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Apical root resorption of maxillary anterior teeth after orthodontic treatment of Class II division 1 occlusion with Roth appliance

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ABSTRACT

The aims of this study were to evaluate the effect of orthodontic treatment on root length (ratios of root length after / before treatment) of the upper anterior teeth after correction of Class II division 1 incisal relation, to evaluate the time of treatment and its effect on root resorption and to show if there is any risk of root resorption in relation to sex.

The sample was composed of 25 patients (15 females and 10 males) 15–25 years old age. All patients were treated with 22×30 slot brackets fixed stainless steel Roth system appliances after extraction of bilateral maxillary first premolars. The canines were retracted individually along the base arch wire with power chain elastics that were changed every 1 week, then the four upper incisors were retracted with vertical loops.

The results of periapical radiograph measurements before and after treatment indicated that there were a noticeable apical root resorption with blunted irregular apex after the completion of orthodontic treatment. The incisor roots were affected more than the canines. In addition, there were no gender differences in root resorption between males and females (except upper left lateral incisor). The mean treatment time from beginning to end of treatment and obtaining Class I incisal relation was 21.4 months.

Key Words: Apical root resorption, Class II division 1, Roth technique.

الخلاصة

الهدف من هذه الدراسة هو تقييم مدى تأثير علاج تقويم الأسنان على طول الجذر بالنسبة للأسنان الأمامية العليا (نسبة طول الجذر بعد / قبل العلاج) بعد علاج إطباق الأسنان الأمامية من التصنيف الثاني النوع الأول، وتقييم الفترة الزمنية اللازمة لإكمال العلاج وتأثير وقت العلاج على طول الجذر، ولملاحظة إذا كان هناك أي تأثير للجنس على طول الجذر بعد العلاج.

تألفت العينة من ٢٥ مريض (١٥ أنثى و١٠ ذكور) تتراوح أعمارهم بين ١٥–٢٥ سنة تم علاجهم بجهاز تقويم ثابت ٢٢×٣٠ ستيل نظام "روث" بعد قلع الضاحك العلوي الأول من كلا الجهتين. تم سحب الناب العلوي على طول السلك الأساسي لجهاز التقويم باستخدام السلسلة المطاطية التي يتم استبدالها كل أسبوع، ومن ثم تم سحب القواطع الأربعة الأمامية العليا باستخدام الأقواس العمودية.

أظهرت نتائج مقارنة الأشعة السينية للأسنان قبل وبعد العلاج أن هناك نسبة ملحوظة في قصر الجذر بالإضافة إلى تشوه في قمة الجذر. كانت القواطع متأثرة أكثر من الأنياب كما وأنه لم يكن هناك اختلاف بين الجنسين في نسبة تغيير طول الجذر بعد العلاج عدا القاطع الجانبي الأيسر. استغرقت الفترة الزمنية لعلاج هذه الحالات معدلاً قدره ٢١.٤ شهر.

INTRODUCTION

Apical root resorption is a common adverse effect during orthodontic treatment.[1] It has been shown that once the stress (orthodontic force) is removed, reparative processes take over, and there is no continued phagocytosis of the dentin (except, perhaps, of sharp margins).[2, 3] An

experimental study showed that the amount of root resorption was significantly less in patients treated with a pause than in those treated without interruption.[4]

Apical root shortening is of particular interest because it is more perceptible on radiographs than other types of root resorption. Buccal and lingual resorptions are less perceptible on intraoral radiographs.[5]

According to the histologic study of Henry and Weinmann,[5] the most frequent idiopathic root resorption occur in the apical area, resorption occurs more readily upon surfaces facing toward the direction of physiologic movement.

Root resorption is one of the most serious iatrogenic problems associated with orthodontic treatment and its diagnosis can only be made by maintaining adequate records. If resorption is discovered, treatment goals must be reassessed and decision should be made to terminate treatment or arrive at a treatment compromise and, when necessary, stop applying forces.[6] These iatrogenic problems occur to a greater degree in adults than they do in adolescents. The occurrence of root resorption in adolescents has been extensively studied and reported to be minimal and generally not likely to outweigh the benefits of orthodontic treatment.[7–10]

Many studies have been done during the past several decades on apical root resorption associated with different kinds of orthodontic tooth movement.

As early as 1914, Ottolengui[11] reported on apical root resorption caused by orthodontic treatment, the resorption usually occurs in the upper incisors.[12–14] DeShields,[15] and Ronnerman and Larsson[16] have studied root resorption with radiographs of the anterior maxillary teeth after orthodontic treatment. However, if there is no apical root resorption seen in the maxillary incisors, then significant apical resorption occurring in other teeth is less likely because the anterior teeth are the most frequently affected.[2, 7, 12, 15, 17]

It can be concluded that the factors affecting the root resorption include: Hormonal and nutritional,[18] genetic and individual[13,19,20] treatment duration[15,19,20–24] trauma,[19, 22] age of patient and stage of root formation at the onset of treatment,[25, 26] orthodontic technique,[2,21,27–29] force magnitude,[30, 31] and chronic forces as nail–biting and tongue–thrusting.[22, 32, 33]

The aims of this study were to evaluate the effect of orthodontic treatment on root length (ratios of root length after / before treatment) of the upper anterior teeth after correction of Class II division 1 incisal relation, to evaluate the time of treatment and its effect on root resorption and to show if there is any risk of root resorption in relation to sex.

MATERIALS AND METHODS

The sample was composed of 25 healthy Iraqi persons (15 females and 10 males) with Class II division 1 Angle classification; overjet ranged between 8–15 mm. The incisal edges of incisors and cusp tips of canines were intact. The age of these patients was ranging between 15–25 years (mean age = 20.4 years) at the starting of treatment. Neither habits nor abnormal tongue posture were found in the history background of the patients.

All patients were treated by stainless steel Dentaurum Roth appliances 22 × 30 after extraction of maxillary first premolars.

Four pre–treatment and post–treatment periapical radiographs were taken (one for each canine, one for the left incisors and one for the right incisors), using paralleling technique.[34] All x–ray films were taken by the same operator and same apparatus, with exposure time 0.5 seconds, 65 kV and 7.5 mA.

The brackets were attached on the facial surface of the teeth using chemical cure composite resin. The first permanent molars were banded. After the alignment and leveling stage, the canines were retracted by sliding method along the rectangular base arch wire (17 × 25 rectangular) by power chain elastics changed every 1 week intervals (to maintain the force level constant about 200 g). When canines retraction was completed, it involved with second premolar and first permanent molar anchorage to retract the incisors by vertical loops (8 mm height tear drop Gabel bend only) using 0.018 × 0.025 steel wire depending on the severity of Class II and patient's age. The time of treatment was

ranged between 16–30 months (mean = 21.4 months).

Evaluation of Resorption

The radiographs have been traced; each tooth has been delineated on these photographs. The longitudinal axis was constructed through the center of the incisal edge in the direction of pulp canal. The construction of the longitudinal axis of the tooth on the first and second photographs was identical (Figure 1). The cemento-enamel junctions (CEJs) at the mesial or distal aspects of the tooth were visible in both radiographs. They were marked and projected perpendicularly on the tooth axis.[22]

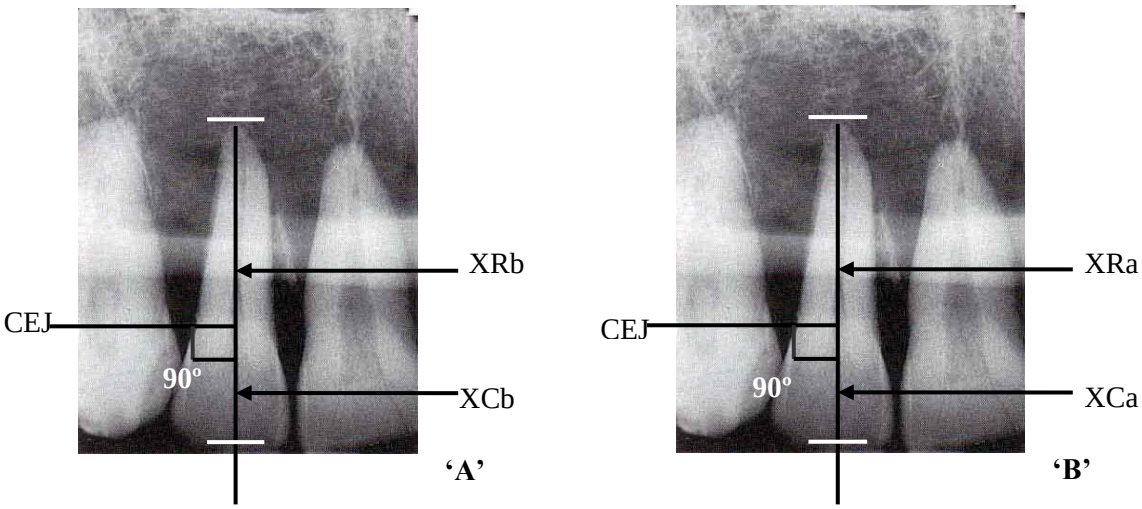

Figure (1): Pre–orthodontic 'A' and post–orthodontic 'B' periapical radiographs taken by paralleling technique

CEJ: Cementoenamel junction;
XRb and XRa: Root length before and after orthodontic treatment respectively (in radiograph);
XCb and XCa: Crown length before and after orthodontic treatment respectively (in radiograph).

Because it was believed that the precise distance between the incisal margin (and tooth apex) and the constructed CEJ could not be measured with sufficient accuracy, accurate measurement of absolute amount of root resorption was not deemed possible.

So that, the relation between the root length before (TRb) and after (TRa) treatment was calculated as follows[35] (Figure 1):

$$\frac{XCb}{XRb} = \frac{TCb}{TRb}, \qquad \frac{XCa}{XRa} = \frac{TCa}{TRa}$$

XCb and XCa: Distance from CEJ to incisal edge on x–ray before and after treatment, respectively.

XRb and XRa: Root length on x–ray films before and after treatment, respectively.

TCb and TCa: Distance from CEJ to inci-sal edge before and after treatment, respectively.

Since TCb = TCa:

$$\frac{XCb \,.\, TRb}{XRb} = \frac{XCa \,.\, TRa}{XRa}$$

$$\frac{XCb \,.\, XRa}{XRb \,.\, XCa} = \frac{TRa}{TRb}$$

Student's t–test for all upper anterior teeth was used to evaluate the sex differences in root resorption. In addition to that, t–test was also used between the teeth to check if there were any significant difference between them in root resorption after orthodontic treatment in total sample.

Reliability of the Method

The reliability of the intraoral radiographic measurement method was tested in normal 10 individuals (no therapy and sh-ort investigation period). This number is enough to get an idea about the method re-liability. No change should be observed and measurements should be the same.

The relation (Tra / TRb) was calculated for each anterior tooth of the normal individuals with the procedure mentioned above. The mean was 0.98 (standard deviation = 0.08), the t–test showed no significant difference at $p \leq 0.01$.

RESULTS AND DISCUSSION

The mean of treatment time was 21.4 months. The mean age of the patients was 20.4 years. The retraction values of maxillary anterior teeth (overjet) were ranged between 8–15 mm with mean = 8.8 mm.

The mean and standard deviation of post / pre–treatment root length ratio of total sample are presented in Table (1). Student's t–test between teeth (Table 2) indicated that there were no significant differences between centrals and laterals and this finding was similar to that observed by Beck and Harris.[21] The apical root resorption of canines was significantly less than that of incisors. This may be attributed to that incisors are retracted against palatal cortical bone unlike canines.

Table (1): Mean and standard deviation of the ratio of root length after / before treatment of total sample

Teeth	Mean	± SD
Upper Centrals	0.87575	0.0356
Upper Laterals	0.88388	0.0342
Upper Canines	0.92602	0.0284

SD: Standard deviation.

Table (2): Student's t–test between teeth of total sample

Teeth	t–value	df	Significance
Upper Centrals vs Canines	7.809	48	S
Upper Laterals vs Canines	6.711	48	S
Upper Centrals vs Laterals	1.1165	48	NS

S: Significant; NS: Not significant, df: Degree of freedom.

The mean and standard deviation of post / pre–treatment root length ratio for the individual teeth of males and females are presented in Table (3). The t–test between both sexes indicated that there were no significant differences for all teeth with the exception of upper left lateral incisor tooth (we cannot find any reason for these results in this study). Many studies showed no correlation between gender and root re-sorption.[36–38]

Several other studies including the study of Newman[39] indicated that females were more susceptible to root resorption than males, but only one study demonstrated that males were more sensitive to root resorption after orthodontic treatment.[40]

In this study, we also concluded that there was a correlation between the duration of treatment and the amount of apical root resorption ($p < 0.05$) (Figure 2). Dermaut and DeMunck[35] and Levander and Malmgren[41] found only trivial, non–significant associations between external apical root resorption and the duration of treatment. Alternatively, DeShields[15] and Linge and Linge[22] reported statistically significant but low correlation between external apical root resorption and the length of treatment time.

Table (3): Mean, standard deviation and Student's t–test of the ratio of root length after/ before treatment between males and females

Teeth	Mean ± SD		t–value	df	Significance
	Males	Females			
Upper Right Centrals	0.87613 ± 0.0249	0.87421 ± 0.0437	0.125	23	NS
Upper Left Centrals	0.87885 ± 0.0258	0.87496 ± 0.0411	0.265	23	NS
Upper Right Laterals	0.87101 ± 0.0281	0.88674 ± 0.0379	1.120	23	NS
Upper Left Laterals	0.86023 ± 0.0205	0.90537 ± 0.0293	4.219	23	S
Upper Right Canines	0.91475 ± 0.0267	0.93227 ± 0.0313	1.451	23	NS
Upper Left Canines	0.91736 ± 0.0223	0.93305 ± 0.0286	1.461	23	NS

SD: Standard deviation, df: Degree of freedom.
S: Significant; NS: Not significant.

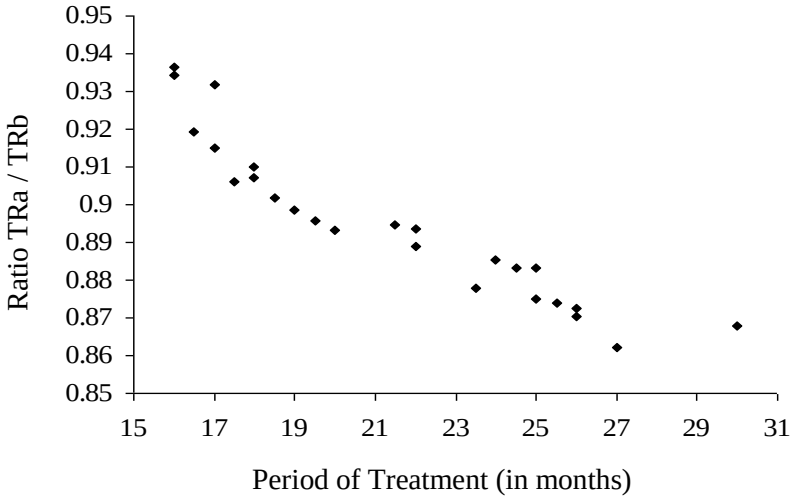

Figure (2): The correlation between treatment time of the 25 Class II division 1 patients and the mean of TRa / TRb ratios of total anterior teeth

TRb, TRa= Root length before and after treatment respectively

CONCLUSIONS

Root resorption of upper anterior teeth after Class II division 1 correction with Roth appliance was significantly affect both central and lateral incisors more than canines.

There were no significant differences in root resorption between males and females with the exception of upper left laterals.

There was a linear correlation between apical root resorption and the treatment time.

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