Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/js3xny98

COMPARATIVE ASSESSMENT OF RE-INFECTION & DEGREE OF RESORPTION IN ORTHODONTIC MOVEMENT OF ENDODONTICALLY TREATED TEETH WITHOUT PERIAPICAL INFECTION, WITH PERIAPICAL INFECTION & WITH ASEPTIC PULP NECROSIS BY DENTAL TRAUMA; A PRE-POST OBSERVATIONAL STUDY

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ABSTRACT

It is common practice to relocate teeth that have received endodontic treatment or are undergoing treatment. Facts on inflammation, tissue repair, tooth movement, resorption, pulp diseases, and periapical illness serve as the foundation for clinical decisions and biological orientations. Teeth that have had or are currently undergoing endodontic therapy often need to be moved. External apical root resorption is an iatrogenic side effect of orthodontic therapy, and orthodontics is arguably the only dental specialty that truly leverages the inflammatory process to address functional and aesthetic issues. The objective of this study was to examine the orthodontic movement of endodontically treated teeth with and without periapical lesions, aseptic pulp necrosis from dental trauma, teeth that were vital, and the degree of resorption in each of these cases. Periapical, cephalometric studies and OPG x-rays were used to assess 80 patients in this observational study prior to treatment and at 1-, 3-, 6-, 12 and 24-month intervals to check for re-infection and the extent of resorption in endodontically treated teeth undergoing orthodontic tooth movement. The findings demonstrated that teeth with aseptic pulp necrosis induced by dental trauma had a higher risk of periapical infection recurrence, followed by teeth with an inflammatory periapical lesion. The degree of resorption was also seen to be higher in cases of teeth impacted by dental trauma, with moderate dental trauma resulting in

increased root resorption. Vital teeth (control group) demonstrated reduced periapical infection and resorption.

Keywords: Endodontically Treated Teeth, Orthodontic Tooth Movement, Periapical Infection, Degree of Root Resorption.

INTRODUCTION

Until 1990, there was almost little movement of endodontically treated teeth during orthodontic treatment. It was widely assumed, but not methodologically validated, that these teeth would be more vulnerable to root resorption during orthodontic movement. Endodontically treated teeth were thought to be more susceptible to root resorption during orthodontic movement, but Spurrier et al.'s publication in the 1990s demonstrated that properly endodontically treated teeth would neither increase nor decrease the risk of root resorption if moved (1,2,3).

Orthodontic treatment for teeth with periapical lesions, only the periapex can develop periapical lesions; other lesions may emerge in this location but are not classed as true periapical disorders. The most common maxillary intrabody lesions are periapical diseases. Inflammatory periapical lesions or diseases are frequently associated with the microbiota in canals where the dental pulp is necrotic, or, in certain cases, with pulp aseptic necrosis caused by dental trauma (4,5).

Non-inflammatory periapical illnesses are uncommon but can occur.

1) Cemental dysplasia (periapical cemento-osseous dysplasia) is an osteofibrous abnormality affecting the periapical bone of lower incisors.

2) Benign cementoblastoma is an odontogenic neoplasm that primarily affects the periapex of lower first molars.

Periapical cemento-osseous dysplasia is a non-inflammatory periapical condition that can be treated with observation alone, while benign cementoblastoma necessitates surgical excision with a favorable prognosis (5,6). Because there isn't much apical resorption, endodontic therapy for acute inflammatory periapical conditions including acute pericementitis and dentoalveolar abscess may be highly successful. Because of their shorter lifespan and homogeneous root surface, endodontic therapy may make it more difficult for bacteria to stay in the root structure. In addition to being clinically disregarded and eventually discovered months or years later by coronary darkening or routine radiographic examinations, such as those conducted for orthodontic planning, aseptic pulp necrosis can also be treated immediately upon onset. If the aseptic necrosis is discovered too late, it may manifest as a tiny periapical granuloma or chronic apical pericementitis (7).

Although it can also happen without orthodontic therapy, external apical root resorption is an iatrogenic side effect of orthodontic treatment. Circumferential apical root resorption is defined as the complete resorption of apical hard tissue components as well as root shortening. Although rarely significant, it is a devastating event when detected radiographically. Root resorption causes root shortening and breaks the integrity of teeth arch and this is very important for successful orthodontic treatment. The only dental specialty that most likely use the inflammatory process to address both functional and aesthetic issues is orthodontics. It was especially challenging to determine the extent of root resorption in relation to essential teeth during orthodontic tooth movement (8).

This is explained by the fact that there are numerous and diverse reasons why endodontic therapy is necessary. In cases of infection or necrosis of the pulp and periodontal tissues, for instance, or in cases of various crown, root, or crown and root trauma—which may be single or numerous, complicated, horizontal or vertical—endodontic treatment may be necessary (9). In practically all situations, the endodontist must carefully determine if the endodontic therapy is sufficient for the teeth that are to be moved orthodontically and what happens to the tooth to be orthodontically moved and what does the prognosis look like? The current study's objective was to come up with a concept for new clinical research on the topic and the findings may give the most reliable evidence for clinical decisions to

reduce the risk and severity of re-infection and apical root resorption that would undoubtedly confirm the evidence.

METHODOLOGY

This observational study was carried out in various hospitals and clinics of Pakistan from 1st June 2022 – July 2024. After the ethical approval, this study included the 80 healthy patients with healthy vital teeth, teeth that were endodontically treated without periapical infection, with inflammatory periapical lesion and aseptic pulp necrosis by dental trauma requiring orthodontic movement. This inclusion criteria were fulfilled by critically evaluating the patients both clinically and radiographically. Periapical, lateral cephalometric studies and OPG Xray's were utilized. The male patients with the age ranging between 16 and 30 years were included in the study. Patients with systematic diseases, those who refused to consent were not included in the study. The patients who had primarily dentoalveolar malocclusion requiring the fixed appliances for orthodontic treatments for correction of class II and class III malocclusion were included in the study.

The 80 patients were divided into 4 groups i.e.; Group A, B, C were experimental groups and group D served as a control group to look for the re-infection and resorption following orthodontic movement.

Group (*n*)	
A (20)	Orthodontic movement in endodontically treated teeth without periapical lesion
B (20)	Orthodontic movement in endodontically treated teeth with inflammatory periapical lesion
C (20)	Orthodontic movement in endodontically treated teeth from aseptic pulp necrosis by dental trauma
D (20)	Orthodontic movement in healthy vital teeth

Orthodontic movement in endodontically treated teeth from aseptic pulp necrosis by dental trauma (group C) was further sub-classified according to severity of trauma i.e.; **Mild dental trauma;** such as concussion, discrete sub-luxation, **Moderate dental trauma;** more severe subluxation, luxation, displacement and extrusion without total avulsion of the tooth on the alveolus.

The degree of root resorption would be classified as; **A.** Irregular root contour **B.** Apical root resorption is less than 2mm **C.** Apical root resorption is from 2mm to 1/3 of initial root length **D.** Apical root resorption is more than 1/3 of the initial root length (10,11).

The patients were called at the recall periods of 1-3 months, 3- 6 months, 6-12 months and 12- 24 months. These 4 groups were monitored for a period of 24 months and any changes in the status of teeth undergoing orthodontic movement were monitored clinically and radiographically.

Statistical Analysis

Statistical package for Social Sciences (SPSS) Version 21 (IBM, Anmork, NY, USA) was used to compile and analyze data. Normality of quantitative variables was assessed using Shapiro-wilk's test of normality. Since the data followed the normal distribution, One-Way repeated measure ANOVA was applied for comparison of pre- versus post comparisons of re-infection, resorption after intervention, after 1-3 months, after 3-6 month, after 6-12 months and 12-24 months, for the mean comparison of 3 groups of orthodontically moving teeth that had undergone endodontic treatment and a control group. $P \leq 0.05$ was considered as significant.

RESULTS

Table 1: Reoccurrence of Periapical Infection

RE-OCCURANCE OF PERIAPICAL INFECTION	1-3 MONTHS	3-6 MONTHS	6-12 MONTHS	12-24 MONTHS
GROUP A	02 (10%)	01 (5%)	06 (30%)	07 (35%)
GROUP B	03 (15%)	03 (15%)	07 (35%)	08 (40%)
GROUP C	05 (25%)	08 (40%)	16 (80%)	20 (100%)
GROUP D	02 (10%)	03 (15%)	05 (25%)	06 (30%)

Table 2: Degree of Resorption

RESORPTION	1-3 MONTHS	3-6 MONTHS	6-12 MONTHS	12-24 MONTHS	P value
GROUP A	Degree 1 (5%)	Degree 1 (18%)	Degree 1/ Degree 2 (36%)	Degree 2 (32%)	0.509
GROUP B	Degree 1 (10%)	Degree 1/ Degree 2 (24%)	Degree 1/ Degree 2 (32%)	Degree 2 (34%)	0.824
GROUP C	Degree 1 (20%)	Degree 1/ Degree 2 (26%)	Degree 2 (44%)	Degree 3 (57%)	0.109
GROUP D	Degree 1 (5%)	Degree 1 (12%)	Degree 1 (26%)	Degree 2 (32%)	0.461

DISCUSSION

In modern clinical practice, orthodontic treatment of endodontically treated teeth is frequently required. On the one hand, the higher incidence of dental injury in preschoolers or teenagers is the reason for the greater orthodontic treatment of teeth that have had endodontic therapy. While the percentage of children with dental trauma in an orthodontic patient population was 10.8%, the "Children's Dental Health Survey," conducted in England in 2003, found that 5% of children had permanent incisor trauma at age 8 and 11% at age 12 (12).

Conversely, the growing number of adult patients seeking orthodontic treatment to restore their occlusal issues is the reason for the rise in orthodontic treatment of endodontically treated teeth (13). Epidemiological studies show that endodontic procedures are more common in adult patients (14). The growing number of orthodontic procedures performed on endodontically treated teeth has made pertinent information essential to achieving the greatest long-term outcome for patients of all ages.

Up until 1990, there was essentially little movement of endodontically treated teeth across several decades. Although it was not methodologically supported, there was a general agreement that these teeth would be more susceptible to root resorption during orthodontic movement. After Spurrier et al.'s publication in the 1990s, it became clear that correctly endodontically treated teeth would neither raise nor decrease the risk of root resorption if they were relocated orthodontically (1).

The present study evaluated the orthodontic movement of endodontically treated teeth without periapical infection, the reoccurrence of periapical infection was noted in 2 cases at the interval of 1-3 months and 1 case in 3-6 months, the percentage of periapical reinfection went higher (30%) between time interval of 6-12 months and 35% between 12-24 months, respectively. The possible cause of this reinfection could be the force applied during orthodontic movement of the teeth due to reactivation of previous periapical lesions- the apical resorptions due to applied forces, a common and

acceptable event from the clinical point of view may open canaculi, accessory canals of apical deltas or tubules.

There were little to no signs of resorption radiographically during the first 3 months of orthodontic movement of teeth, however, Degree 1 resorption was noted in 18% cases in 3-6 months, 36% in 6-12 months and 32% in 12-24 months. The degree of resorption also increased from 3-24 months from grade 1-2. The little to no signs of resorption in first 3 months does not mean that no resorption would have taken place because it is not possible to move orthodontically treated teeth without resorption although such minor resorptions could be seen microscopically. According to a study by Brezniak et al., radiographic detection of earlier root resorption occurs after orthodontic therapy. A significant risk of additional root resorption is indicated by minor root resorption or an uneven root contour found 6–9 months after the start of orthodontic therapy. There won't be any serious root resorption at the end of orthodontic therapy if it doesn't happen after six to nine months (15).

In an animal study evaluating the effects of orthodontic movement of endodontically treated teeth, it was determined that resorption in these teeth is higher than that observed in vital teeth, increases with treatment duration, and may be due to periapical inflammation rather than orthodontic forces (16,17). A further experimental study in upper mammals revealed that endodontically treated teeth had more cementum loss than live teeth, both radiographically and histologically (18). This research also supports the findings of present study mentioned in Table 1 & Table 2 in which vital teeth (control group) showed less resorption and less chances of periapical reinfection compared to the experimental groups.

Additionally, the current study assessed the orthodontic movement in endodontically treated teeth with inflammatory periapical lesions. The findings showed that 15% of cases experienced periapical reinfection between 1-3 and 3-6 months, while 35% and 40% of cases experienced periapical reinfection between 6-12 and 24 months, respectively. In these set of cases, the endodontic therapy's inherent limits were found to be the cause of the re-infection or treatment failure rather than the orthodontic movement of the tooth. Because the apical and periapical region is filled with soft tissue from the old periapical granuloma or from the granulation tissue of the ongoing repair, the application of orthodontic forces in chronic periapical lesions of teeth that have been properly endodontically treated would not interfere with the microbiota or the repair, according to multiple studies in the literature that support the current study's findings (19). Another study found that the vessels cannot be compressed by applying forces in this area since the walls are not firm and are only 0.25 mm from the periodontal space. Reconstruction actually involves a lot of soft tissue. When a soft tissue is repaired in a location that was previously occupied by a chronic periapical lesion, the force required to compress a delicate structure like the periodontal ligament will not affect the soft tissue in a broader area (20).

According to group B's results in the current study, 10% of teeth showed evidence of degree 1 resorption during the first three months of orthodontic movement; however, 24% of instances showed degree 1/degree 2 resorption over the first three to six months, 32% during the sixth to twelve months, and 34% during the twelve to twenty-four months. The incidence of irregular areas caused by apical resorptions was found to be high and to have risen with time in cases of chronic periapical infection. These conclusions are supported by a number of studies in the literature, including one by Andreasen JO et al. found that the apical abnormalities brought on by a protracted periapical infection—possible persistence of microbial biofilms—were the source of the high resorption degree. In addition to the presence of apical deltas, the material used, and numerous other factors that influence the outcome, failures in the hermetic closure of the apical opening caused by inherent anatomical imperfections can also be justified (21). The current study's findings demonstrated that the degree of root resorption increased over time in comparison to groups A and B.

In group C, endodontically treated teeth with aseptic pulp necrosis following dental trauma, with or without periapical lesions, showed the same behavior when moved orthodontically as teeth endodontically treated for pulp necrosis with infected canals. However, table 2 shows that this study

adhered to the principle that any previously traumatized tooth that has been moved may exhibit earlier and more severe root resorptions by the end of orthodontic treatment and with the increased length of time [3 months (26%-Degree 1), 6-12 months (44% Degree 2), 12-14 months (57% Degree 3). The results of a prior study that found that cells of osteoblastic lineage with receptors for bone turnover mediators have a higher likelihood of repairing the cementoblastic layer after dental trauma, both focally and eventually, explain the findings of this investigation. The cementoblastic layer lesions in dental trauma are more extensive than those brought on by orthodontic treatment. The compression of orthodontic forces causes periodontal bone resorption as expected, even though the cells behave morphologically and physiologically like cementoblasts or cementoblast-like cells and accumulate the usual mediators on the ligament. However, it also causes root resorption, which is normally protected by true cementoblast cells that lack receptors for these mediators. This is because, following a few hours of force application, the cementoblast-like cells, which are actually osteoblasts, quickly assume control of the bone remodeling units and resorb the root (22,23). The results of this study also revealed that cases with mild trauma showed less resorption compared to those with moderate trauma over the time.

CONCLUSION

The endodontist and orthodontist opinion must be sought before initiating the orthodontic teeth movement which had or are undergoing endodontic therapy.

Radiographic monitoring is necessary for patients with significant orthodontically induced root resorption at 3- to 6-month intervals throughout treatment. A 3-month radiographic follow-up is advised for patients who have an increased risk of resorption and a fostered likelihood of re-infection. Future studies on genetic and molecular biological pathways are necessary for the prevention and early detection of root resorption. Orthodontic information and patient education prior to patient's consent to undergo treatment is important as it may be subject to significant variation and unpredictability in resorption.

Data Availability

The corresponding author can provide the data used to support the study's findings upon request.

Conflicts of Interest

The authors declare no conflict of interest.

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