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ALVEOLAR BONE CHANGES AND ROOT RESORPTION CONCOMITANT WITH RECTANGULAR NITI IN INITIAL LEVELING AND ALIGNMENT

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ABSTRACT

Introduction: Fixed orthodontic appliances include a wide variety of archwires used as a means of delivering forces on teeth. As there are a variety of available archwires, it is important to know which is the most efficient during the initial aligning stage of the treatment. During the initial phase of orthodontic treatment, the use of rectangular arch wires has been reported to result in decreased incisor inclination compared to the traditional round NiTi arch wires. Debates still exist regarding the effect of SLB on the alveolar bone and the root length. **Aim of the study:** The aim of this clinical study is to evaluate the changes in the alveolar bone and the root resorption during initial leveling and alignment with rectangular NiTi arch wires. **Materials and methods:** The current randomized clinical prospective study was conducted on a total sample of 20 patients, divided into two groups of ten. Group I consisted of 10 patients treated with active self-ligating stainless-steel brackets and round Cu NiTi wires using the conventional sequence for leveling and alignment. Group II consisted of 10 patients treated with active self-ligating stainless-steel brackets and rectangular Cu NiTi archwires for leveling and alignment. CBCTs were taken after achieving the study objectives (post leveling and alignment) to be used for analyzing the study measurements and comparison with the pretreatment CBCT data. Both groups were compared regarding alveolar bone length, alveolar bone thickness and root length. **Conclusion:** We concluded that there was no significant difference between the two groups concerning alveolar bone length and thickness. However, group II (treated with rectangular Cu NiTi archwires) showed a significant decrease in root length.

INTRODUCTION

Fixed orthodontic appliances include a wide variety of archwires used as a means of delivering forces on teeth. The aligning archwires are intended to be inserted into the fixed orthodontic appliance at the beginning of the treatment, mainly to correct crowding and dental rotations.[1] The success of the orthodontic treatment may depend on the selection of the aligning archwires. As there are a variety of available archwires, it is important to know which is the most efficient during the initial aligning stage of the treatment.[2] During the initial phase of orthodontic treatment, the use of rectangular arch wires has been reported to result in decreased incisor inclination compared to the traditional round NiTi arch wires.[3]

Self-ligating brackets are considered as a revolution in the bracket systems. They do not require an elastic or wire ligature, but have an inbuilt mechanism which can be opened and closed to secure the archwire.[4] Proponents of self-ligating brackets claimed that it presents several clinical advantages among which are reduced friction, better sliding mechanics, full arch wire engagement, higher rate of dental movement, improved oral hygiene, better acceptance by patients and better

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treatment results.[4,5] However, debates still exist regarding the effect of SLB on the alveolar bone and the root length. Some studies concluded that there were no significant differences between SLB and conventional brackets regarding dentoalveolar changes and root resorption[6-8], while others have found SLB more safe.[9]

Based on the above hypothesis, the current study measures the changes in the alveolar bone and the root length with active self-ligating brackets using round versus rectangular NiTi arch wires in initial alignment.

MATERIALS AND METHODS

The current randomized clinical prospective study was conducted on a total sample of 20 patients, divided into two groups of ten. They were selected from the orthodontic clinic, Department of Orthodontics, Faculty of Dental Medicine (Boys), Al-Azhar University, Cairo, Egypt.

Patients were included when their age ranged between 14 and 20 years old, all permanent teeth were erupted (3rd molar not included), Angle Class I with normal facial proportions, mild to moderate crowding in maxillary dental arch, all cases treated with fixed appliance using non-extraction approach, good oral and general health. Patients were excluded when there was evidence of horizontal bone loss, root resorption, periodontal or oral disease such as enamel hypoplasia, systemic disease or regular medication that could interfere and/or affect orthodontic teeth movement, previous orthodontic treatment.

The orthodontic patients involved in this study were treated using fixed orthodontic appliances. According to the type of the initial wires that used for leveling and alignment, the patients were randomly divided into two groups (I&II). The random allocation was achieved by online computer software.

Group I consisted of 10 patients treated with active self-ligating stainless-steel brackets and round Cu NiTi wires using the conventional sequence for leveling and alignment. Group II consisted of 10 patients treated with active self-ligating stainless-steel brackets and rectangular Cu NiTi archwires for leveling and alignment.

The following routine records were obtained for each patient before treatment: intra-oral and extra-oral photographs, orthodontic study casts, panoramic radiograph, lateral cephalometric radiograph, cone beam computed tomography (CBCT).

CBCTs were taken after achieving the study objectives (post leveling and alignment) to be used for analyzing the study measurements and comparison with the pretreatment CBCT data.

All patients in the current study were treated with 0.022 × 0.028 inch - slot active self-ligating stainless-steel brackets, Prodigy system, Ormco, Glendora, California, USA. Cu NiTi archwires, Ormco, Glendora, California, USA were used during the leveling and alignment stage. The wires were changed every 2 months in all patients during the study period (6 months), while the cross section and the sequence of the wire replacement were different in each group:

Group I: For both maxillary and mandibular arches; round Cu NiTi archwires were used during leveling and alignment in the conventional sequences: 0.14 inch, 0.016 inch and 0.018 inch.

Group II: For the maxillary arch; rectangular Cu NiTi archwires were used during leveling and alignment in the following sequences: 0.014 × 0.025-inch, 0.016 × 0.025-inch and 0.017 × 0.025-inch. While in the mandibular arch; round Cu NiTi archwires were used during leveling and alignment in the conventional sequences: 0.14 inch, 0.16 inch and 0.18 inch.

Pre-alignment and post-alignment CBCT scans of the maxillary arch were taken for all patients and analyzed for the following variables: alveolar bone level at first molars, first premolars and central incisors, buccal bone thickness at first molars, first premolars and central incisors, root length of central incisors.

The CBCT images were acquired at Photon Scan Center using a Planmeca Promax Mid machine. A scout view was obtained and adjustments were made to ensure that the all patients were correctly aligned in the scanner according to adjustment light beam before acquisition.

The machine was operating at the following protocol for all the scans of the study: Tube voltage 90 Kvp, Exposure time 12 S, Current 12 mA, Voxel size 200 mm, Field of view 401cm Height x 401cm width x 401 depth.

After acquisition, data were exported and transferred in DICOM format and downloaded via a Compact Disk (CD) to a personal computer for linear measurements, where in vivo Dental software was utilized.

Superimposition module was used to superimpose the postoperative scan over the preoperative one, where four landmarks at different anatomical areas were chosen at each scan, and then registration of these landmarks was automatically performed by the software. Superimposition sequence was repeated for each patient individually.

After completion of superimposition, the two scans (preoperative and postoperative) were one unit and move in the same sequence. Orientation of the whole volume was made to ensure that the orthogonal reference lines (axial, coronal and sagittal) were following certain planes.

In order to assign maxillary plane,[10] three points were identified at the level of the hard palate; ANS anteriorly, right and left posterior maxillary points (rPMP and lPMP).

1. Buccal alveolar bone level:

At sagittal view for central incisors and coronal view for 1st premolars and 1st molars, the distance between the lowest point of the alveolar bone and the maxillary reference plane was measured.

2. Buccal alveolar bone thickness:

A vertical line was drawn from the maxillary plane to the lowest point of the alveolar crest at the mesiodistal midway of the measured tooth. Three measurements for the buccal alveolar bone thickness were taken; at the widest area of the alveolar bone crest, at the level of root apex and at the midpoint between them. The measurements were taken at sagittal view for central incisors and coronal view for 1st premolars and 1st molars.

3. Root length

The vertical distance between the apex and the line representing CEJ of the central incisors was measured.

Numerical data were explored for normality by checking the data distribution using Kolmogorov-Smirnov and Shapiro-Wilk tests. All data showed parametric distribution except for bone thickness, changes, % changes in all measurements data which showed non-parametric distribution.

For parametric data; Student's t-test was used to compare between mean ages in the two groups. Repeated measures ANOVA test was used to study the changes by time within each group as well as to compare between the two groups. Bonferroni's post-hoc test was used for pair-wise comparisons when ANOVA test is significant.

For non-parametric data; Wilcoxon signed-rank test was used to study the changes by time within each group. Mann-Whitney U test was used to compare between changes as well as % changes in the two groups.

Qualitative data (Gender data) were presented as frequencies and percentages. Fisher's Exact test was used to compare between the two groups.

Measurement error was assessed using Dahlberg's formula:

$$\text{Measurement error} = \sqrt{\frac{d^2}{2n}}$$

Where (d) is the difference between the measurements and (n) is the number of duplicates.

The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM SPSS Statistics Version 20 for Windows.

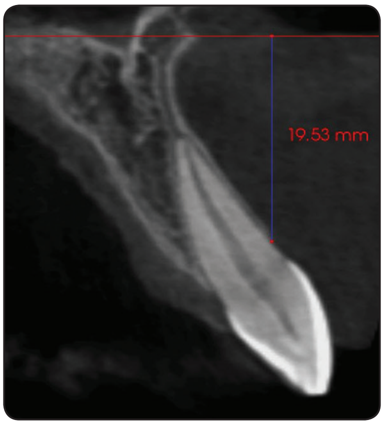

FIG (1) Sagittal view showing measurement of alveolar bone level at central incisor

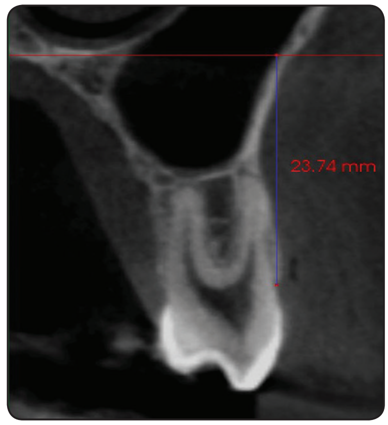

FIG (2) Coronal view showing measurement of alveolar bone level at 1st premolar

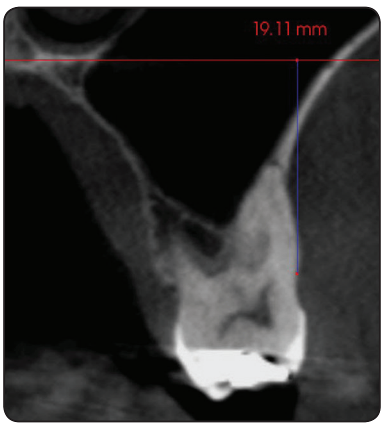

FIG (3): Coronal view showing measurement of alveolar bone level at 1st molar

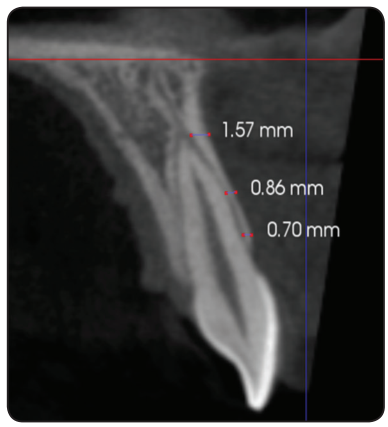

FIG (4): Sagittal view showing measurement of labial alveolar bone thickness at central incisor

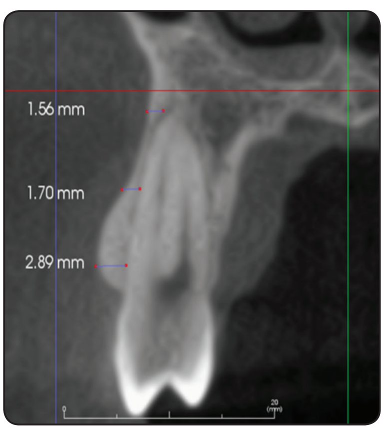

FIG (5): Coronal view showing measurement of buccal alveolar bone thickness at 1st premolar

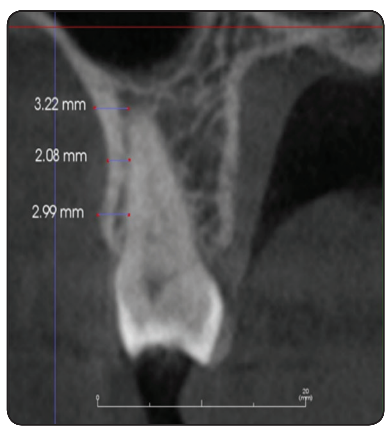

FIG (6): Coronal view showing measurement of buccal alveolar bone thickness at 1st molar

FIG (7): Coronal view showing measurement of root length of central incisor

RESULTS

In the current study 3 cases out of a total sample of 22 randomly selected orthodontic patients have dropped out. The remaining 17 patients (6 males and 11 females) were 8 patients in group I (2 males and 6 females) and 9 patients in group II (4 males and 5 females).

Comparison of age and gender between the two groups are presented in tables 1-2.

TABLE (1): Descriptive statistics and results of Student's t-test for comparison between age values in the two groups

Age	Round	Rectangular	P-value
Mean (SD)	16.3 (1.0)	16.4 (1.4)	0.755
Median	16.0	16.0	
Range (Minimum – Maximum)	15.0 – 18.0	15.0 – 19.0	
95% CI (Lower bound – Upper bound)	15.4 – 17.1	15.3 – 17.5	

** Significant at P ≤ 0.05*

TABLE (2): Descriptive statistics and results of Fisher's Exact test for comparison between gender distributions in the two groups

Gender	Round		Rectangular		P-value
	n	%	n	%	
Males	2	25.0	4	44.4	0.620
Females	6	75.0	5	55.6	

** Significant at P ≤ 0.05*

Statistical data analysis is shown in tables 3-28.

TABLE (3): Mean, standard deviation (SD) and test of significance (ANOVA) to compare alveolar bone level measurements (mm) at first molars after leveling within each group and between groups

Group	Before treatment		After leveling		P-value within group
	Mean	SD	Mean	SD	
Round	13.25	2.18	13.06	2.03	0.448
Rectangular	15.21	2.96	14.93	3.02	0.235
P- value between groups	0.145		0.160		

** Significant at P ≤ 0.05*

TABLE (4): Mean, standard deviation (SD) and test of significance (Mann-Whitney U test) to compare the changes of alveolar bone level at first molars between the two groups

Time	Round		Rectangular		P-value
	Mean	SD	Mean	SD	
Change (mm)	-0.18	0.19	-0.28	0.90	0.699
% Change	-1.25	1.33	-1.73	5.80	0.700

** Significant at P ≤ 0.05*

TABLE (5): Mean, standard deviation (SD) and test of significance (ANOVA) to compare alveolar bone level measurements (mm) at first premolars after leveling within each group and between groups

Group	Before treatment		After leveling		P-value within group
	Mean	SD	Mean	SD	
Round	14.43	2.30	13.71	2.70	0.010
Rectangular	16.11	3.13	15.78	2.92	0.167
P- value between groups	0.230		0.151		

**Significant at P ≤ 0.05*

TABLE (6): Mean, standard deviation (SD) and test of significance (Mann-Whitney U test) to compare the changes of alveolar bone level at first premolars between the two groups

Time	Round		Rectangular		P-value
	Mean	SD	Mean	SD	
Change (mm)	-0.72	0.48	-0.34	0.84	0.385
% Change	-5.55	4.57	-1.79	5.79	0.248

** Significant at P ≤ 0.05*

TABLE (7): Mean, standard deviation (SD) and test of significance (ANOVA) to compare alveolar bone level measurements (mm) at central incisors after leveling within each group and between groups

Group	Before treatment		After leveling		P-value within group
	Mean	SD	Mean	SD	
Round	14.67	2.09	14.17	2.17	0.003*
Rectangular	16.37	3.26	15.97	3.49	0.008*
P- value between groups	0.227		0.228		

** Significant at P ≤ 0.05*

TABLE (8): Mean, standard deviation (SD) and test of significance (Mann-Whitney U test) to compare the changes of alveolar bone level at central incisors between the two groups

Time	Round		Rectangular		P-value
	Mean	SD	Mean	SD	
Change (mm)	-0.50	0.32	-0.40	0.45	0.736
% Change	-3.49	2.30	-2.72	2.63	0.564

** Significant at P ≤ 0.05*

TABLE (9): Mean, standard deviation (SD) and test of significance (Wilcoxon signed-rank) to compare alveolar bone thickness measurements (mm) at first molars apically after leveling within each group and between groups

Group	Before treatment		After leveling		P-value within group
	Mean	SD	Mean	SD	
Round	2.99	1.75	2.74	1.84	0.018*
Rectangular	2.89	1.86	2.32	1.63	0.008*
P- value between groups	0.962		0.810		

** Significant at P ≤ 0.05*

TABLE (10): Mean, standard deviation (SD) and test of significance (Mann-Whitney U test) to compare the changes of alveolar bone thickness at first molars apically between the two groups

Time	Round		Rectangular		P-value
	Mean	SD	Mean	SD	
Change (mm)	-0.25	0.26	-0.57	0.65	0.176
% Change	-11.40	13.00	-28.39	30.54	0.102

** Significant at P ≤ 0.05*

TABLE (11): Mean, standard deviation (SD) and test of significance (Wilcoxon signed-rank) to compare alveolar bone thickness measurements (mm) around first molars at the middle third after leveling within each group and between groups

Group	Before treatment		After leveling		P-value within group
	Mean	SD	Mean	SD	
Round	1.10	0.54	0.90	0.68	0.079
Rectangular	1.51	0.91	0.93	0.75	0.012*
P- value between groups	0.311		0.630		

** Significant at P ≤ 0.05*

TABLE (12): Mean, standard deviation (SD) and test of significance (Mann-Whitney U test) to compare the changes of alveolar bone thickness around first molars at the middle third between the two groups

Time	Round		Rectangular		P-value
	Mean	SD	Mean	SD	
Change (mm)	-0.20	0.20	-0.58	0.43	0.091
% Change	-35.51	42.03	-46.57	25.60	0.248

** Significant at P ≤ 0.05*

TABLE (13): Mean, standard deviation (SD) and test of significance (Wilcoxon signed-rank) to compare alveolar bone thickness measurements (mm) around first molars at the cervical third after leveling within each group and between groups

Group	Before treatment		After leveling		P-value within group
	Mean	SD	Mean	SD	
Round	1.64	0.38	1.45	0.47	0.161
Rectangular	1.54	0.51	1.08	0.31	0.011*
P- value between groups	0.700		0.112		

** Significant at P ≤ 0.05*

TABLE (14): Mean, standard deviation (SD) and test of significance (Mann-Whitney U test) to compare the changes of alveolar bone thickness around first molars at the cervical third between the two groups

Time	Round		Rectangular		P-value
	Mean	SD	Mean	SD	
Change (mm)	-0.19	0.43	-0.46	0.34	0.311
% Change	-10.79	27.56	-27.26	15.01	0.054

** Significant at P ≤ 0.05*

TABLE (15): Mean, standard deviation (SD) and test of significance (Wilcoxon signed-rank) to compare alveolar bone thickness measurements (mm) around first premolars at the apical third after leveling within each group and between groups

Group	Before treatment		After leveling		P-value within group
	Mean	SD	Mean	SD	
Round	0.99	0.75	0.99	0.80	0.236
Rectangular	1.02	0.71	1.10	1.02	0.594
P- value between groups	0.773		0.885		

** Significant at P ≤ 0.05*

TABLE (16): Mean, standard deviation (SD) and test of significance (Mann-Whitney U test) to compare the changes of alveolar bone thickness around first premolars at the apical third between the two groups

Time	Round		Rectangular		P-value
	Mean	SD	Mean	SD	
Change (mm)	0.00	0.29	0.08	0.40	0.923
% Change	-4.27	26.64	9.85	97.86	0.847

** Significant at P ≤ 0.05*

TABLE (17): Mean, standard deviation (SD) and test of significance (Wilcoxon signed-rank) to compare alveolar bone thickness measurements (mm) around first premolars at the middle third after leveling within each group and between groups

Group	Before treatment		After leveling		P-value within group
	Mean	SD	Mean	SD	
Round	0.87	0.52	0.76	0.54	0.035*
Rectangular	0.94	0.42	0.77	0.68	0.122
P- value between groups	0.663		1.000		

** Significant at P ≤ 0.05*

TABLE (18): Mean, standard deviation (SD) and test of significance (Mann-Whitney U test) to compare the changes of alveolar bone thickness around first premolars at the middle third between the two groups

Time	Round		Rectangular		P-value
	Mean	SD	Mean	SD	
Change (mm)	-0.11	0.12	-0.18	0.35	0.699
% Change	-20.35	26.55	-28.42	44.33	0.847

** Significant at P ≤ 0.05*

TABLE (19): Mean, standard deviation (SD) and test of significance (Wilcoxon signed-rank) to compare alveolar bone thickness measurements (mm) around first premolar at the cervical third after leveling within each group and between groups

Group	Before treatment		After leveling		P-value within group
	Mean	SD	Mean	SD	
Round	1.69	0.65	1.07	0.66	0.021*
Rectangular	1.53	0.31	1.10	0.39	0.011*
P- value between groups	0.360		1.000		

** Significant at P ≤ 0.05*

TABLE (20): Mean, standard deviation (SD) and test of significance (Mann-Whitney U test) to compare the changes of alveolar bone thickness around first premolar at the cervical third between the two groups

Time	Round		Rectangular		P-value
	Mean	SD	Mean	SD	
Change (mm)	-0.62	0.86	-0.43	0.21	0.594
% Change	-34.18	31.40	-29.57	19.03	0.923

** Significant at P ≤ 0.05*

TABLE (21): Mean, standard deviation (SD) and test of significance (Wilcoxon signed-rank) to compare alveolar bone thickness measurements (mm) around central incisors at the apical third after leveling within each group and between groups

Group	Before treatment		After leveling		P-value within group
	Mean	SD	Mean	SD	
Round	1.86	0.66	1.54	0.95	0.091
Rectangular	1.93	0.70	2.22	0.96	0.314
P- value between groups	0.962		0.102		

** Significant at P ≤ 0.05*

TABLE (22): Mean, standard deviation (SD) and test of significance (Mann-Whitney U test) to compare the changes of alveolar bone thickness around central incisors at the apical third between the two groups

Time	Round		Rectangular		P-value
	Mean	SD	Mean	SD	
Change (mm)	-0.32	0.51	0.29	0.84	0.135
% Change	-25.09	39.52	23.57	66.12	0.102

** Significant at P ≤ 0.05*

TABLE (23): Mean, standard deviation (SD) and test of significance (Wilcoxon signed-rank) to compare alveolar bone thickness measurements (mm) around central incisors at the middle third after leveling within each group and between groups

Group	Before treatment		After leveling		P-value within group
	Mean	SD	Mean	SD	
Round	0.94	0.19	0.81	0.17	0.108
Rectangular	1.08	0.35	1.02	0.60	0.512
P- value between groups	0.626		0.664		

** Significant at P ≤ 0.05*

TABLE (24): Mean, standard deviation (SD) and test of significance (Mann-Whitney U test) to compare the changes of alveolar bone thickness around central incisors at the middle third between the two groups

Time	Round		Rectangular		P-value
	Mean	SD	Mean	SD	
Change (mm)	-0.13	0.17	-0.07	0.41	0.962
% Change	-12.18	16.95	-8.38	35.81	0.923

** Significant at P ≤ 0.05*

TABLE (25): Mean, standard deviation (SD) and test of significance (Wilcoxon signed-rank) to compare alveolar bone thickness measurements (mm) around central incisors at the cervical third after leveling within each group and between groups

Group	Before treatment		After leveling		P-value within group
	Mean	SD	Mean	SD	
Round	1.15	0.26	0.76	0.22	0.012*
Rectangular	0.97	0.30	0.71	0.23	0.008*
P- value between groups	0.067		0.596		

** Significant at P ≤ 0.05*

TABLE (26): Mean, standard deviation (SD) and test of significance (Mann-Whitney U test) to compare the changes of alveolar bone thickness around central incisor at the cervical third between the two groups

Time	Round		Rectangular		P-value
	Mean	SD	Mean	SD	
Change (mm)	-0.40	0.16	-0.26	0.17	0.123
% Change	-33.83	11.87	-25.93	14.08	0.162

** Significant at P ≤ 0.05*

TABLE (27): Mean, standard deviation (SD) and test of significance (ANOVA) to compare the root length measurements (mm) of central incisors after leveling within each group and between groups

Group	Before treatment		After leveling		P-value within group
	Mean	SD	Mean	SD	
Round	12.91	0.93	12.74	0.87	0.032*
Rectangular	14.07	1.71	13.40	1.64	<0.001*
P- value between groups	0.112		0.323		

** Significant at P ≤ 0.05*

TABLE (28): Mean, standard deviation (SD) and test of significance (Mann-Whitney U test) to compare the changes of root length of central incisors between the two groups

Time	Round		Rectangular		P-value
	Mean	SD	Mean	SD	
Change (mm)	-0.18	0.18	-0.67	0.24	0.002
% Change	-1.35	1.25	-4.73	1.54	0.001

** Significant at P ≤ 0.05*

DISCUSSION

The current study was done on 17 patients with an age ranged between 14 and 20 years, with a mean age of 16 ± 1.2 years. The age range was selected in such way to diminish as much as possible the gap in age between patients to ensure the same biological response in all patients. In addition, adolescents and young adults were selected in order to negate the effects of aging on the periodontium, since many previous studies have indicated that the prevalence of alveolar bone loss and root length reduction increases with age.[11,12]

CBCTs have been used in the current study, for measuring the linear variables. Various studies[10,13,14] have indicated that CBCT images can be used to obtain accurate linear and angular dento-skeletal measurements. Another study [15] found a small systematic error, which became statistically significant only when combining several measurements.

In the present study, maxillary plane[10] which is fixed skeletal reference line was used to assess the crestal bone level to overcome the problem with the landmarks used in previous studies. Those studies have been assessed the buccal bone level changes by measuring the distance from CEJ to the alveolar crest[16-19] or from cusp tip to alveolar crest.[6] The problem with measurement from the cusp tip is that; the cusp tip is a dental structure which may be changed due to other factors rather than the real treatment changes, for example the cusp tip may be liable to wear or even fractured accidentally during treatment. In addition, with using cusp tip or CEJ as a reference, the tooth as a whole may undergo vertical intrusive or extrusive movements during leveling which of course affects the reliability of measurements.

Concerning the bone thickness, previous studies assessed its changes measuring the distance from the lamina dura of the root surface to the outer surface of the alveolar bone by using the long axis of tooth and CEJ as references guide.[18-21] Using the tooth as a reference in assessment alveolar bone changes, a measurement possibly lies within fraction of millimeter, could be misleading. This is due to the possible changes occurring in the vertical tooth position during treatment, which could affect the measurements on the corresponding points on alveolar bone. Therefore, in the present study, maxillary plane which is fixed skeletal reference was used to assess the buccal bone thickness to overcome the problem with using the previous landmarks.

As regarding the root length changes, the upper incisor was chosen because it has been suggested that these are at most risk of root resorption.[22] The root resorption was measured as distance from CEJ to the apex of the root.[23]

The effect of treatment on the maxillary buccal alveolar bone level

The results of the present study have shown a significant mean reduction in the alveolar bone level in the round group at the first premolar and at the central incisor.

This is in agreement with Kortam et al,[6] who found that both buccal bone height and thickness decrease significantly after treatment with smart clip active SLBs. These results are also in accordance with Castro et al,[16] who found that the distance from the cemento-enamel junction to the alveolar bone crest changed after orthodontic treatment; the distance was greater than 2 mm in 11% of the surfaces before treatment and in 19% after treatment.

However, the mean reduction was non-significant at the first molar. This finding is disagree with the findings of Kortam et al[6] and Castro et al[16]. This disagreement may be related to the difference in the way of measurement or to the amount of force applied.

The results of the present study have shown a non-significant reduction in the alveolar bone level in the rectangular group at the first molar and at the first premolar. This finding may be related to the reduced force applied on these teeth during the leveling and alignment stage. On the other hand, the bone level at the central incisor showed a significant reduction after leveling and alignment with rectangular wire. This significant change reflects the amount of force applied on these previously crowded teeth. This finding is in accordance with many studies.[6,16,24]

The alveolar bone height changes in both groups are not significantly different, indicating that the rectangular wire with active self-ligating brackets in leveling and alignment stage might not affect the alveolar bone height rather than round wire.

The effect of treatment on the maxillary buccal alveolar bone thickness:

Concerning the alveolar bone thickness at the cervical third in both groups, round and rectangular, it mostly showed significant reduction in buccal bone thickness in both groups indicating the possible crown tipping during the leveling and alignment stage either with round or rectangular archwire.

This finding was also explained on the basis of the reduction in alveolar bone height concomitant with many teeth in this study. This finding are in agreement with many other studies.[6,20,25,26]

The buccal bone thickness was significantly reduced in apical and/or middle third of other studied teeth with either round or rectangular archwire.

The effect of treatment on the root length:

This study showed a significant root length reduction in both groups, round and rectangular archwire groups, during the leveling and alignment stage as indicated by the CBCT measurements. The root length reduction during orthodontic procedures was common in many studies.[27-29]

The finding of Andreasen and Amborn 1989[30] was disagree with the finding of this study. This disagreement may be related to the difference in the methodology. The present study was performed using CBCTs, while the compared previous study used periapical radiographs.

The significant difference in the amount of reduction in the rectangular archwire group than the round archwire group may be related to the amount of force exerted by rectangular archwire on the incisors during leveling and alignment. This difference disagree with Mandall et al,[23] who found no statistically significant difference. However, their results should be interpreted with caution as the standard deviations were large. Besides, they used periapical radiographs while the present study used CBCTs.

CONCLUSION

Based on the findings of the current study, the following conclusions could be obtained:

Concerning the labial alveolar bone level and thickness:

1. Orthodontic alignment with both round and rectangular CuNiTi wires when combined with active self ligating brackets causes variable amounts of alveolar bone loss of maxillary teeth.
2. No wire type is preferred over the other in reducing the risk for alveolar bone loss during the alignment phase of orthodontic treatment.

Concerning the root resorption:

1. Orthodontic alignment with both round and rectangular CuNiTi wires causes considerable amounts of apical root resorption of maxillary incisors.
2. Round CuNiTi wire is preferred over rectangular in reducing the risk for root resorption during the alignment phase of orthodontic treatment.

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