

Radiographic Comparison of Apical Root Resorption During Orthodontic Treatment with Bracket Slot Size 0,018-inch and 0,022-inch

Braket Yuvası Boyutu 0,018-inç ve 0,022 inç ile Ortodontik Tedavi Sırasında Apikal Kök Resorpsiyonunun Radyografik Karşılaştırılması

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ABSTRACT

Objectives: Orthodontic induced apical root resorption is an unavoidable side effect of orthodontic treatments which is seen in more than 90% of the cases. Orthodontic Induced Inflammatory Root Resorption (OIIRR) occurs as a result of individual biologic variations and mechanical stimuli effects.

Material and method: In this study the extent of root resorption is compared in patients who have received fixed orthodontic treatment (by straight wire system), with two different sizes of slots (0.018 inch and 0.022 inch) and the same wire diameter. For this purpose, panoramic radiographs were used to examine some 720 teeth before and after the treatment. Two different approaches were used to evaluate the root resorption, first based on Malgren classification and the other based on Crown-Root ratio (C/R).

Result: Average duration of treatment for patients treated by 0.018-inch slot brackets was 26 months and for those who were treated by 0.022-inch slot brackets it was 25 months. No significant difference was found in the two groups explored in this study (p-value = 0.684). Slot size has no effect on root resorption and there are some other features including the efficiency of the slots which might be influential.

Conclusion: As no significant difference was found in the two groups explored in this study, it could be argued that slot size has no effect on root resorption and there are some other features including the efficiency level of the slots which might be influential. As previous studies indicate, 0.022-inch slot brackets could have more influence on root resorption. Apex shape has no effect in that regard.

Key Words: Root Resorption (RR), orthodontic Induced Inflammatory root resorption (OIIRR), panoramic radiography

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ÖZET

Amaç: Ortodontik kaynaklı apikal kök rezorpsiyonu, vakaların% 90'ından fazlasında görülen ortodontik tedavilerin kaçınılmaz bir yan etkisidir. Ortodontik Kaynaklı İnflamatuvar Kök Rezorpsiyonu, bireysel biyolojik varyasyonlar ve mekanik uyarıların bir sonucu olarak ortaya çıkar.

Yöntem: Bu çalışmada, iki farklı büyüklükte slot (0.018 inç ve 0.022 inç) ve aynı tel çapı ile sabit ortodontik tedavi (düz telli sistem) alan hastalarda kök rezorpsiyonunun kapsamı karşılaştırılmıştır. Bu amaçla, tedavi öncesi ve sonrası 720 dişi incelemek için panoramik radyografiler kullanıldı. Kök rezorpsiyonunu değerlendirmek için ilk önce Malgren sınıflamasına, diğeri ise Crown-Root oranına (C / R) dayanan iki farklı yaklaşım kullanılmıştır.

Bulgular: Öncelikle, 0.018 inçlik yuva destekleri ile tedavi edilen hastalar için ortalama tedavi süresi 26 ayı ve 0,022 inçlik yuva destekleriyle tedavi edilenler için 25 ay idi. Bu çalışmada araştırılan iki grupta anlamlı bir fark bulunmamıştır (p değeri = 0.684). Yuva büyüklüğünün kök rezorpsiyonu üzerinde bir etkisi yoktur ve etkili olabilecek yuvaların verimliliği de dahil olmak üzere başka bazı özellikler vardır.

Sonuç: Bu çalışmada incelenen iki grupta anlamlı bir fark bulunmadığı için, slot büyüklüğünün kök rezorpsiyonu üzerinde bir etkisi olmadığı ve etkili olabilecek slotların etkinlik seviyesi de dahil olmak üzere başka bazı özelliklerin olduğu tartışılabilir. Önceki çalışmalarda belirtildiği gibi, 0,022 inçlik yuva destekleri kök rezorpsiyonu üzerinde daha fazla etkiye sahip olabilir. Apex şeklinin bu konuda hiçbir etkisi yoktur.

Anahtar Sözcükler: Kök Rezorpsiyonu, ortodontik indüklenmiş inflamatuvar kök rezorpsiyonu, panoramik radyografi

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INTRODUCTION

Orthodontic induced apical root resorption is an unavoidable side effect of orthodontic treatments. Root resorption is a complicated biological process whose many aspects are still unknown, occurring when the force on apex goes beyond the peri-apical tissue resistance and reparability. It would be irreversible when the adjacent dentin be included as well (1,2). For most patients, External Root Resorption is clinically insignificant; however, in a few cases the resorption might turn out to be severe (3).

The root resorption starts roughly within the first 2-5 weeks of the treatment but it takes 3-4 months to be detectable through Radiography (2). Should a tooth loses more than half of its root length, its function and endurance will be put at risk (4).

Histological studies indicate that in more than 90% of the cases of orthodontic treatments, root resorption is seen (5-7). However, in most of the cases, the destruction of the root structure is low and clinically insignificant. By the way, when radiography is used as a diagnostic technique, RR is usually reported less in percentage. In a study carried out by Lupi et al, the prevalence of External apical root resorption (EARR) was reported as being 15% prior to the treatment and 73% after treatment (8).

Using Panoramic radiography or Peri-apical Radiography, the average Orthodontic Induced Inflammatory Root Resorption (OIIRR) is usually lower than 2.5 mm (i.e.6-13% of the root which varies for different teeth) (9-13).

Despite a wide range of studies conducted so far, it is still unknown how orthodontic treatments induce RR. Though various complex Etiological factors may be at work, it appears that RR occurs as a result of a combination of individual biological variation and the effect of mechanical stimuli. Patient related factors include the type and severity of malocclusion, root shape, root canal treatment history, trauma, alveolar bone density, etc. On the other hand, orthodontic treatment associated factors include the type of appliances used, the amount of force, force duration, direction of tooth movement, the amount of apex displacement, etc.(1)

Administering graded scales, the OIIRR is usually classified as minor or moderate for most orthodontically treated patients (14-17). Severe resorption which by definition afflicts more than 4 mm or one third of root length, has been reported in 1 to 5% of the teeth examined (8,9,14,18).

Nowadays the most commonly used appliances in Fixed Orthodontic Treatment are Preadjusted and Edge Wise bracket systems. These brackets are produced in two different versions of 0.022 and 0.018-inch-wide slots whose treatment efficacy does not differ much but they vary in the amount of force exerted and the size of the wires used in the treatment (19). Given the importance of orthodontic induced apical root resorption, this comparative study, using radiographs as its diagnostic tools, seeks to examine the extent of root resorption in patients who has received fixed orthodontic treatment with 0.018 and 0.022-inch slot brackets. To this end, Panoramic radiographs were used to examine some 720 teeth before and after the treatment. The results were then compared in two different groups according to the type of slots (0.018 and 0.022-inch-wide) used.

MATERIALS and METHODS

This study was conducted in 2016 on patients referred to Mazandaran Dental Center. This research was first conducted as a pilot study on some 300 teeth, the results of which were used as a basis for determining the sample size of the main study. Accordingly, the study's population was set as 720 teeth which were then evenly divided into two groups: group A consisting of 360 teeth which were treated by 0.018-inch-wide slots and group B consisting of the same number of teeth which were treated by 0.022-inch-wide slots. In accordance with the principles of ethics, all patients received consent. All patient information remains confidential. This study was conducted with the code of ethics "IR.MAZUMS.REC.95.2591".

Treatment was administered through Straight wire technique, using Ni-Ti 0.012, Ni-Ti 0.014, Ni-Ti 0.016, stainless steel 0.018, Ni-Ti 25*17 and stainless steel 25*17 wires for 0.018-inch-wide slots and Ni-Ti 0.014, Ni-Ti 0.018, stainless steel 0.018, Ni-Ti 25*17 and stainless steel 25*17 wires for 0.022-inch-wide slots.

In this study, we explored the patients whose fixed orthodontic treatments were finished, using Panoramic Radiography. The patients were selected based on the following criteria:

- 1- Being diagnosed with Malocclusion Class I crowding;
- 2- Having mild to Moderate Crowding (<7mm);
- 3- Having received Non-extraction treatment;
- 4- The teeth under study being completely formed;
- 5- The teeth under study not having received trauma or previous orthodontic treatments;
- 6- Being healthy systemically

All of patients had class I crowding malocclusion and were treated by non extraction approach . The information regarding the patients including the type of the appliance and the slot size used for their treatment as well as their apex form in the right mandibular second premolar were recorded. Based on previous similar studies and the evaluations made by our co-epidemiologist, 18 patients from among those who had been treated by 0.018-inch-wide slots and 18 patients from those who had been treated by 0.022-inch-wide slots were singled out. All patients were evaluated with digital panoramic radiography before and immediately after treatment. All radiographs applied by the same machine (Sordex, Cranen D, Finland, Helsinki). For evaluating root resorption, two different approaches were used: in the first one, two observers working in oral radiology department evaluated the radiographs based on Malgren classification as followed. In cases where the results reported by the observers did not match, a third observer was called upon to have the final say on the data collected.

- 0 No change was found in the apex
- I There existed some irregularities in the apex
- II 2mm shortening was found in the root length
- III Root was being resorbed 2mm to 1/3 of root length
- IV More than 1/3 of the root length had been resorbed

The greatest distance between cementoamel junction and apex was measured as root length before and after treatment.

As there might be some changes in patients' head position during panoramic radiographing which could in turn affect the extent of magnification of the images taken, another method based on Crown-Root ratio (C/R) was used in which the ratio was recorded before and after the treatment. Any increase in the ratio which occurs due to root shortening was considered as root resorption.

In this study, apex shape of right mandibular second premolar is, according to Levander and Malgren, classified within one of the following four groups:

- 0 short root
- 1 blunt root
- 2 root with an apical bend
- 3 root with a pipette shape apex

Then the relationship between root resorption and apex form was investigated. Finally, the results derived from the study of the two groups were compared based on Mannwhitney test, using central tendency and dispersion index as well as relevant tables and charts for describing the data. P value <0.05 was considered as meaningful.

RESULTS

Average duration of treatment for patients treated by 0.018-inch slot brackets was 26 months and for those who were treated by 0.022-inch slot brackets it was 25 months. Average age in patients treated by 0.018-inch slot brackets was 16 years and 2 months (consisting of 11 females and 7 males) and it was 14 years and 8 months for those treated by 0.022-inch slot brackets (consisting of 9 females and 9 males).

Table 1 shows the statistical distribution of the amount of root resorption based on Malgren classification. As Table 2 shows, the average changes in C/R for the group treated by 0.018-inch slot brackets was reported as 0.0108, and 0.0093 for the one treated by 0.022-inch slot brackets. As diagram 3 shows, the average variation in Crow/Root is nearly the same for both groups.

Table 1- Root Resorption

Group			Frequency	Percent	Valid Percent	Cumulative Percent
0.018 inch	Missing	System	40	100.0		
	Valid	No Resorption	337	93.6	93.6	93.6
		0-1 mm Resorption	20	5.6	5.6	99.2
		1-2 mm Resorption	1	.3	.3	99.4
		more than 2 mm Resorption	2	.6	.6	100.0
	Total	360	100.0	100.0		
0.022 inch	Valid	No Resorption	345	95.8	95.8	95.8
		0-1 mm Resorption	15	4.2	4.2	100.0
		Total	360	100.0	100.0	

Table 2- Crown root ratio

Group	N	Mean	Std. Deviation	Minimum	Maximum	P-value
0.018 inch	360	.0108	.04847	0.00	.43	
0.022 inch	360	.0093	.05041	0.00	.42	0.684
Total	720	.0100	.04942	0.00	.43	

DISCUSSION

Orthodontic induced apical root resorption is an unavoidable complication. Root resorption occurs as result of a combination of individual biologic varieties and mechanical stimuli effects(12). Patient related factors include type and severity of malocclusion, root form, previous endodontic treatment, trauma, alveolar bone density, etc. (10-13). Orthodontic induced factors include the type of the appliance used for the treatment, the amount of orthodontic force, duration of applying force, direction of tooth movement, the amount of apical replacement, etc(10-13).

The type of appliance used for orthodontic treatment is one of the most influential and somewhat controllable factors in root resorption(14-16). Excluding other effective controllable factors, the current study merely investigated the effect of the size of slot used in straight wire technique on external apical root resorption. As two different slot sizes with the same wire sequence were used in the study, we expected lower rate of root resorption in patients who were treated by 0.022-inch slot brackets than those treated by 0.018 inch ones because 0.022 slots provide more room space for movement of the wire and lead to less friction. In other words, the more wire movement in the width of bracket, the less friction, frictional resistance and destructive force would be, and thus less heavy forces would be transferred to apex(13).The amount of apical root resorption in this study is less than other similar studies maybe this result is due to the nonextraction treatment method used in this study. It is in agreement with other studies that described more resorption after extraction orthodontic therapy(17,18).One possible explanation could be an increased mesiodistal tooth movement of the posterior teeth compared with nonextraction cases in order to close extraction spaces. our aim in this study was to evaluate the role of brackets slot size and wire play on the amount of apical root resorption. Our results showed no significant difference in the amount of radiographic root resorption between the two groups(022 and 018 slot). Panoramic films have been used because they are easy to obtain and the patient is less exposed(11).

In some randomized controlled trials, applying heavy forces caused much more root resorption than the cases which received light forces or than the control group (20-23). It is believed that high stress levels may increase the possibility of root resorption because in such circumstances the lacuna formation gets faster and tissue is less likely to repair (20-26). However, some non-randomized studies reject such findings. According to the study carried out by Owman-Moll et al, doubling or quadrupling the amount of force (from initial force of 50 CN) has no effect on prevalence and severity of root resorption or on the speed of tooth movement. As individual variations are significantly effective in root resorption and the speed of tooth movement, normal individual variations may reduce the effect of doubling the force (27).

However, the results of this study should be interpreted cautiously because the criteria for selecting premolars were not strong enough and the external factors which may make the teeth susceptible to root resorption had not been excluded. Also, the accuracy of serial sectioning protocol in diagnosing and

measuring the resorption holes was problematic and the holes could have easily been ignored partially or completely (25).

Malgren classification requires accurate measurement of root length before and after treatment which might have some errors due to different magnifications of the panoramic radiographs For reducing the magnification error of panoramic views we used crow to root ratio scale of Levander . As a result, to verify the consistency of the measurements against Malgren classification, C/R was measured before and after the treatment. In a similar study, Kriger also compared C/R before and after treatment to avoid magnification error, but he reported only the occurrence rate and severity of root resorption during the treatment (3).

It appears that Bio efficient treatments using modern orthodontic materials may cause much less root resorption than the simple standard edgewise system or straight-wire edgewise system. It is believed that super elastic, heat-activate and smaller stainless steel rect wires play a role in incisors retrusion and finishing.

In a controlled case study by Blake et al (28), a prospective trial by Pandis et al (29), and prospective clinical trial by Scott et al (30) which were all carried out to compare commonly used edge wise systems and different active and passive self-ligating appliances, no significant statistical differences in terms of root resorption was found.

To investigate the prevalence of apical resorption following fixed orthodontic treatment, Castro et al (2012) conducted a study whose sample population comprised of 1256 dental roots from 30 patients with the average age of 13 years old and malocclusion class I and were treated by non-extraction method. Castro et al recorded the CBCT images taken before and after the treatment and found that root resorption was obvious in all patients but had no significant relationship with their age and gender. According to the results of their study, the highest rate of prevalence and severity of root resorption was found in incisors and distal roots of maxillary and mandibular molars (31).

Recent studies have also proved no relationship between apex shape and the extent of orthodontic induced root resorption. For example, Parys (2011) studied 88 patients to explore any possible relationship between pipette-shaped roots and tooth agenesis and root resorption. Comparing panoramic radiographs taken before and after the treatment, he found no significant relationship between them. In our study, root shape of mandibular second premolars was classified into four groups according to Levander and Malgren classification, one of which being pipette-shaped. The results of both of these studies indicate that there is no relationship between root resorption and apex shape (32).

However, in another study which was conducted by Nigul on 75 panoramic radiographs to investigate the factors related to root resorption in patients under orthodontic treatment, root anomaly was considered as an effective factor in root resorption. The study in which root shapes were classified based on Levander and Malgren's classification model, the same as we did, found that root resorption had occurred only in such roots that were abnormally shorter than the other ones, but there were no differences in the extent of root resorption in other groups (33).

In this study, some patients were not willing to cooperate due to concerns about their personal information. After clarifying the purpose of this study, as well as the confidentiality of the information, this problem was resolved. Study is a cross-sectional archive-based study, which evaluated panoramic radiographs for determination of external apical root resorption. Prospective studies are ideally suited but have disadvantages like increased cost and long-term follow-up of the study sample.

3D modalities like CBCT are more accurate in evaluation of apical root resorption but entail extra cost and increased radiation dosage without commensurate benefits for the patient. Magnification and blurring seen in panoramic views make accurate estimation of root resorption difficult. However, in the present study, only those OPGs in which root apices were clearly visible were evaluated for resorption assessment.

CONCLUSION

As no significant difference was found in the two groups explored in this study, it could be argued that slot size has no effect on apical root resorption and there are some other features including the efficiency level of the slots which might be influential. Also apical Apex shape has no effect in root resorption.

Conflict of interest

No conflict of interest was declared by the authors.

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