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ORIGINAL ARTICLE

Evaluation of Apical Root Resorption during Alignment Phase of Fixed Orthodontic Treatment: A Prospective Study

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ABSTRACT

Purpose: External apical root resorption (EARR) is a permanent shortening of the root apex, often detected through radiographic imaging, characterized by the loss of the protective outer layer.To evaluate the apical root resorption during alignment phase of fixed orthodontic treatment

Method: Prospective Study was conducted in the Department of Orthodontic, Nishtar Institute of Dentistry, and Multan from 6th October 2020 to 5th April 2021. The study included a 110 patients aged between 18 and 25 years. The evaluation of External Apical Root Resorption (EARR) was conducted prior to and following the therapy. In order to carry out this assessment, a group of 110 patients underwent periapical radiographs utilizing the paralleling approach. The radiographs were taken at the beginning of the treatment and then again at the conclusion of a three-month research period. Afterwards, the length from the incisal edge to the apex of all incisors was carefully measured using a vernier caliper. The difference in root length, measured in millimeters, between the pre-treatment (T0) and post-treatment (T1) stages was measured and expressed as a percentage of the initial root length.

Results: Root resorption may initiate during the initial leveling stages of orthodontic treatment. The age range of these patients was quite broad, as the minimum age observed was 12.0 years, and the maximum age reached 25.0 years. It was noted that 35.45% of the enrolled patients were male, amounting to 39 individuals, while the majority, comprising 64.54%, were female, totaling 71 patients. For the maxillary central incisor on the upper right side, the mean root length before treatment was 17.51mm, which decreased to 16.30mm after treatment. The difference, indicating root resorption, was 1.21mm, with a standard deviation of 3.431.

Practical Implication: These results contribute to enhancing the overall safety and efficacy of orthodontic procedures, benefiting patient outcomes.

Conclusion: Root resorption was observed in all maxillary incisors to varying degrees, with central incisors experiencing greater resorption compared to lateral incisors. Root resorption can be detected in the initial phases of orthodontic therapy, according to the study.

Keywords: Apical Root Resorption, Endodontically Treated, Orthodontic Treatment, Root Apex,

INTRODUCTION

External apical root resorption (EARR) is the permanent shortening of the root apex, which is typically discerned through radiographic imaging. EARR is characterized by the loss of the protective outer layer of cells surrounding the tooth root. It manifests during orthodontic treatment when the forces applied to the root apex surpass the resistance and reparative capacity of the periapical tissues.[1,2] Greater levels of root resorption have been observed during orthodontic tooth movement in comparison to the natural root resorption process in humans.[3] The prevalence of apical root resorption following orthodontic treatment can range from 5% to 18%. Approximately 5% of adults and 2% of adolescents may experience root resorption exceeding 5 mm in at least one tooth during their orthodontic treatment.[4]

Various patient characteristics, including malocclusion type, gender, age, root morphology, dental anomalies, and prior dental trauma, have been proposed as potential risk factors. Root resorption is a common occurrence among orthodontic patients, and in most cases, it is clinically asymptomatic.[5] Fortunately, severe root resorption leading to clinical issues is quite rare, with the benefits of achieving aesthetic and functional improvements through orthodontic treatment far outweighing these typically minor side effects. However, in a few of individuals (about 5-10%), the degree of root resorption exceeds tolerable thresholds, which could potentially jeopardize the long-term viability of the affected teeth.[6]

Patients having fixed orthodontic treatment often experience moderate generalised root resorption, which affects all of their teeth. Maxillary incisors tend to be more commonly affected by this condition. It is a rare phenomenon, and there are cases where individuals undergo root resorption even in the absence of any history of orthodontic treatment.[7]The main determinants of severe localised resorption, which is notably more pronounced in maxillary incisors, include prolonged treatment duration and the application of excessive forces during orthodontic procedures. Root resorption typically initiates within 2 to 3 weeks following the application of orthodontic forces, and this initial phase can be identified through the use of periapical radiographs.[8]

Radiography serves as a valuable tool across various fields of medicine and dentistry, aiding in both diagnosis and treatment planning. Any alterations in radiographic quality can potentially lead to misinterpretations, subsequently leading to inaccurate diagnoses and treatment planning.[9] In the realm of orthodontics, radiographic assessment is a fundamental diagnostic step, crucial for identifying external apical root resorption and assessing root morphology during the progress of orthodontic treatment.[10]

The results of this study will provide orthodontists with important knowledge to actively recognize and reduce excessive root resorption in upper front teeth. Periapical radiography enables the early diagnosis of orthodontic therapy progress as early as four months.

MATERIALS AND METHODS

After approval from the hospital's ethical review board (ERB), this prospective study was conducted at the Department of Orthodontics, Nishtar Institute of Dentistry, Multan, and will include patients who had fixed orthodontic treatment, ranging in age from 12 to 25 years, including both male and female subjects within our department. We achieved alignment using a combination of round and rectangular superelastic wires. Radiographic records of patients were acquired from the patient’s record within the orthodontics department, strictly adhering to the specified inclusion criteria. A total of 110 teeth, as well as the maxillary right and left sides, as well as the central and lateral incisors (teeth 12, 11, 21, and 22), were present in the 20 patients.

These radiographic assessments were conducted at two key junctures: the first measurement was taken before the start of treatment (T1), and the second measurement was taken around 3

months following the implantation of maxillary incisor brackets, indicating the completion of the alignment phase (T2). The evaluation focused exclusively on the maxillary lateral and central incisors, as these teeth are particularly susceptible to dental injury and root resorption. This study excluded patients who had already had orthodontic treatment.

The periapical radiographs obtained prior to the commencement of treatment were designated as T1, whereas radiographs collected for the experimental group after 3 months of treatment initiation were labeled as T2. The research primarily targeted the upper central and lateral incisors, with the goal of identifying any changes in root length. To assess the differences within the T1 as well as T2 radiographs, the images were replicated and modified to precisely match the real size of a periapical radiograph. The measurements were conducted using a digital vernier caliper with an accuracy of 0.02/0.001 mm. The disparity in length between T2 and T1 was quantified, encompassing the prominent ridge on the top of the crown to the extremity of the root. The variations were categorized into four groups according to the ranges of 0.01–0.05 mm, 0.06-0.10mm, 0.11-0.15mm, and 0.16–0.5 mm. In order to ensure data consistency and verify calibration correctness, a sole investigator performed all the studies.

The statistical studies were performed using SPSS version 20. A t-test was employed to compare the data before therapy (T1) and after treatment (T2). The statistically significant value was determined with a level of significance of P <.05.

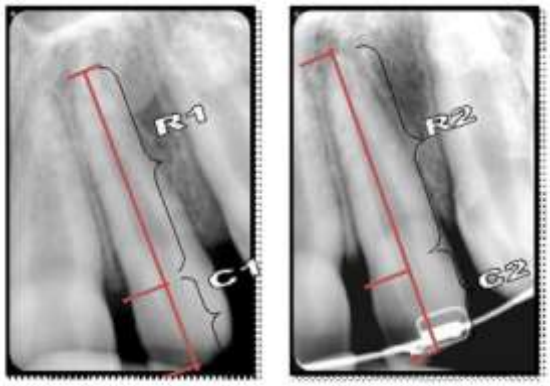

Figure 1: Quantitative analysis of radiographs before treatment and after alignment. C1 represents the crown length observed on the pre-treatment radiogram, whereas C2 represents the crown length observed on the post-alignment radiogram. R1 represents the root length before treatment, and R2 represents the root length after the levelling phase

STUDY RESULTS

The age range of these patients was quite broad, as the minimum age observed was 12.0 years, and the maximum age reached 25.0 years. On average, the patients' age was 18.67 years, with a relatively low standard deviation of 2.77, indicating that most of the patients were clustered closely around this mean age.

When categorized into age groups, 38.18% of the patients were in the 13–16 year range, 34.54% fell within the 17–20 year category, and the remaining 27.27% were aged 21 years or older. Regarding gender distribution, it was noted that 35.45% of the enrolled patients were male, amounting to 39 individuals, while the majority, comprising 64.54%, were female, totaling 71 patients, as shown in Table 1.

For the maxillary central incisor on the upper right side, the mean root length before treatment was 17.51mm, which decreased to 16.30mm after treatment. The difference, indicating root resorption, was 1.21mm, with a standard deviation of 3.431. Similarly, the maxillary lateral incisor on the upper right side showed a slight decrease from 15.85mm to 15.74mm in mean root length, resulting in a difference of 0.12mm with a standard deviation of 3.514. On the upper left side, the maxillary central incisor had a mean root length of 17.61mm before treatment, which reduced to 17.12mm after treatment, yielding a difference of 0.49mm with a standard deviation of 2.769. The maxillary lateral incisor on the upper left side exhibited a decrease in mean root length from 15.86mm to 15.21mm after treatment, leading to a difference of 0.56mm with a standard deviation of 2.378 as shown in table 2.

Table 1: Age and gender distribution of enrolled patients, n=110

Variables	Characterstics	No. of Patients
Age	Minimum	12.0
	Maximum	25.0
	Mean	18.67
	Std. Deviation	2.77
	Mean ± SD	18.67±2.77
	13-16 years	42(38.18%)
	17-20 years	38(34.54%)
	≥ 21 years	30(27.27%)
Gender	Male	39(35.45%)
	Female	71(64.54%)

Table 2: The difference in mean root lengths among maxillary incisors n=110

Tooth Type	Mean Root Length Before Treatment (T1)	Mean Root Length After Treatment (T2)	Difference (T1-T2)	Std. Deviation
Maxillary Central incisor on the upper right side	17.51mm	16.30 mm	1.21 mm	3. 431
Maxillary lateral incisor on the upper right side	15.85mm	15.74mm	0.12 mm	3.514
Maxillary central incisor on the upper left side.	17.61mm	17.12 mm	0.49 mm	2.769
Maxillary lateral incisor on the upper left side.	15.86mm	15.21 mm	0.56 mm	2.378

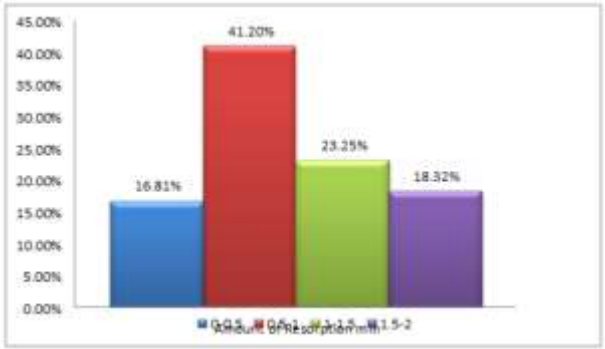

Figure 2: The proportion of patients experiencing the highest level of resorption in a single maxillary incisor within each 0.5-mm interval

DISCUSSION

External apical root resorption (EARR) is identified by the reduction or truncation of the root apex, and it is commonly linked to orthodontic therapy. Erosion of the root surface (EARR) is more likely to occur in some teeth, such as the mandibular and maxillary incisors, with a higher susceptibility observed in the maxillary lateral incisors. Previous studies have established a correlation between narrow root forms and resorption. Therefore, it is not surprising that the lateral incisors of the maxilla are more susceptible to resorption compared to other teeth following orthodontic treatment. [11]

The aim of this study was to evaluate the extent of external apical root resorption (EARR) in the maxillary central and lateral incisors in persons who have undergone fixed orthodontic treatment three months after the treatment. The objective was to determine whether root resorption shows an increase as

orthodontic treatment progresses. Research consistently shows that the average amount of tooth loss for the six front teeth of the upper jaw, the four incisors of the upper jaw, or both sets of incisors on either side of the upper jaw is typically less than 1.5 mm. [12,13]

In 2013, Fritz et al. conducted a study to analyse the comparative alterations in the length of roots in a total of 456 upper and lower incisors. According to their findings, the upper incisors showed a significant rise in average resorption rates, reaching up to 10%.13. Smale et al. did a study in 2015 that investigated root resorption in maxillary incisors. A total of 290 people were included in the study. Standardized periapical radiographs were taken before treatment (T1) and approximately 6.4 months after the placement of maxillary incisor braces (T2). The mean root resorption for the four incisors was 0.53 mm, while the mean for the most extensively damaged tooth per person was 1.18 mm. [14] In 2016, Armstrong et al. used panoramic radiographs from 114 individuals to assess the lengths of the maxillary and mandibular incisors before and after treatment. Their findings demonstrated a considerable reduction in the length of the lower incisors after treatment, which is consistent with the outcomes obtained in our study. [15,16,17]

Faridha et al. (2014) conducted a study that found that computerized assessment of apical resorption of roots (RR) revealed an average RR of 0.53±0.47 mm for all four incisors. The mean root resorption (RR) assessment for the incisors in the center was 0.48 ± 0.53 mm. [17,18]

This study only observed the extent of root resorption at a single time point, limiting its ability to capture the entire process of root resorption and its subsequent repair. As a result, it is recommended that a more comprehensive longitudinal study be conducted to track patients over time, providing a deeper understanding of the complete process of root resorption and the subsequent repair mechanisms.

CONCLUSION

Root resorption was observed in all maxillary incisors to varying degrees, with central incisors experiencing greater resorption compared to lateral incisors. The study revealed that root resorption can be detected in the initial phases of orthodontic therapy, even while the teeth are being aligned..

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