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Evaluation of maxillary alveolar bone changes following canine retraction with different types of orthodontic brackets (cone beam study)

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Abstract---Background: The alveolar bone is traditionally and practically considered the anatomical limitation of orthodontic tooth movement. Canine retraction is important step in cases with incisor crowding where extraction provides space for incisor alignment without the need to procline them. Materials and methods: This randomized clinical trial was carried on twenty patients candidates for extraction camouflagic treatment. CBCT was done to all patients and buccal bone thickness was evaluated. The patients was devided into 2 groups. The treatment of group (A) was done using self-ligating brackets and group (B) treatment was done using conventional brackets. Canine retraction was done using sliding mechanics After canine retraction completion CBCT was done again and buccal bone thickness was evaluated again. Results: The results show that there was statistically significant increase in canine labial bone thickness at L1, L2 and L3 in group (A) and group (B) after canine retraction. The results show that there was statistically insignificant difference in percentage of change of canine labial bone thickness at L1, L2 and L3 between group (A) and (B). Conclusion: There was a statistically significant increase in labial bone thickness between (Pre) and (Post) groups with both conventional and SL brackets. There was a statistically insignificant increase in percentage of change in labial bone thickness between group (A) treated with SL-brackets when compared to group (B) treated with conventional bracket.

Keywords---canine retraction, cone beam computerized tomography, bone thickness, mini screw.

Introduction

There are a lot of issues concerning bone remodeling during orthodontic treatment. It is generally accepted that tooth movement can occur either with the bone or through the bone. But the question that is of significant interest and always strikes the orthodontist is whether "bone traces tooth movement" or, more specifically, when an orthodontic tooth movement occurs, the bone surrounding the alveolar socket always remodel to an equal extent or not(1). Orthodontic treatments that result in pronounced tooth inclinations are considered to be risk factors for dehiscence and fenestrations.One possible factor related to these occurrences is the reduced thickness of the alveolar bone around the roots.canine retraction is one of the main procedures carried out during orthodontic treatment. The canine tooth shares an important role in oral functions, esthetics, occlusion, arch shape, and stability.Their unique position connects the anterior and posterior segments of the dental arch and makes their orthodontic movement of great clinical importance, especially in the first premolar extraction cases.(2)

Self-ligating brackets was introduced in claim to overcome certain problems associated with the conventional ligating systems.Self-ligating brackets have presented to practice associated with claims to provide many advantages as it provide a secure engagement of the arch wire resulting in control of tooth movement, decreased friction , ability to achieve optimal force level due to decreased force decay, no displacement of wire , better mentainance of oral hygiene , and less time-consuming than conventional ligation brackets. (3) Space closure can be done either by Friction or Frictionless mechanics. In Friction or sliding mechanics, the space site is closed by means of coil springs or elastics allowing the brackets to slide on the orthodontic arch-wire. Although friction wastes a considerable degree of energy in this method, the friction-based technique is very commonly used due to clinical convenience and its high predictability of results, since the arch-wires dictate the direction of tooth movement. so in this study we used friction mechanics as it is superior to frictionless mechanics in rotational control and arch dimensional maintenance, less complicated, more comfortable to the patient and require less chair time. (4)

Conventional 2D lateral cephalograms have numerous drawbacks in terms of investigating the changes in the alveolar bone and roots,particularly in the canine region. CBCT scanning is the three dimensional imaging technique giving quantitative assessments of the labial and lingual cortical bone plates and labio-lingual width of alveolar bone with elevated accuracy and precision ,the high spatial resolution, low radiation dose, and relative affordability of this technique. So this study was designed to use CBCT scan measurements duo to their ability to provide distortion-free slice images of single roots provides the excellent possibilities to study alveolar bone change Therefore, assessment changes in thickness of alveolar bone was more precise.(5)

Materials and Methods

This study was carried out upon Twenty patients were selected from patients suffering from protrusion of upper anterior teeth and candidates for extraction.

Inclusion criteria

All patients were characterized by the following criteria:

- No history of previous orthodontic treatment.
- Treatment plan indicates bilateral first premolars extraction and canine
- retraction
- No systemic disease.

Exclusion criteria

- Non extraction cases.
- Canine root abnormality or resorption.
- Missing teeth other than third molar

Groups Randomization

The final sample of 20 patients fulfilling all the above criteria was randomly divided in one of the following two groups:

- Group (A): Canine retraction using self-ligating metal brackets (Damon Q)
- Group (B): Canine retraction using conventional brackets metal (Mini 2000 ORMCO).

Randomization and allocation concealment

Randomization was accomplished using a simple randomization method to ensure a 1:1 allocation ratio, and allocation concealment was achieved with similar looking sealed opaque envelopes. The name of the groups “self-ligating” and “conventional” appeared on 10 pieces of paper each, resulting in a total of 20 pieces of paper that were folded and shuffled in a box. They were removed and, without opening, placed in 20 opaque envelopes that were then sealed and replaced in the box. The envelopes were shuffled inside the box, and each patient was asked to pick one envelope from the box. The patient was then assigned to the group designated and recorded by an investigator who was not involved in the intervention or data analysis.

Diagnostic Records

Figure 1. Example of one of the cases enrolled in the study

Case history was taken in details for each of the patients. Then, the patients were examined for conformity with criteria for inclusion in the study. Complete orthodontic records were taken. and proper diagnosis for each case and then detailed treatment plan was set. Figure (1), CBCT scans were taken for each patient before the beginning of orthodontic treatment for assessment of area of the center of resistance for the canine ,bone thickness (buccal and palatal), Precise assessment of the point of entry of the mini screw implant in relation to the roots of the adjacent teeth and air sinuses, soft tissue thickness at the point of entry of the mini screw and bone density in the area of entry of the mini screw.

Linear measurements

The labial alveolar plate thickness was measured in 3 section separated by 1 mm (S1, S2, S3) nearly at the midline of the canine parallel to its long axis at three levels:

L1: Three mm apical to CEJ
L2: At mid root
L3: Apex of the root

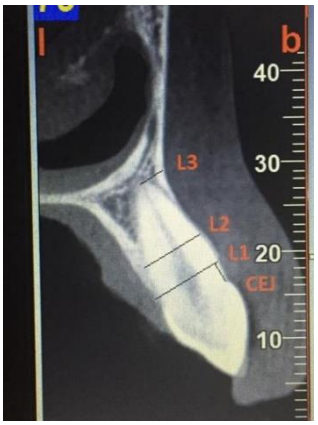

Figure 2. labial bone thickness measurement

Before extraction of first premolar leveling, alignment and derotation were completed, then rectangular stainless steel arch wires were placed passively. Extraction of first premolar was done then CBCT was checked visually for the assessment of the availability of space apical to the area of the roots of the maxillary second premolar to the second molar for assessment of: point of entry of the mini screw implant in relation to vital structures (roots and air sinus) ,The soft tissue thickness at the area of entry, alveolar bone thickness (buccal and palatal width) to choose appropriate length of the core (threads) of the mini screw implant, and assessment of the bone density in the area of entry of the mini screw insertion

Figure 3. leveling and alignment SL group

Retraction of canine was done using sliding mechanics (two steps technique) by elastomeric continuous power chain on stainless steel wire size 19 x 25 with crimpable hook was placed mesial to bracket of the canine, with length reach to the area of the center of resistance of the canine that estimated from CBCT. Elastomeric power chain applying nearly 50±100 gm was used for retraction, stretched bilaterally from the mini-screws to the hooks. figure (5). Patients were recalled every two weeks for checking appliance integrity, oral hygiene instructions and amount of retraction achieved. Power chain activation was done every one month. Canine retraction completion was checked according to following criteria:

- Tight contact between canine and second upper premolar is achieved clinically.
- Root parallelism between canine and second upper premolar is achieved and checked from CBCT.

Figure 5. cannine retraction by elastomeric power chain

After canine retraction completion CBCT was repeated and the labial alveolar bone thickness is measured again in the same manner as done before treatment (T2). The labial alveolar plate thickness was measured in 3 section separated by 1 mm (S1,S2,S3) nearly at the midline of the canine parallel to its long axis at three levels :

L1 : Three mm apical to CEJ
L2 : At mid root
L3 : Apex of the root

Figure (6), To keep measurements consistent, only one examiner performed pre and post assessment of bone thickenss.

Figure 6. labial bone thickness measurement after canine retraction

Results

L1 results

Relation between Pre and Post (table 1)

- Group A (Self ligating bracket):
  There was a statistically significant difference between (Pre) and (Post) groups where ($p<0.001$).table (1) The highest mean value was found in (Post) group, while the lowest mean value was found in (Pre group)
- Group B (Conventional bracket):
  There was a statistically significant difference between (Pre) and (Post)groups where ($p<0.001$). . The highest mean value was found in (Post) group,while the lowest mean value was found in (Pre) group.

There was no statistically significant difference between (Group A) and (GroupB) groups where ($p=0.212$) table (2). The highest mean value of change was found in (Group A), while the lowest mean value of change was found in (Group B).

L2 results

Relation between Pre and Post (table 3)

- Group A (Self ligating bracket): There was a statistically significant difference between (Pre) and (Post) groups where ($p<0.001$). The highest mean value was found in (Post) group, while the lowest mean value was found in (Pre group).
- Group B (Conventional bracket):
  There was a statistically significant difference between (Pre) and (Post) groups where ($p<0.001$). The highest mean value was found in (Post) group,while the lowest mean value was foundin (Pre group).

Relation between different: Group s (table 4) (Percentage of change): There was no statistically significant difference between (Group A) and (Group B) groups where ($p=0.807$). The highest mean value of change was found in (Group A), while the lowest mean value of change was found in (Group B).

L3 results

Relation between Pre and Post (table 5)

- Group A (Self ligating bracket):
  There was a statistically significant difference between (Pre) and (Post) groups where ($p<0.001$). The highest mean value was found in (Post) group, while the lowest mean value was found in (Pre group).
  Group B (Conventional bracket): There was a statistically significant difference between (Pre) and (Post) groups where ($p<0.001$). The highest mean value was found in (Post) group, while the lowest mean value was found in (Pre group).

Relation between different groups (table 6) (Percentage of change): There was no statistically significant difference between (Group A) and (Group B) groups where (p=0.974). The highest mean value of change was found in (Group A), while the lowest mean value of change was found in (Group B).

Discussion

There are a lot of issues concerning to bone remodeling during orthodontic treatment. It is generally accepted that tooth movement can occur either with the bone or through the bone. But the question that is of significant interest and always strikes orthodontist is whether "bone traces tooth movement" or, more specifically, when an orthodontic tooth movement occurs, the bone surrounding the alveolar socket always remodel to an equal extent or not[7]. The longevity of a tooth depends on its periodontal health. Evidences show that orthodontic treatment can result in loss of periodontal support in the presence of plaque and inflammation. Orthodontic treatments that result in pronounced tooth inclinations are considered to be risk factors for dehiscence and fenestrations. One possible factor related to these occurrences is the reduced thickness of the alveolar bone around the roots.[8]

Canine retraction is one of the main procedures carried out during orthodontic treatment. The canine tooth shares an important role in oral functions, esthetics, occlusion, arch shape, and stability. Their unique position connects the anterior and posterior segments of the dental arch and makes their orthodontic movement of great clinical importance, especially in the first premolar extraction cases.[9] Canine is important because orthodontic treatment objectives in many cases indicate extraction of the first premolar and canine retraction either for the relief of crowding, reduction of dento-alveolar protrusion and improving the facial esthetics, or correction of inter arch malrelationships through dental camouflage.[10]

Table (1): The mean, standard deviation (SD) values of Accuracy of different groups.

Variables	L1			
	Group A		Group B	
	Mean	SD	Mean	SD
Pre	0.380	0.052	0.300	0.073
Post	0.620	0.070	0.480	0.120
p-value	<0.001*		<0.001*	

*: significant (p<0.05)

Table (2): The mean, standard deviation (SD) values of Accuracy of different groups.

Variables	L1	
	Percentage of change	
	Mean	SD
Group A (Self ligating bracket)	38.75	4.37
Group B (Conventional bracket)	37.17	3.49
p-value	0.212ns	

ns; non-significant (p>0.05)

Table (3): The mean, standard deviation (SD) values of Accuracy of different groups.

Variables	L2			
	Group A		Group B	
	Mean	SD	Mean	SD
Pre	1.210	0.088	1.240	0.075
Post	1.470	0.106	1.460	0.060
p-value	<0.001*		<0.001*	

*; significant (p<0.05)

Table (4): The mean, standard deviation (SD) values of Accuracy of different groups.

Variables	L2	
	Percentage of change	
	Mean	SD
Group A (Self ligating bracket)	18.20	2.55
Group B (Conventional bracket)	17.92	4.39
p-value	0.807ns	

ns; non-significant (p>0.05)

Table (5): The mean, standard deviation (SD) values of Accuracy of different groups.

Variables	L3			
	Group A		Group B	
	Mean	SD	Mean	SD
Pre	2.320	0.052	2.140	0.088
Post	2.750	0.073	2.420	0.101
p-value	<0.001*		<0.001*	

*; significant (p<0.05)

Table (6): The mean, standard deviation (SD) values of Accuracy of different groups.

Variables	L3	
	Percentage of change	
	Mean	SD
Group A (Self ligating bracket)	16.20	1.96
Group B (Conventional bracket)	16.18	2.24
p-value	0.974ns	

*: significant (p<0.05)

Self-ligating brackets were introduced in claim to overcome certain problems associated with the conventional ligating systems. Self-ligating brackets have presented to practice associated with claims to provide many advantages as it provide a secure engagement of the arch wire resulting in control of tooth movement, decreased friction , ability to achieve optimal force level due to decreased force decay, no displacement of wire , better mentainance of oral hygiene , and less time-consuming than conventional ligation brackets . So in this study we investigated the difference in change in labial bone thickness after canine retraction in self ligating brackets and conventional brackets .(11)

Space closure can be done either by friction or frictionless mechanics. In friction or sliding mechanics; the space site is closed by means of coil springs or elastics allowing the brackets to slide on the orthodontic arch-wire. Although friction wastes a considerable degree of energy in this method, the friction-based technique is very commonly used due to clinical convenience and its high predictability of results, since the archwires dictate the direction of tooth movement. so in this study we used friction mechanics as it is superior to frictionless mechanics in rotational control and arch dimensional maintenance, less complicated, more comfortable to the patient and require less chair time. (12)

Nickel–titanium (NiTi) coil springs have the slowest amount of force decay as well as the lightest initial force. However, they are expensive more difficult to use and cause more tissue irritation to the patient. Another force component can be used is elastomeric chain, which are easier to use, better tolerated, quite resistant to microbial infection, and much more economic. In this study frequent short term follow up visits to all cases were performed to monitor oral hygiene and careful assessment of treatment progress so elastomeric chain was preferred(13),(14) In order to assess dento-alveolar morphology in both sagittal and vertical dimensions, orthodontists often use cephalometric tracings. However, this fails to assess bone thickness. Conventional 2D lateral cephalograms have numerous drawbacks in terms of investigating the changes in the alveolar bone and roots, particularly in the canine region. CBCT scanning is the three-dimensional imaging technique giving quantitative assessments of the labial and lingual cortical bone plates and labio-lingual width of alveolar bone with elevated accuracy and precision, the high spatial resolution, low radiation dose, and relative affordability of this technique. So this study was designed to use CBCT scan measurements due to their ability to provide distortion-free slice images of single roots provides the excellent possibilities to study alveolar bone change

Therefore, assessment changes in thickness of alveolar bone was more precise.[15],[16]

With the debate between whether the bone labial bone thickness of canine increase or decrease after retraction during orthodontic treatment. Some studies have found that there is significant decrease in labial bone thickness after retraction like Ahn et al study at 2013[17] while some other studies have found there is increase in canine labial bone thickness after retraction during orthodontic treatment like Shah Aakash et al at 2017[18] In this study as the maxillary canine was retracted, the labial bone thickness at 3mm below CEJ level and at mid-root and at apex level were statistically significantly increased ($p < 0.05$) in both groups (A) and (B) which supports the results obtained from previous study by Shah Aakash etal.[18] and Runzhi guo systematic review[19] in contrary with results of Ahn et al study at 2013(17) may be due to differnt mechanics used in retraction. In the results of this study there was no significant difference in percentage of change in canine labial bone thickness between group (A) treated using self-ligating brackets and group (B) treated using conventional brackets which support the results of study of Almeida M et al. in 2015.[20]

Conclusions

From the results of this work the following conclusions can be extracted:

- There was a statistically significant increase in labial bone thickness between (Pre) and (Post) groups with both conventional and SL brackets
- There was a statistically insignificant increase in percentage of change in labial bone thickness between group (A) treated with SL-brackets when compared to group (B) treated with conventional bracket at levels
  - L1 : Three mm apical to CEJ
  - L2 : At mid root
  - L3 : Apex of the root

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