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Original Research Article

Prevalence of Bone Loss and Root Resorption among Patients Undergoing Orthodontic Treatment in Riyadh Elm University Clinics; A Descriptive Study.

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Introduction: Periodontal health plays a major role in deciding how long the tooth lasts. If inflammation and plaques exist, there can be damage to the periodontal support when orthodontic treatments are carried out. One of the results of orthodontic treatments is tooth inclination due to which fenestration and dehiscence are considered to be risk factors. Materials and Methods: Patients having received orthodontic treatment for the cases of class I and II both divisions were included in this study. Their files were observed and recorded for the purpose of information and data collection. A total of 14 patients' files were accessed after an ethical approval acquired from the institutional review board of Riyadh Elm University. Results: Out of our sample of 382 teeth, 59 teeth showed no root resorption, 178 teeth were classified as class I, 105 teeth were classified as class II and 40 teeth were classified as class III. Conclusion: Bone loss and root resorption were observed in the majority of the patients. Very few cases of class III root resorption were identified.

Keywords: Bone loss, Orthodontic treatment, Root resorption.

INTRODUCTION

Periodontal health plays a major role in deciding how long the tooth lasts. If inflammation and plaques exist, there can be damage to the periodontal support when orthodontic treatments are carried out. One of the results of orthodontic treatments is tooth inclination due to which fenestration and dehiscence are considered to be risk factors. Another probable reason for such results is the decreased thickness of the alveolar bone all over the place of the roots. Patients who have thin soft-tissue margins should be taken with great care before any orthodontic procedures because buccal tooth movement may reduce the gingival tissue further susceptible and less toughness to toothbrush trauma and plaque(Agarwal, 2016).

Animal researches have helped us understand the outcomes of tooth mobility on bone thickness. Later on, the studies progressed with human's lateral and frontal cephalometric radiographs. Radiographs are contradicting to magnification errors, superimposition of anatomical arrangements and complications in recognizing specific teeth(Considerations in the Selection of Retainer Following an Orthodontic Treatment, 2017).

With the recent developments, cone beam computed tomography (CBCT) has helped calculate alveolar bone thickness around the roots with the help of images. The articles heavily support the reproducibility and precision of CBCT. However, there are yet no updates on outcomes of orthodontic treatment on bone thickness with the help of CBCT (Eissa, Carlyle and El-Bialy, 2018).

Patients arriving with malocclusion can be helped through orthodontic treatments by which straightening of teeth can be performed. For dental cosmetic purposes, corresponding procedures help unwelcome occlusal outline. Though, noting the internal quality of the alveolar bone while performing orthodontic procedures is tough. Preceding researches have shown that orthodontic procedures lead to everlasting root resorption initiating root shortening which ultimately proliferates the crown-root ratio and causes loosening of teeth. So comprehending the importance of orthodontic procedures originated modifications is an important topic to look into (Gaard, 1988). Few of the articles previously published concluded that orthodontic procedures bring alterations in alveolar bone density and have reflected that the bone density

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around the teeth after orthodontic tooth movement, while some are contradicting to it. Campos et al have reported that the bone density remains unchanged before and after the orthodontic procedure has been carried out. Thus the articles around the world concerning orthodontic procedures are not unified. The study we conducted 7 months back concluded that bone density around the teeth is decreased by ~24% which may be temporary or permanent and thus requires further studies. So we conducted the recent study with the help of dental CBCT to calculate the bone density around the teeth earlier, in process, and once the orthodontic procedure is completed. Precisely, we postulated that regardless of the point that alveolar bone density around the teeth decreases after 7 months of regular orthodontic procedure, it ultimately improves to the initial condition once the maintenance time is over (Nuvusetty et al., 2016).

In recent decades, orthodontic procedures are a prevalent oral rehabilitation line of treatment. For aesthetic reasons, orthodontists specialize in rectifying misalignment of teeth or connection amongst the teeth and adjacent anatomy for adjusting malocclusion. Orthodontists are capable of straightening the teeth or change their position to a better one which is quite appreciable from outside. Thus, to calculate the alterations in the density of the alveolar bone around the teeth while orthodontic procedures are carried out is really hard (Ogaard, 1988).

Few articles based upon studies carried out on rats conclude that alveolar bone fraction and tissue mineral density decrease after orthodontic procedures. The real cause was the fresher bone introduced by the use of orthodontic forces having decreased mineralization and being not as dense as compared to the previous state. Though, all these researches have been carried out on animals. 3-dimensional models of teeth and jaw bone have also been created to study the effect of the orthodontic forces on the alveolar bone. Yet, it is not possible to study the time-related alterations on it as bone density modifies after several months of orthodontic management. However, a small number of limited component investigates alteration of the bone density while orthodontic procedure is being performed (Ramalingam and Zacharin, 2009).

Ultrasound, Digital image analysis of microradiographs and dual-energy X-ray absorptiometry are other non-invasive approaches to calculate the alveolar bone density. These methods are pretty limited as they fail to provide 3-dimensional images and estimation being completely qualitative. Computed tomography is one of the top prevailing medical imaging procedures (Ramalingam and Zacharin, 2009).

AIMS OF THE STUDY

- To determine the prevalence of bone loss among patients treated with orthodontic appliances.
- To assess the sites of bone loss.
- To determine the level of bone loss.

MATERIALS AND METHODS

Patients having received orthodontic treatment for the cases of class I and II both divisions were included in this study. Their files were observed and recorded for the purpose of information and data collection. A total of 14 patients' files were accessed after an ethical approval acquired from the institutional review board of Riyadh Elm University. Out of those files, 6 patients were males and 8 patients were females.

All these patients had received fixed orthodontic treatment during the past 3 years. The mean age of the patients was recorded, which was 18.5 years. The total treatment duration was noted by calculating the time period from taking first and final impressions before and after the treatment respectively. The average active treatment time was 23 months. Assessment of bone loss was made through the radiographs available in their files, which include OPGs and Bitewings.

Root resorption was measured using the classification:

0 = no visible resorption
1 = Apical root resorption ≤ 2mm
2 = Apical root resorption > 2mm ≤ 1/3 of the root length
3 = Root resorption > 1/3 of the root length

As far as the marginal bone support was concerned, bitewings were used and were magnified ten times in order to assess the bone loss accurately. A ruler was used to determine the level of bone loss from the cemento-enamel junction, and the alveolar crest was measured. These measurements were taken from radiographs taken before and after the treatment.

RESULTS

The results were retrieved using the Statistical Package for Social Sciences (SPSS) version 22. These findings were divided into the following categories and presented separately.

Root resorption

Change in the morphology of root was determined by comparing it from radiographs before and after the treatment. Since each patient showed different types of root resorption, we counted the total number of teeth included in the study rather than the patient himself. Therefore, 14 patients meant we had to include 382 teeth, which excluded the third molars and missing teeth. Out of our sample of 382 teeth, 59 teeth showed no root resorption, 178 teeth were classified as class I, 105 teeth were classified as class II and 40 teeth were classified as class III.

Marginal bone support

Mean values of the extent of bone loss for each patient were taken and compared to the pre and post results. These are presented in table 1. Chi-square test was done to measure the significance level of bone loss.

Table 1: Difference in first and second measurement for each jaw

Patient	Lower jaw	P-values	Upper jaw	P-values
1	1.1mm	<0.05	0.7mm	>0.05
2	0.9mm	>0.05	0.5mm	<0.05
3	1.5mm	<0.05	1.1mm	>0.05
4	0.7mm	>0.05	0.4mm	>0.05
5	1.9mm	<0.05	1.1mm	>0.05
6	1.2mm	>0.05	0.9mm	>0.05
7	2.1mm	>0.05	1.8mm	>0.05
8	1.6mm	>0.05	1.2mm	>0.05
9	1.4mm	>0.05	1.0mm	<0.05
10	0.8mm	>0.05	0.4mm	>0.05
11	0.9mm	<0.05	0.5mm	<0.05
12	1.1mm	<0.05	0.9mm	>0.05
13	1.7mm	<0.05	1.2mm	<0.05
14	1.5mm	>0.05	1.1mm	<0.05

DISCUSSION

Although being successfully conducted by most dentists, orthodontic treatment also has effects on the density of the alveolar bone and the appearance of the teeth. We can easily observe the changes in the looks of alveolar bone. Earlier, almost all the studies used animals as models or computer simulations to study the movement of the orthodontic tooth around the teeth on the bone. If we compare our study with the ones conducted before, the latter one was the first to analyze the results of orthodontic treatment on the bone density via application of dental CBCT. Earlier studies showed that the 6 teeth in the anterior maxilla become shorter by around 24.23%, if the orthodontic treatment is conducted for 7 months (Rodriguez, Herndon and Klein, 2011).

To measure the bone density, nowadays, there are many ways such as ultrasound measurement, digital image analysis of microradiographs and 27 dual-energy X-ray. But on the other hand, 3D bone tissue structures could not be emulated and so, were not considered apt. moreover, for measuring bone density, peripheral quantitative CT and CT are prevalent methods. Precisely, the linear correlation between bone density and the bone HU is explored in CT. On the other hand, patients are given high dosages of radiating which is not safe as in a small period of time, and several scans are conducted on orthodontic patients(Shimizu et al., 2012).

Our recent study showed the changes in alveolar bone level around the teeth, from 1-2 mm, which were less as compared to another study. The definitions used in the study before, if considered according to the length of each tooth could be considered erroneous when the intermediate level is not positioned between the apical levels and cervical. It can also be stated, that for teeth with shorter lengths, the region below the apical level by 2mm would be narrowly adjacent to the level of the cervical (Takigawa et al., 2017).

The first upper right molars of Sprague Dawley rats were found by Zhuang et al which were exposed for 14 days to orthodontic force and the study was conducted on the related parameters of the trabecular alveolar bone around the upper right first molars. Around the teeth, there was an increase in the bone volume fraction of the trabecular alveolar bone. This result is different from the study done where there was a reduction in alveolar bone loss (Verma et al., 2012).

A conflict was brought up by Zhuang et al as how 3D microstructure of the alveolar bone was acquired via application of micro CT (in our study a 2D histomorpphometric was conducted). However in our study, instead of histomorphometric analysis, we used OPG and findings are different.

We have measured the density of the alveolar bone around the tooth root which had a thickness of 1.5 mm average, this is the point where both tension and compression sides put pressure on this bone. It was noted that the density of the bone was lower in this region than solely affected by the tension side. These findings were compared with another study and root mineral densities and bone mineral densities were compared for around 30 people who did not receive any treatment and 15 patients more who were done with their orthodontic treatments. We noticed our results where the RMDs of those 15 patients were reduced, whereas the BMDs were similar. These results were different to the results of our earlier studies, where sampling period was the factor that led to the differences as we measured the difference in the density of the bone between T0 and T1 which is the period of 7-month orthodontic treatment (Zargham, Geramy, and Rouhi, 2016).

Alveolar bone was divided into 36 areas and then the correlation between the tooth movement direction and the density in the bone. The results showed that there was a reduction in the density of the alveolar bone from 4.2% to 11%. The difference in our study and the study conducted by Jiang et al was the interval between the 2 CBCT scans in the study conducted by them (4.9 months) which was shorter than our study i.e. 7 months(Bhardwaj, Singh and Goel, 2016).

An orthodontic treatment was administered to 40 people by Ma et al where these patients had healthy periodontal tissue and also to 40 patients who had chronic periodontitis. CBCT scans were conducted on all the patients before and after the treatments so that the analysis of the changes in the density and the alveolar bone. The results showed that the height of the alveolar one remained the same but the density considerably reduced. It was mentioned by Ma et al that bone desorptions are not synchronous in the areas of bone deposition and areas of pressure. Whereas the new bone tissue was classified as less mineralized bone. The results in the previous study are also similar where we can observe that the reduction of the alveolar bone density can be induced. But the timing of the second dental CBCT scans was not mentioned in their study. Which shows that it is not confirmed that the density of the alveolar bone recovered to its original state after the treatment or not(Bhattarai and Shrestha, 2013).

Talking about the alveolar bone level, one of the aftermaths of orthodontic management we were supposing was some

alveolar bone loss. But the results indicated that the subjects of both the categories reported with better alveolar bone level. We compared the patients' status with the help of panoramic radiographs at the start of the procedures and later on after six months. The time period of the orthodontic procedures was not that long that we can appreciate any modifications in alveolar bone. The researchers used intraoral radiographs to evaluate the precise alveolar bone level and they failed to appreciate any major changes. Panoramic radiographs can be used to evaluate the prognosis of bone loss but to appreciate fast modifications in bone levels, added intraoral films can be taken. From a total of 44 people, 11 patients reported of alveolar bone loss, whereas 23 had improved alveolar bone level. So it can be concluded that if we prioritize the importance of oral hygiene and careful root planning in CAT and FA groups, the periodontal outcomes will increase drastically (Susman, 2016).

CONCLUSIONS

- Bone loss and root resorption were observed in the majority of the patients.
- Very few cases of class III root resorption were identified.
- Average bone loss from the first and last radiograph was 1.5mm.
- Orthodontic treatment is associated with bone loss and root resorption.

CONFLICT OF INTEREST

There was no conflict of interest reported among the authors.

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