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A RADIOGRAPHIC ANALYSIS OF EXTERNAL APICAL ROOT RESORPTION (EARR) OF MAXILLARY INCISORS AFTER 6 MONTHS OF INITIATION OF FIXED ORTHODONTIC APPLIANCE THERAPY

Orthodontics

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ABSTRACT

Consequences of External apical root resorption (EARR) range from slight tooth mobility due to mild amounts of root resorption to complete loss of teeth due to excessive root resorption. The purpose of this study was to measure the amount of EARR that might occur on the 4 maxillary incisor teeth while using the MBT system and to evaluate its clinical significance during a 6-month period of active treatment. In addition, the contribution of gender, and how extraction and non-extraction of premolars is related to maxillary incisor EARR was examined. A sample of 40 patients between 12 -20 years of both genders reporting to the Department of Orthodontics & Dentofacial Orthopaedics of KD Dental College was selected for this study. The amount of EARR for the 160 teeth was examined. There was no statistically significance difference ($p>0.05$) found between change in root length of Maxillary right Central incisor, Maxillary right lateral incisor, Maxillary left central incisor and Maxillary left lateral incisor. There was no statistically significant difference was found among male and female with EARR and there was no statistical difference ($p>0.05$) found in external apical root resorption among participants with premolar extraction and without premolar extraction. This study concludes that all the maxillary incisors in this investigation did not show any kind significant EARR after the follow-up period of 6months of active orthodontic treatment with MBT treatment techniques, no significant changes in EARR was observed when comparison was made for gender and also for treatment where premolar extraction was done.

KEYWORDS

External apical root resorption: EARR; MBT technique

INTRODUCTION:

External apical root resorption (EARR) is an undesirable sequela of orthodontic therapy that in some cases may compromise the results of successful treatment.[1]Root resorption associated with orthodontic treatment is more apparent in subjects where the applied forces are strong and of extended duration, delivered to the tooth in unfavourable directions, or when the tooth is unable to withstand normal forces due to a weakened support system.[2, 3, 4] There is no single explanation why certain teeth resorb severely, but a number of factors taken together may explain why resorption takes place.[5] In the literature some risk factors are mentioned: deviating root form, [6,7]treatment with torque and up righting springs[8] and treatment with Class II elastics or rectangular arch wires for a long period. [9] In another study, traumatized teeth with signs of root resorption prior to orthodontic treatment were found to be more prone to root resorption during treatment.[10] Other implicated factors include trauma, tooth devitalization, ectopic eruption of adjacent teeth, traumatic occlusion, recurrent heavy forces to the dentition such as bruxism, and habits such as tongue thrusting and finger nail biting.[11] The literature suggests that movement of teeth with mature roots, extensive root movement, and intrusive mechanics enhance the risk of EARR.[12]

Although the resorption process stops when the active appliances are removed, the longevity of severely resorbed teeth might be compromised in patients susceptible to marginal periodontal breakdown. In addition, teeth with abnormally short roots might not be suitable as abutments if bridges are required in the future.[13]

Since there are limited studies available to measure the amount of EARR that occurs on maxillary incisor teeth using the MBT system, and no literature rendering details of its clinical significance during a 6-month period of active treatment to the best of our knowledge, we aimed to conduct this study to measure the amount of EARR that might occur on the 4 maxillary incisor teeth while using the MBT system and to evaluate its clinical significance during a 6-month period of active treatment. In addition, the contribution of gender, and how extraction and non-extraction of premolars is related to maxillary incisor EARR was also examined.

METHODOLOGY:

The study was conducted in Department of Orthodontics and Dentofacial Orthopaedics, K. D. Dental college and hospital, Mathura in collaboration with Department of radiology, K. D. Dental college and hospital, Mathura based on Standardized periapical radiographs obtained for all 4 maxillary incisors with the long-cone paralleling technique prior to initiation of treatment and after continuation of the treatment for 6 months. Ethical clearance was obtained from the institutional ethical committee. The radiographs were been collected at random from patient reporting for treatment and the radiograph were evaluated based on their linear measurements with implementation of the correction factor to rule out any magnification error.

Definition of study subject:

Radiographic analysis of External Apical Root Resorption (EARR)of maxillary incisors after 6 months of initiation of fixed orthodontic appliance therapy.

Inclusion criteria:

1. Age of the patient should be between 12 -20 years.
2. Both male and female.

Exclusion criteria:

1. The selected patients should not be presented with any history of genetic or developmental abnormalities, systemic disorders, periodontal disease, trauma, impacted maxillary canines, endodontic treated maxillary incisors and crown fracture or incisal edge abrasion of the upper incisors.
2. There should not be any history of previous Orthodontic treatment.

Procedure:

Forty patients were selected for the study with age range from 12 – 20 years. None of the selected patients were presented with a history of genetic or developmental abnormalities, systemic disorders, hormonal imbalance, periodontal disease, trauma, impacted maxillary canines, endodontic treatment of maxillary incisors, previous orthodontic treatment, or crown fracture or incisal edge abrasion of the upper incisors. Informed consent was obtained from each patient or his/her guardian prior to obtaining the radiographs. The amount of EARR for the 160 teeth was examined. Standardized periapical radiographs were obtained by a single operator with the long-cone paralleling technique prior to initiation of treatment. Durr Vista Scan Nano Easy scanner and digital image plates were used and the angles were obtained by an intraoral XCP film holder (Rinn Corporation, Elgin, Illinois, USA). The radiographs were developed with the Durr Vista Scan Nano Easy scanner and were scanned at a resolution of 635 dpi the images were printed.

The root apex, incisal edge, and cementoenamel junction (CEJ) of each maxillary incisor were demarcated on the scanned images. For the CEJ, the most distinct landmark either mesial or distal was used, but once selected, the same side was used for all of the follow-up radiographs. The longitudinal axis of each tooth was constructed from the root apex to the incisal edge following the root canal as accurately

as possible. The marked CEJ was then projected perpendicular to this axis. Crown length was measured from the incisal edge to the projected CEJ, and root length from the projected CEJ to the apex on the constructed longitudinal axis. All measurements were performed for each tooth separately. Treatment protocol consisted of the MBT technique. The appliance used in the group were 0.022-inch slot MBT brackets Follow-up radiographs were obtained 6 months after the start of treatment and the crown and root lengths of the maxillary incisors were measured using the method described. Any image distortion between the pre-treatment and follow-up radiographs was corrected using the crown length registrations, assuming the crown lengths to be unchanged over the observation period. A correction factor (CF) was calculated using the following formula:

$CF = C1/C2$

where C1 is the crown length on the pre-treatment radiograph, C2 on the 6-month follow-up radiograph.

EARR per tooth in millimetres was calculated using the following formula:

$EARR = R1 - (R2 \times CF)$

where R1 is the root length on the pre-treatment radiograph, R2 on the 6-month follow-up radiograph.

Fig. 1: Pre Treatment Iopar

Fig 2: 6 Month Follow Up Iopar

Statistical Analysis:

Changes in root length that occurred after 6 months for the central and lateral tooth groups were determined with a paired-samples t -test. EARR of more or less than1 mm at 6 months after treatment initiation (clinically significant EARR), were assessed using the t- test. The generalized estimating equations (GEE) analysis was used to determine the regression parameters and to account for the correlation between each patient's observations (EARR values for left and right central and lateral incisors of each patient). A multiple regression model was constructed for each tooth group separately to evaluate the effect of age, gender, and maxillary premolar extraction on the amount of EARR at the 6 months follow-up. The Statistical Package for Social Sciences (IBM SPSS version 20) was used to obtain the descriptive statistics and to perform the paired samples t –test, t- test and GEE analysis. Pvalues less than 0.05 were considered statistically significant.

RESULTS:

The final sample size comprised of 40 participants on whom all the 4 maxillary incisors were included for the study.

Age wise distribution of participants

A total of 40 participants between the age group of 12 to 20 years took part in the study in which the mean age group was 16.95 ±1.907. The minimum age of the participant was 14 years and maximum was 20 years. Maximum participants were from the age of 16 and 18 years old.

Gender wise distribution of participants

Out of the total study participants, most of them were female 28(70%) and male were 12(30%)

Premolar extraction wise distribution of participants

Among total participants, 16 (40%) participants had undergone orthodontic premolar extraction and remaining 24 (60%) participants were under non extraction treatments.

Difference between root lenght at initial and 6 month

There was no statistically significance difference($p>0.05$) found between change in root length 0f Maxillary right Central incisor (2.275±7.33), Maxillary right lateral incisor (5.925±10.0), Maxillary left central incisor (1.150±7.92) and Maxillary left lateral incisor (2.050±6.64). (Table:4)

Table 4: Difference Between Root Lenght At Initial And 6 Months

CHANGE IN ROOT LENGTH	PRE AND POST (AFTER 6 MONTHS)							
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
MAXILLA RY RIGHT CENTRAL INCISOR	2.275	7.332	1.159	-.070	4.620	1.962	39	.057
MAXILLA RY RIGHT LATERAL INCISOR	5.925	10.00	1.581	9.123	2.727	3.747	39	.068
MAXILLARY LEFT CENTRAL INCISOR	1.150	7.922	1.253	3.684	1.384	-.918	39	.364
MAXILLARY LEFT LATERAL INCISOR	2.050	6.469	1.023	-.019	4.119	2.004	39	.052

Results of generalized estimating equations analysis for the central and lateral incisors at the 6-month follow-up

A regression model was run to predict EARR from age, gender, treatment (Premolar extraction). All three variables added were not statistically significant to predict EARR ($p>0.05$) except EARR in maxillary right lateral incisor were statistically significant with gender ($p>0.05$) and treatment (Premolar Extraction).

External apical root resorption in millimetres of original root length for tooth groups at 6 months subdivided by gender (Table 6)

1. Maxillary right central incisor –

There was no statistically significant difference was found among male (.74±.28) and female (.58±.371) with EARR.

2. Maxillary right lateral incisor -

There was no statistically significant difference was found among male (.50±.28) and female (.73±.360) with EARR

3. Maxillary left central incisor –

There was no statistically significant difference was found among male (.96±.530) and female (.74±.410) with EARR

4. Maxillary left lateral incisor-

There was no statistically significant difference was found among male (.87±.450) and female (.69±.3571) with EARR

Table 6: External Apical Root Resorption In Millimetres Of Original Root Length For Tooth Groups At 6 Months Subdivided By Gender.

Extrnal Apical Root Resorption	Gender	Mean	Std. Deviation	F	Sig.
Maxillary Right Central Incisor	Male	.74	.280	.246	.623
	Female	.58	.371		
Maxillary Right Lateral Incisor	Male	.50	.284	1.329	.256
	Female	.73	.360		
Maxillary Left Central Incisor	Male	.96	.530	1.569	.218
	Female	.74	.410		
Maxillary Left Lateral Incisor	Male	.87	.450	1.588	.215
	Female	.69	.571		

External apical root resorption in millimeters of original root length for tooth groups at 6 months subdivided by treatment plan (Table:7)

1.Maxillary right central incisor - There was no statically difference ($p>0.05$) were found in external apical root resorption among participants with premolar extraction (0.52±0.271) and without premolar extraction (0.71±0.382)

2. Maxillary right lateral incisor – There was no statically difference

(p>0.05) were found in external apical root resorption among participants with premolar extraction (0.67±0.298) and without premolar extraction (0.65±0.390)
3. Maxillary left central incisor – There was no statically difference (p>0.05) were found in external apical root resorption among participants with premolar extraction (0.61±0.350) and without premolar extraction (0.93±0.478)
4. Maxillary left lateral incisor - There was no statically difference (p>0.05) were found in external apical root resorption among participants with premolar extraction (0.79±0.532) and without premolar extraction (0.71±0.552)

Table 7:external Apical Root Resorption In Millimeters of Original Root Length For Tooth Groups At 6 Months Subdivided By Treatment Plan

Extrnal Apical Root Resorption	Premolar Extraction	Mean	Std. Deviation	F	Sig.
Maxillary Right Central Incisor	Yes	.52	.271	1.827	.184
	No	.71	.382		
Maxillary Right Lateral Incisor	Yes	.67	.298	1.293	.263
	No	.65	.390		
Maxillary Left Central Incisor	Yes	.61	.350	2.466	.125
	No	.93	.478		
Maxillary Left Lateral Incisor	Yes	.79	.532	.258	.615
	No	.71	.552		

DISCUSSION:

External apical root resorption (EARR) is an undesirable sequela of orthodontic therapy that in some cases may compromise the results of successful treatment. It has been of concern to clinicians since the early report of Ottolengui (1914). Root resorption associated with orthodontic treatment is more apparent in subjects where the applied forces are strong and of extended duration, delivered to the tooth in unfavourable directions, or when the tooth is unable to withstand normal forces due to a weakened support system.[1,2,3] Several factors have been implicated in the initiation and progression of EARR during orthodontic treatment. These can be divided into biological, mechanical, or a combination of the two as reported by Brezniak and Wasserstein (1993).[14]A lot of controversy exists in the reports of clinical and laboratory investigations of root resorption, regarding the incidence and amount of EARR. The mean degree of resorption varies from 0.2 (Costopoulos and Nanda, 1996)[15] to 2.93 mm (Copeland and Green, 1986)[16] , whereas the prevalence of radiographically detectable resorption varies from 0 to 100 percent.[17] In our study the Crown and root lengths were measured separately for each of the four maxillary incisors on scanned periapical radiographs taken using the long-cone paralleling technique, similar to a study conducted by Linge and Linge (1983).[9] Using of correction factor (c.f) also help to increase the accuracy of the measurement by eliminating any dimension or angulation difference between exposures (McFadden et al., 1989; Blake et al., 1995; Mavragani et al., 2000).[18, 19] There have been few reports devoted to the clinical consequences of EARR associated with orthodontic treatment. In some cases, the amount of EARR might be statistically significant but with no discernible clinical importance (Blake et al., 1995; Proffit, 2000)[20] However, some patients may experience root structure loss to the point where the treatment plan needs to be reviewed in order to avoid excessive tooth mobility and eventual tooth loss (Vlaskalic and Boyd, 2001).[21] In our study for external apical root resorption, the maxillary incisors were selected as representatives of external apical root resorption as these teeth are more susceptible to the iatrogenic consequences of orthodontic forces (Brezniak and Wasserstein, 1993).[22] The selection of 12 years, as the lower age limit of the sample in the study was to exclude the undesirable effect of residual root growth (Linge and Linge, 1983,1991; Horiuchi et al,1998).[23] The higher age limit of 20 years was chosen in order to eliminate the unfavourable effect of age that may lead to increased EARR due to creation of more hyalinized areas, longer hyalinization duration, and lower healing activity in adults (Costopoulos G, Nanda R 1996).[15]This study showed that no statistically significant correlation was found between EARR and appliance system at the 6-month follow-up. The findings were in consistent with earlier study conducted by Reukers et al.[24] in which no significant difference was observed between EARR and appliance system the same was also observed in a similar study conducted by Mavragani et al.[19]which also reports of no significant difference in EARR. However other study conducted by Yi, Jianru et al.[25] showed that there was significant amount of EARR during fixed orthodontic treatment. This study also implies that there was no significant correlation between external apical root resorption and gender, this finding is consistent with some previous study conducted by Linge and Linge[9] and also Harris et al.[4] However, other have found correlation between EARR and gender in study conducted by Levander and Malmgren[5] which indicated that significant difference did occur. However, in our other study using generalized estimating equation analysis it was observed that there was significant external apical root resorption in female in comparison to male which is due to unequal distribution of male and female participants in the study. In our study the maxillary incisor teeth of the patients for whom first premolar extractions were carried out did not demonstrated significant more EARR compared with the nonextraction group. Which is mostly due to short duration of our study interval which have not allowed the premolars to undergo retraction phase. Meanwhile Previous studies conducted by Blake et al.[3] and Harris et al[4] have reported have showed significant correlation following premolar extraction and EARR. Extraction subjects generally require larger tooth movement and apical displacement to correct malocclusions.[26, 27] This results in more resorptive activity at the apical region which may cause greater amounts of EARR and a higher percentage of teeth with clinically significant resorption. However, in our other study using generalized estimating equation analysis it was observed that there were significant EARR in cases with premolar extraction which is due to unequal distribution of cases with premolar extraction and non-extraction cases. From the results and the observations of this study we can say that no significant changes were observed for EARR during initial 6 months of active orthodontic treatment and no significant contribution of gender, treatment technique and extraction of maxillary first premolars to EARR was observed during the initial 6 month of active orthodontic treatment. The small sample size and unequal distribution of participants based on gender, cases with premolar extraction and relatively short follow-up period are the limitations of this study which should be taken into account.

CONCLUSION:

This study concludes that all the maxillary incisors in this investigation did not show any kind significant External Apical Root Resorption after the follow-up period of 6months of active orthodontic treatment with MBT treatment techniques. Study also showed that statistically no significant changes in External Apical Root Resorption was observed when comparison was made for gender and also for treatment where premolar extraction was done. Hence no much significant changes in External Apical Root Resorption were found during initial 6 months of treatment. Therefore, longer interval or continuation of the study by Standardized monitoring radiographs of the maxillary incisors could help in determination of External Apical Root Resorption in orthodontic patients and identification of those who may become severely affected. Considering the clinical significance of EARR may help in minimizing the risk of severe root resorption during orthodontic treatment.

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