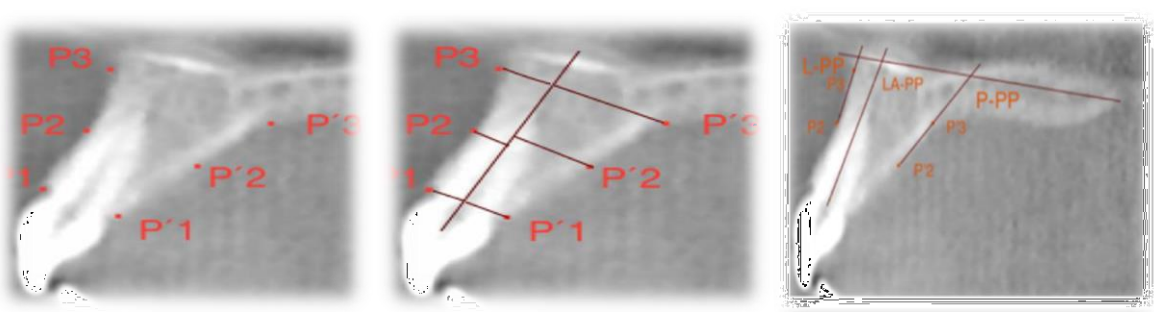
Orthodontic Intervention:

All included patients were treated using a pre-adjusted edgewise fixed appliance (3M Gemini Unitek, Monrovia, CA, USA, 0.022-inch MBT prescription brackets). All teeth in each jaw were included in the appliance, including second molars. Alignment started with a 0.014-inch nickel-titanium (NiTi) archwire, then with a sequence of 0.018-inch, 0.016×0.022-inch and 0.019×0.025-inch NiTi arch wires. Elastomeric power chain from second molar to second molar was used to close spaces. Patients were instructed to contact the clinic within 24 hours if any bracket was de-bonded. The patients were followed on regular appointments every month, at each visit the elastomeric power chain was replaced with a new one. Amount and rate of space closure was measured with the use of digital caliper and rate of space closure was calculated as space closure achieved in mm/month (Fig.4).

Statistical Analysis:

Collected data were presented as mean ± standard deviation (SD), intra-examiner error was tested by a paired Student's t-test. A paired Student's t-test was done to compare the changes between pre-treatment data (T1) and after orthodontic treatment to close teeth spacing (T2) on each jaw. Hence, changes between T1 and T2 were calculated separately, presented as Mean and SD, in each group. One-way analysis of variance (ANOVA) with Tukey multiple comparisons was used to compare the difference between anterior teeth on both jaws. All analyses were done on SPSS version 19.0 for Window package (IBM Corp., Armonk, NY). The significance level was set at a P value of 0.05 for all tests (at $p < 0.05$).

Figure 1: The alveolar height is the distance between the root apex and the middle point of the line connecting the mesial and distal alveolar crest.



A **B**

Figure 2: Six points (P) defining alveolar change from T1 to T2: P1 (most coronal point on labial alveolar crest), P′1 (most coronal point on palatal alveolar crest), P3 (deepest midline point between anterior nasal spine and prosthion, P′3 (a point constructed from bisecting angle formed by palatal plane and palatal alveolar plane), P2 (midpoint between P1 & P3), P′2 (midpoint between P′1 & P′3). (A) Linear distance between reference points and long axis of incisor, (B) Angles between buccal and palatal alveolar planes and palatal plate and angle between long axis of tooth and palatal plate.

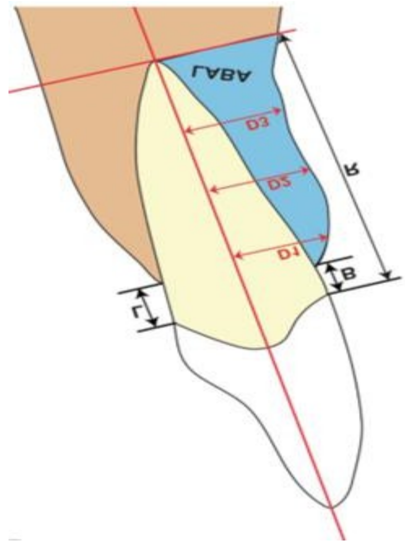


Figure 3: Diagrammatic illustration of the variables measured from sagittal plane CBCT image: 1. LABA, alveolar bone area of labial side of mandibular anterior teeth (in blue color). 2. Vertical alveolar bone loss (distance from CEJ to alveolar bone crest); B, Buccal bone loss; L, lingual bone loss. 3. R, root length (distance from CEJ to root apex, measured parallel to tooth long axis); 4. Upper (D1), Middle (D2), and Lower (D3) alveolar thicknesses.

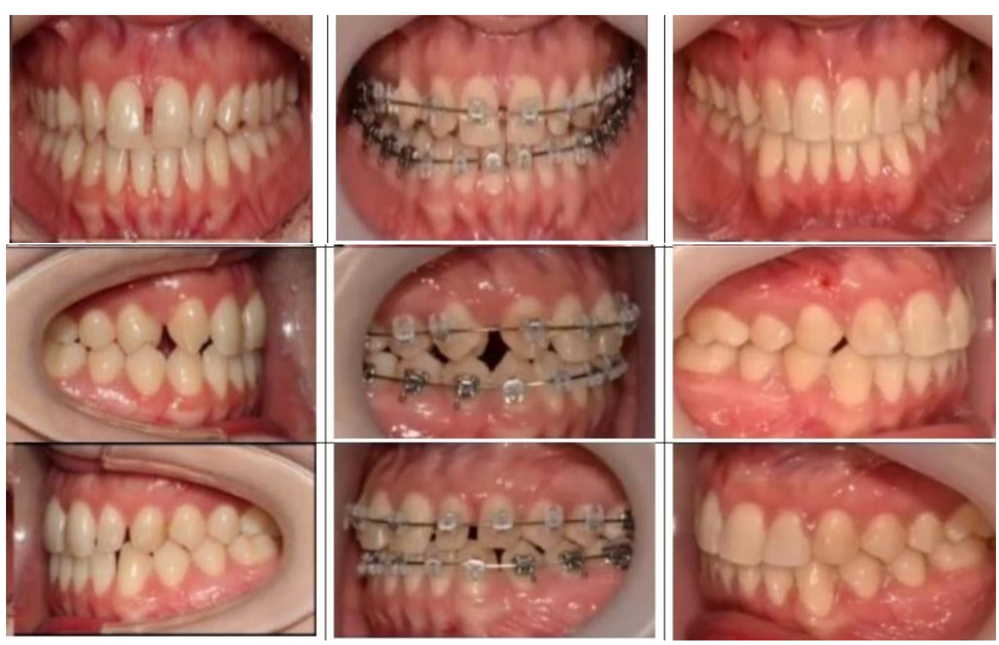


Figure 4: Photographs showing of a case with teeth spaces between maxillary and mandibular anterior teeth, before orthodontic closure of the spaces (on the left), during the orthodontic closure procedure (in the middle) as well after completion of the treatment (on the right).

Results

All included patients completed the designed treatment and attended at the scheduled visits; there were no complaints or argue from any patients regarding the procedure. By the end of treatment they were completely satisfied with the obtained results and were happy to have closure of teeth spacing involving their anterior teeth on the both upper and lower jaw (Figure 4). Clinical examination of the oral cavity with the criteria of GI, PlI, and PDI, did not record marked changes at each visit during the follow up period compared with those recorded initially at the baseline prior to orthodontic treatment (data not included here).

a. Bone Level: It was measured at anterior teeth prior to closing of teeth spacing as well as after their closing; results are presented in Tables 1, 2 and 3.

Location	*Time: T1 Mean ± SD mm*	*Time: T2 Mean ± SD mm*	*Alveolar Bone Change (T2–T1)*	*P**
B	2.1 ± 1.2	2.4 ± 1.3	0.4	*NS*
P	1.8 ± 1.1	2.9 ± 1.1	1.1	*.001*
DB	3.8 ± 1.8	2.6 ± 1.6	−1.2	*<.001*
MB	2.1 ± 0.9	2.6 ± 1.1	0.5	*.NS*
DP	3.1 ± 1.4	2.3 ± 1.0	−0.8	*.008*
MP	1.9 ± 0.9	2.7 ± 1.1	0.8	*NS*

*Alveolar bone change, estimated difference of alveolar bone level from T1 to T2. B, Buccal; DB, Distobuccal; DP, Distopalatal; P, Palatal; MB, Mesiobuccal; MP, Mesiopalatal. *P for difference between T1 and T2 according to the linear mixed model analysis*.

Table 1: CBCT determination of alveolar bone level of Maxillary Teeth at Pretreatment (T1) and Posttreatment (T2)

Location	*Time: T1 Mean ± SD mm*	*Time: T2 Mean ± SD mm*	*Alveolar Bone Change (T2–T1)*	*P**
B	1.9 ± 1.2	2.2 ± 1.1	0.3	*NS*
L	1.7± 1.0	2.7 ± 1.1	1.0	*.001*
DB	3.6 ± 2.1	2.6 ± 1.5	−1.0	*<.001*
MB	2.1 ± 1.0	2.4 ± 1.0	0.3	*.NS*
DL	3.0 ± 1.5	2.1± 1.0	−0.9	*.008*
ML	1.8 ± 1.0	2.5 ± 1.1	0.7	*NS*

Alveolar bone change, estimated difference of alveolar bone level from T1 to T2. B: Buccal; DB: Distobuccal; DL: Distolingual; L: Lingual; MB: Mesiobuccal; ML: Mesiolingual. P for difference between T1 and T2 according to the linear mixed model analysis.

Table 2: CBCT determination of alveolar bone level of Mandibular Teeth at Pretreatment (T1) and Posttreatment (T2).

Location	*Alveolar Bone Change (T2–T1) involving Maxillary Teeth*	*Alveolar Bone Change (T2–T1) involving Mandibular Teeth*	*Significance*
B	0.4	0.3	*NS*
P	1.1	1.0	*S*
DB	−1.2	−1.0	*S*
MB	0.5	0.3	*NS*
DP	−0.8	−0.9	*NS*
MP	0.8	0.7	*NS*

Table 3: The comparisons between alveolar bone changes involving the both jaws evaluated applying CBCT views

b. Results of associated External Root Resorption following the orthodontic tooth movements are presented in Table 4.

Variable	***Maxillary Teeth Mean ± SD***	***Mandibular Teeth Mean ± SD***	***p***
ERR T1	0.16 ± 0.40	0.16 ± 0.40	1.000
ERR T2	1.50 ± 1.04	1.00 ± 0.00	0.336
ERR T2-1	1.34 ± 0.81	0.84 ± 0.40	0.240

Table 4: Comparison between the amounts of external root resorption (ERR) occurred on maxillary and mandibular teeth, presented as the mean +SD of resorption recorded initially (ERR T1) and post-treatment (ERR T2) of maxillary and mandibular teeth. The associated net difference between resorption recorded at the completion of treatment was calculated (ERR T2 – ERR-2).

c. Horizontal and Vertical changes of alveolar bone viewed on CBCT are illustrated in Figures 3 and 4

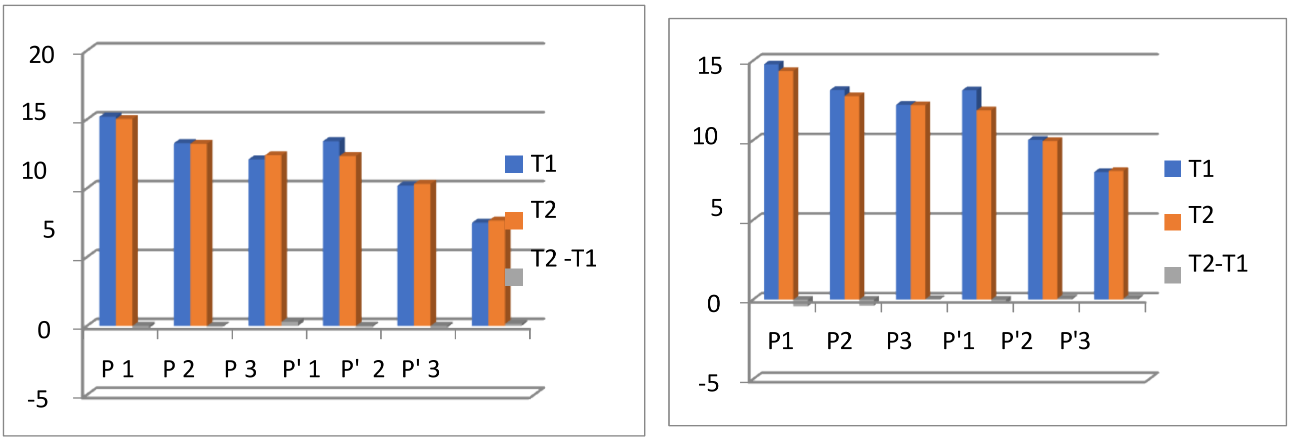


Figure 3: CBCT horizontal changes in position of reference points between T1 and T2 of maxillary anterior teeth (A), and mandibular anterior teeth (B); there was change in position of reference points between T1 and T2; non- significant changes from T1 to T2, while changes in horizontal position of P2 and P′2 as well as changes positions of points P1 and P′1 were significant from T1 to T2 ($P \leq .001$).

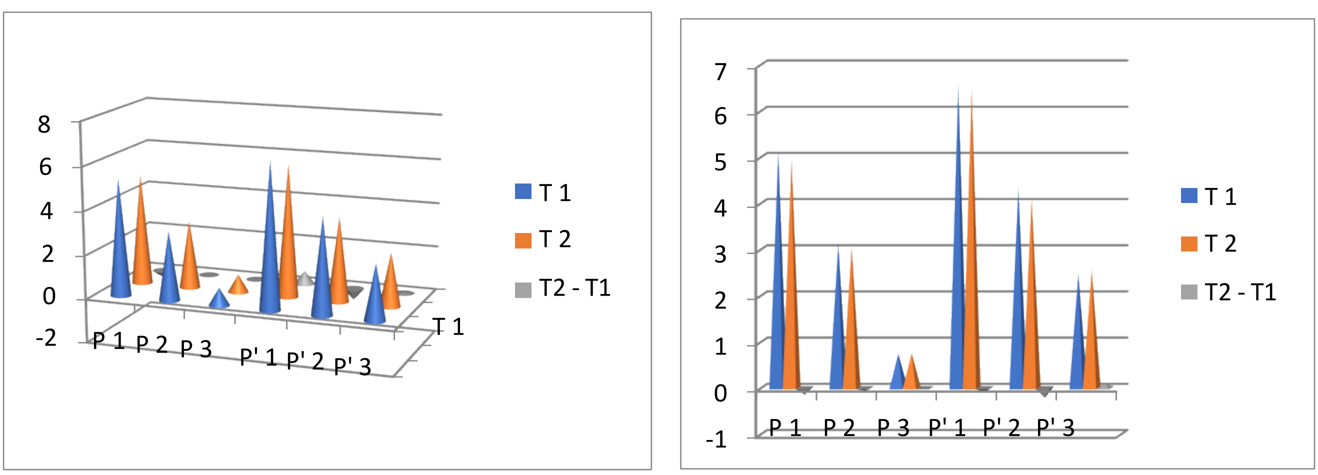


Figure 4: CBCT vertical changes in position of reference points between T1 and T2 of maxillary anterior teeth (A), and mandibular anterior teeth (B). The position of points P3 and P′3 didn't show significant changes from T1 to T2. Vertical changes in positions of P′2 were highly significant ($P < .001$), change in position of P2 was, also, significant but to a lesser degree ($P < .05$), while changes in positions of P1 and P′1 were highly significant from T1 to T2 ($P \leq .001$).

d. **Bone Density and Bone Height Changes:** The alveolar density of maxillary bone showed significant decrease from 126.21 to 111.53 while the mandibular bone density was decreased from 136.13 to 123.56. Alveolar maxillary bone showed a statistically smaller bone density before treatment. There was a significant loss of bone density for both jaws after orthodontic tooth movement; maxillary bone showed a greater bone density loss compared to mandibular alveolar bone. The average alveolar height was 9.37 mm for maxilla 1 and 10.86 mm for mandible prior to treatment. The difference between pre-treatment and post treatment was 0.16 mm in maxillary bone and 0.11 mm in mandibular bone; no significant bone height loss in each jaw bone after orthodontic closure of teeth spacing (Table 5).

Variable	**Maxillary Teeth** ***Mean ± SD***	**Mandibular Teeth** ***Mean ± SD***	**Comparison** ***P value***
D1	125.67 ± 23.45	147.78 ±26.04	0.02 *S*
D2	98.67± 13.65	134.35 ± 16.66	< 0.001 *HS*
D2 – D1	-27±4.55	-13.43±3.08	0.02 *S*
H1	8.89 ± 2.09	10.89 ±2,02	< 0.001 *HS*
H2	8.04 ± 1.68	10.38 ± 1.08	< 0.001 *HS*
H2 – H1	-0.85±0.14	-0.51±0.19	0.53 *NS*

D1: *Alveolar bone density before treatment;* ***D2:*** *Alveolar bone density after treatment;* ***H1:*** *Alveolar bone height before treatment;* ***H2:*** *Alveolar bone height after treatment.*

Table 5: The recorded changes involving the Bone density and Bone height

Discussion

It has been acknowledged that, positioning the incisors more perpendicular to the basal bone will aid to increase the support around the teeth roots that ultimately produce good periodontal tissue status.[2] Bone will follow the trace of tooth movement, hence bone remodeling and tooth movement ratio is 1:1 is required; however the compensation procedure of bone remodeling is not matched with tooth movement magnitude.[17, 18, 23] Therefore, prior to orthodontic treatment, evaluation of the bone structure at anterior tooth is mandatory to avoid the occurrence of fenestration or dehiscence and to obtain a stable position after treatment. Basically, in incisors movement, optimal stability will be obtained if the teeth are placed in the medullary region of alveolar bone as well as in good balance with labial and lingual muscles. However, it should be kept in mind that, orthodontic teeth movement must be efficient with minimal iatrogenic effects on teeth and their alveolar bone as much as possible.[4,8] Space closing has been considered as an important factor for success of orthodontic treatment and several orthodontic mechanics were designed for this purpose.[40] It is of importance for the professional to determine precisely the system of forces generated, i.e. it is important for the orthodontist to know the magnitude of the forces and the moments released when these devices are activated.[9] An improper use of orthodontic mechanics to close spaces can result in undesirable effects as loss of anchorage and root resorption. Such effects added to increased treatment time may, also, cause irreversible tissue damage. In this situation, knowledge of mechanical behavior of orthodontic appliance is of importance to obtain better results and good clinical outcomes. Basically, two main retraction techniques can be applied to close spacing: en masse retraction or two-step retraction, however the choice between these two methods is the clinician's preference, but most orthodontists decide to use two step retraction in cases in which posterior anchorage control is critical. [41]

An apical root resorption of anterior incisors during orthodontic treatment has been reported.[42] However, significant bone density loss after orthodontic treatment; bone resorption / deposition is not synchronous, and bone resorption in areas of pressure might precede bone formation seen in areas of tension during tooth movement.[43] Additionally, bone loss in patients with periodontitis was greater than those with normal periodontal support. A net reduction of alveolar bone density occurred as a consequence of hyperactivity of regional bone absorption. In this respect, a tooth could be orthodontically moved into area of reduced bone height with maintenance of height of alveolar bone support. [44] Orthodontic treatment not only will cause root resorption but can, also, cause height reduction of alveolar bone top.[7] Equally, alveolar bone did not affected if applied force kept minimal and light which will induce displacement of tooth, alveolar bone and cortical bone, so light force application is considered a principle of tooth movement in any direction [8,9] CBCT due to its minimal distortion allowing accurate measures of bone changes which make it useful for accuracy assessment of alveolar bone changes (height and thickness) over time, as CBCT offers better capability over traditional methods.[19,20, 23-26]

It has been found that, alveolar bone thickness at labial cervical third significantly increased and decreased at the palatal cervical and middle thirds. Additionally, tooth movement can alter the distance between alveolar cortical plates in relation to roots of the teeth moved by orthodontic treatment, i.e., anteroposterior movement of incisors can lead to bone loss in movement direction.[24] The changes occurring during orthodontic treatment phase, were significant in following variables: crown-root ratio, incisor length. At the final stage of orthodontic treatment, the results of measured variables indicated that maxillary central incisors were more protruded at end of treatment than those of mandibular teeth. The maxillary incisors presented a statistically significant decreased labial alveolar bone thickness at cervical third in relation to mandibular incisors.[24]

The results showed that, labial bone thickness at cervical area on maxillary incisors was increased while bone thickness decreased in mandibular incisors, alveolar bone thickness at other root areas did not undergo any significant changes; a finding that may provide evidence that alveolar cortical plates could be submitted to re-anatomization, modifying their shape and position.[30] The results were contrary to the hypothesis of limitation of the tooth movement by alveolar cortical plates,[8] showing that alveolar bone remodeling is possible during tooth movement induced by biological forces.[5] External root resorption was reported as a consequence to orthodontic tooth movement. In present study an evaluation of external root resorption was investigated utilizing the scores previously proposed.[39] In this respect, it was proposed that one biological factor influencing root resorption during orthodontic movement is root morphology, however, other factors as age, gender, metabolism velocity and tooth anomaly, which cannot be controlled, also can influence the process of root resorption during orthodontic movement.[42] In this respect, factors related to treatment include: amount of movement, treatment time and magnitude of the applied force.[45,46] Results of the present study did not find statistically significant differences in root resorption at anterior teeth of the two dental arches. Additionally, patients submitted to retraction of anterior teeth through lingual root torque presenting low bone thickness, i.e., small alveolar width; clinically demonstrate a decrease in alveolar bone thickness and a greater tendency towards external root resorption. [42,45]

The obtained results, here, showed significant increased bone loss at both buccal and lingual sides of mandibular central incisors; results were inconsistent with a study[47] reported that, alveolar loss rate was relatively higher in labial aspect than lingual; this differences may 9 be due to different biomechanics, different force levels, as well as to individual variations.48 In addition, bone loss was noted at the mesial, the distal, the buccal, as well as on the lingual sides of mandibular incisors after the orthodontic teeth movement, a finding agree with that of other studies.[49] In addition, alveolar bone loss at mandibular central incisors was more lingual side, which may support that of study found that distance between CEJ and alveolar bone crest did not change by orthodontic movement,[50] while another study reported decreased distance between CEJ and alveolar bone crest after intrusion or extrusion.[51] However, significant higher alveolar bone loss at distal aspect than mesial aspect was reported. [52,53]

It is worthy note to mention that, there are some limitations to the present study that need to be considered. For example, this study focused on tooth-supporting structures changes that associate closure of teeth spaces by orthodontic treatment; many other biological aspects also need to be considered, as individual and age differences. Hence, it would be of value to continue studying this aspect on larger sample of both genders with wide age range and doing CBCT views at various intervals during the treatment. Such line of investigation may provide clearer and meaningful information toward better clarification of this aspect.

Conclusions

Teeth protraction to close spaces causes changes in alveolar bone level; maxillary incisors showed a greater amount of bone loss than at mandibular incisors, in particular at the oral aspect. Greater bone loss on buccal and palatal aspects of maxillary incisors compared to mandibular buccal and lingual aspects. During orthodontic treatment it is of value to select the optimal orthodontic displacement to minimize adverse effects periodontal tissues. Subsequent research focusing on specific pattern of tooth movement under periodontal conditions is needed.

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