External apical root resorption in orthodontically treated Class II malocclusions with 2-phase protocol (A 10-year Experience)

Omar Fawzi Chawshli[1]

Background and objectives: External apical root resorption is one of the proposed sequels of fixed orthodontic appliances used for the treatment of different types of malocclusions specially class II. Many factors may be involved in the etiology and severity of such resorption. This study is conducted to explore the prevalence of root resorption and specify the most possible causative factors during orthodontic treatment.

Method: Records of 103 patients (case sheet, panoramic and cephalometric radiograph) with class II malocclusion were retrieved from private clinics and dentistry college clinics. Patients with planned premolar extractions and 2-phase protocol for space closure were involved in the study. The pre- and post-treatment panoramic radiographs were evaluated for external apical root resorption using a scoring method proposed by Levander and Malmgren The effect of variables like age, gender and duration of the treatment on external root resorption were studied.

Results: Statistical analysis showed that age and gender has insignificant relation with root resorption. A highly significant relation found between the severe external apical root resorption and the duration of treatment.

Conclusion: External apical root resorption is highly associated with long-term duration treatment protocols.

Key words: External apical root resorption, class II malocclusion, 2-phase protocol.

(1)Department of Pedodontics, Orthodontics and Preventive Dentistry, College of Dentistry, Hawler Medical University, Erbil, Iraq.

Introduction

External apical root resorption (EARR) is one of the clinically high concern to orthodontists since orthodontic treatments has been always resulted in a high frequency of apical root resorption specially in adolescent populations.[1,2] The etiologic, morphologic, and treatment factors associated with EARR are not completely clear till now. Trauma to the teeth, could be caused before or during treatment.[3,4] The morphological abnormalities during the root development,[5,6] the time required for treatment with appliance,[7] and the stage of root formation at the time of appliance placement[8,9] have all been proposed as the most possible risk factors for root resorption during orthodontic treatment. The role of the treatment protocol weather done in a 1-phase or 2-phase treatment till now remains unclear.[10, 11]

Most of the general dentists and non-orthodontic dental specialists believe that

EARR could be prevented and blame the orthodontists for the EARR that is associated with most types of orthodontic treatments.[12] Therefore, it is necessary to point out which orthodontic treatment factors may have role in enhancing EARR and to address the ways of inhibiting or minimizing the process.

Class II malocclusion represents the higher percentage of malocclusions in most populations which should be treated in early ages,[13,14] and since most of the literatures regarding EARR concentrate on intrusion and canine impaction,[15-17] the prevalence and severity of EARR problem was explored in the anterior segment of patients with class II malocclusions.

The predictability, prevention, and early diagnosis and prognosis of EARR associated with orthodontic treatments are, in fact, questionable.[18] It is therefore important to search for and study the causes and factors that may enhance or avoid the possibility of EARR. That is why the aim of this study was to explore the relation of orthodontic treatment of class II cases with 2-phase treatment protocol with EARR and to find the most associated risk factors.

Patients and method

Sample selection. Orthodontic records were obtained from patients treated previously with fixed orthodontic appliances for both upper and lower arches by the same orthodontist from the higher education clinic at the College of Dentistry / Hawler Medical University and the Private clinic and center that the author worked at.

Patients' records were collected during the time from 2007 till 2016 with a total of 10-year duration. Patients with class II division 1 dental malocclusions with no skeletal base malrelationship were enrolled in this study.

Out of 471 patient records only 103 cases (71 female and 32 male) their age ranged between 15 to 24 years old fulfilled the inclusion criteria which were: presence of full records of case sheet and pre and post panoramic and cephalometric radiographs; no known medical condition, no evidence of EARR at start of treatment; no impacted canines; complete root formation at the start of treatment for maxillary incisors; intact and non-carious or root canal treated maxillary incisors; cases only that was treated with 2-phase protocol and 2 unit upper 1st premolars extractions.

The arch wire sequence and treatment mechanics was the same for all the patients. The arch wires sequence was 0.016-in, 0.018-in, and 0.019×0.025-in nickel-titanium (3M) ligated with elastomeric ligatures and finished with 0.019×0.025-in stainless steel ligated with stainless steel ligature ties for canine retraction as phase I then followed with mechanic of 4 incisors retraction with 0.019×0.025-in TMA closing loops as phase II of treatment protocol followed by finishing with 0.019×0.025-in TMA wire.

EARR Measurement. For assessing EARR, panoramic radiographs were used, and the root lengths and shapes of the 4 maxillary incisors were compared before and after treatment using a scoring system proposed by Levander and Malmgren (1988) [6] as shown in figure 1.

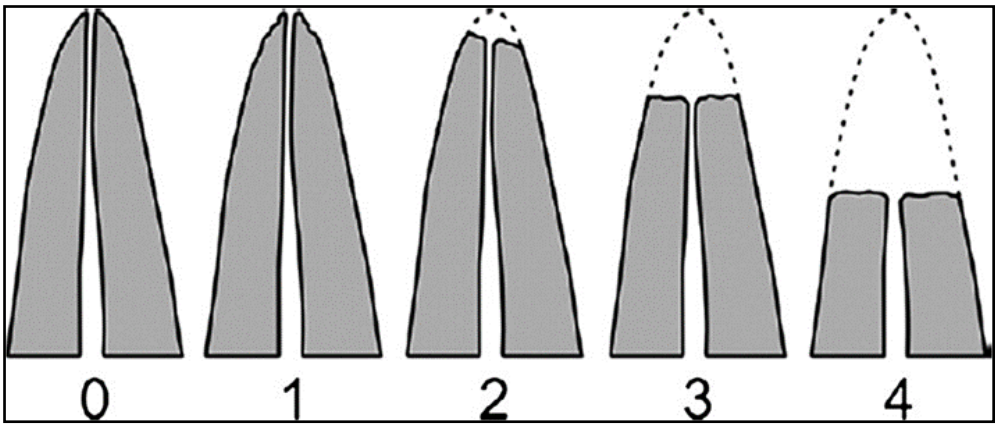

Figure 1: EARR score system by Levander and Malmgren 1988.

Signs of apical root resorption were registered by the same clinician with index scores from 0 to 4: 0, no resorption; 1, irregular root contour; 2, apical root resorption less than 2 mm; 3, apical root resorption from 2 mm to a third of the original root length; and 4, root resorption exceeding a third of the original root length.

Magnification by panoramic radiographs considered being no more than 10% of the real root resorption in maxillary incisors area19 and this magnification is considered for all pre- and post-treatments radiographs.

Furthermore, to assess intra-examiner and inter-examiner reliability, 10 panoramic radiographs were randomly retraced from the records, and the lengths of the 4 maxillary incisors were re-scored by same orthodontist at different times and by another orthodontist. The *P* value showed non-significant difference for both intra- and inter-examiner calibrations.

Ethical approval. The scientific and ethical committee of the College of Dentistry - Hawler Medical University has approved the study before beginning data collection that was done as a part of treatment procedure that has been carried previously for curative reasons and not for research.

Statistical analysis. The results were organized and analyzed using the Statistical Package for Social Science software (version 14.0, SPSS, Chicago). The outcome variable, severe root resorption was divided as Yes for patients with at least 1 tooth in stage 4 (root resorption exceeding a third of the original root length) and No for patients without resorption or those with stages 1 to 3 resorption.

Using chi-square test the following independent variables were assessed: age, gender and duration of treatment, then tested. For statistical reasons the age was classified into 2 groups; young group, below 20 years (15-19) and old group, above 20 years (20-24). The duration of the treatment was classified into two groups; short group, below 19 months (18-21) and long group, above 21 months (21-30). Significance for all statistical tests was predetermined to be $P \leq 0.05$.

Results

The demographic characteristics of the patients' records that have been involved in the study were shown in table 1.

The prevalence of severe root resorption was 14.56 % (n=15). Table 2 shows the distribution of the variables for presence or absence of severe resorption. Statistically non-significant ($P=0.567$ and $P=0.799$) differences were observed between the outcome (severe root resorption) and the age or gender differences respectively while a highly significant difference ($P<0.001$) was recorded between the outcome (severe root resorption) and the duration of treatment.

Table 1: Demographic characteristics of the study sample.

Characteristics	Mean ± SD	Number (%)
Age (years)	19.2 ± 1.31	_
Gender Female	_	71 (68.93%)
Gender Male	_	32 (31.06%)
Treatment duration (months)	20.42 ± 2.27	_

Table 2: Analysis of relationship between severe root resorption and independent variables

Variables	Severe root resorption		Total	P value
	Yes	No		
Gender	**No. (%)**	**No. (%)**	**No. (%)**	
Female	10 (14.08)	61 (85.92)	71 (100)	0.567
Male	5 (15.62)	27 (84.38)	32 (100)	
Age	**No. (%)**	**No. (%)**	**No. (%)**	
Old age	7 (14.28)	42 (85.72)	49 (100)	0.799
Young age	8 (14.81)	46 (85.19)	54 (100)	
Duration of treatment	**No. (%)**	**No. (%)**	**No. (%)**	
Long duration	5 (45.45)	6 (54.55)	11 (100)	<0.001
Short duration	10 (10.87)	82 (89.13)	92 (100)	
Total	15	88	103	

Discussion

Root resorption is one of the most controversial issues in the literature as a consequence of orthodontic treatment. In the present study high prevalence of EARR noted specially in patients treated for durations more than 20 months and this may be the reason for the high rate of EARR, since longer duration expose the root to more force magnitudes and though higher chance of resorption.

High prevalence of severe root resorption compared to the findings from other studies was evident.[3,5,9] However, it is difficult to compare the frequency and severity of EARR with other studies because of the different populations and methods used. Studies defining severe root resorption as greater than a quarter of the root length reported root resorption of 1%[6] to 11%. [20]

Most studies[21-23] agree with the fact that class II patients who had had premolar extractions during orthodontic treatment have greater chances of severe resorption than those treated without extractions. The possible cause for this could be the increased range of movement and retraction of the apex to the extraction space with longer duration of treatment time.

High prevalence of the EARR was not related to the age or the gender in this study which is in agreement with other studies done in other populations.[22] While a high prevalence of severe EARR was recorded in this study may be related to the long duration of treatment time which render the fact that the anterior teeth were subjected to heavy forces for longer durations and odontoclastic activity, and since extraction cases require more time for extraction space closure than non-extraction cases[21] so more EARR is suspected.

Longer duration required for 2-phase treatment protocol (as present in this study) is another factor to increase the rate of EARR which agree with the finding of Brin et al (2003).[23] Who studied the rate of root resorption in the posterior area in patients with class II malocclusions treated with both 1-phase and 2-phase treatment protocols.

High prevalence of EARR could be expected in long duration orthodontic treatments, which could be prevented by encouraging non-extraction treatments, and shorter treatment durations offered by en-masse retraction mechanics

Conclusions

Class II patients treated with premolar extraction and 2-phase protocol are more vulnerable for severe EARR

Treatment period plays a major role in root resorption process.

Conflicts of interest

The author reported no conflict of interest.

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