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Root Resorption Associated With Orthodontic Tooth Movement

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Abstract: *External apical root resorption is one of the most common iatrogenic sequelae of orthodontic treatment. It is destruction of the cementum or dentin by cementoclastic or osteoclastic activity; it may result in the shortening or blunting of the root. However orthodontically induced root resorption is multifactorial in nature. The current studies have focused on the factors that may cause or affect root resorption occurring during orthodontic treatment and possible means for limiting apical root resorption. This review aims to highlight the main coordinates of risk issues of root resorption in orthodontics.Treatment and patient factors that have traditionally been investigated are discussed, along with the results of current research in this area.*
Key words: *Root resorption, EARR, OIIRR.*

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I. Introduction

The goal of orthodontic treatment is to improve the patient's life by enhancing dental and jaw function as well as dentofacial esthetics. However, like any other treatment modality, orthodontic treatment, in addition to its benefits, has also been associated with some risks and complications. Apical root resorption is one such undesirable effect that leads to permanent loss of dental structure.

Root resorption is defined as the destruction of the cementum or dentin by cementoclastic or osteoclastic activity; it may result in the shortening or blunting of the root.[1] It is an inflammatory process resulting in an ischemic necrosis in the periodontal ligament when the orthodontic force is applied. Root resorption occurs when the pressure on the cementum exceeds its reparative capacity and dentin is exposed, allowing the multinucleated odontoclasts to degrade the root substance.[1]

The etiologic factors are complex and multifactorial, but it appears that apical root resorption results from a combination of individual biologic variability, genetic predisposition, and the effect of mechanical factors. Root resorption is undesirable because it can affect the long-term viability of the dentition, and reports in the literature indicate that patients undergoing orthodontic treatment are more likely to have severe apical root shortening. By using graded scales, orthodontically induced root resoprtion is usually classified as minor or moderate in most orthodontic patients.[2]Severe resorption, defined as exceeding 4 mm, or a third of the original root length, is seen in 1% to 5% of teeth.[3]

This review aims to highlight the main coordinates of risk issues of root resorption in orthodontics.

A. Patient factors

Individual susceptibility is considered a major factor in determining root resorption potential with or without orthodontic treatment.[4]

1. Genetic predisposition

Genetic factors account for at least 50% of the variation in external apical root resorption.IL-6 SNP rs1800796 GC is a risk factor for external apical root resorption.[5] Variation in the Interleukin 1 beta gene in orthodontically treated individuals accounts for 15% of the variation in external apical root resorption.[6]

2. Age

Periodontal membrane becomes narrower and less vascularized, aplastic, alveolar bone becomes denser, less vascularized and aplastic, and cementum becomes wider with age. Through these changes adults show higher susceptibility to root resorption[7]. When a patient is older than 11 years, risk for root resorption increases.

3. Previous history of root resorption

There is a high correlation between the two. It has been reported that in such cases incidence of root resorption increased from 4% to 77% after treatment.[7]

4. Tooth-root morphology

Regardless of genetic or treatment-related factors, the maxillary incisors consistently average more apical root resorption than any other teeth, followed by the mandibular incisors and first molars. Short roots, blunt roots, apically bent roots and pipette shape roots are the most susceptible root form for root resorption.[7]

5. Alveolar bone density

Reitan found that a strong continuous force on less dense alveolar bone causes the same root resorption as a mild continuous force on highly dense alveolar bone. It has also been suggested the amount of root resorption occurring during orthodontic treatment increases with the increase in the density of the bone and vice versa.[8]

6. ***Bone thickness***

According to Handelman,[8] the dimension of the alveolus (UA + UP) seems to set limits to orthodontic treatment and challenge these limits can accelerate iatrogenic fenestrations and root resorption. Horiuchi, Hotokezaka and Kobayashi[9] observed that the proximity of the apex to the palatal cortex also influences the resorption.

7. Previous history of trauma

Dental trauma may cause root resorption to the teeth without orthodontic treatment. Orthodontically moved traumatized teeth with previous root resorption are more sensitive to further loss of root material[4]. The teeth can be treated orthodontically three months after the tooth transplantation or replantation. According to the research data, a completely assimilated transplanted tooth reacts to orthodontic force as a normal tooth.[10]

B. Treatment Factors

1. Discontinuous vs continuous force

Acar et al[11]compared a 100-g force with elastics in either an interrupted (12 hours per day) or a continuous (24 hours per day) application. Continuous force produced significantly more root resorption than discontinuous force application.

2. Removable thermoplastic appliance vs fixed light and heavy force

Barbagallo et al[12]compared forces applied with clear removable thermoplastic appliances (TA) and fixed appliances. The results showed that teeth experiencing orthodontic movement had significantly more root resorption than did the control teeth with no force. Heavy force (225 g) produced significantly more resorption (9 times greater than the control) than light force (25 g) (5 times greater than the control) or thermoplastic appliances (TA) force (6 times greater than the control) application. It was concluded that light force and TA force result in same amount of root resorption.

3. Light vs heavy continuous forces

Studies have reported that heavy forces produced significantly more root resorption than light forces or controls.[13, 14] Chan and Darendeliler[13]found that the mean volume of the resorption craters was 11.59 times greater in the heavy-force group than in the control group (significant). Heavy forces in both compression and tension areas produced significantly more root resorption than in regions under light compression and light tension forces.

4. Intrusive vs extrusive force

Han et al[14]found that root resorption from extrusive force was not significantly different from the control group. Intrusive force significantly increased the percentage of resorbed root area (4 fold). Harris et al[15]found that the volume of craters after intrusion was directly proportional to the magnitude of the intrusive force.

5. Archwire sequence

Mandall et al[16]compared 3 orthodontic archwire sequences in terms of patient discomfort, root resorption, and time to working archwire and found that there was no statistically significant difference between archwire sequences, for the amount of root resorption in different groups.

6. Effect of a treatment pause in patients experiencing Orthodontically Induced Root Resorption

Levander et al[17]investigated the effect of a pause of 2-3 months in active treatment on teeth that had experienced apical root resorption during the initial 6-month period with fixed appliances. The results of the study showed that the amount of root resorption was significantly less in patients treated with a pause (0.4 - 0.7 mm) than in those treated with continuous forces without a pause (1.5 - 0.8 mm).

7. Straight wire vs standard edgewise

Reukers et al[18]compared the prevalence and severity of root resorption after treatment with a fully programmed edgewise appliance (FPA) and a partly programmed edgewise appliance (PPA). All FPA patients were treated with 0.022-in slot Roth prescription and misplaced brackets were rebonded. All PPA patients were treated with 0.018-in slot Microloc brackets (GAC, Central Islip, NY), and the archwires were adjusted for misplaced brackets. Results showed no statistically significant differences in the amount of tooth root loss between the groups.

8. Two-phase vs 1-phase Class II treatment

Brin et al[19]examined the effect of 2-phase vs 1-phase Class II treatment on the incidence and severity of root resorption. The results showed that children treated in 2 phases with a bionator followed by fixed appliances had the fewest incisors with moderate to severe orthodontically induced root resorption, whereas children treated in 1 phase with fixed appliances had the most resorption. However, the difference was not statistically significant. As treatment time increased, the odds of root resoprtion also increased.

9. ***Overjet and Overbite***

There is a consensus in considering the overjet as a risk factor for resorption, because the correction requires the retraction of anterior teeth, and the greater the magnitude of this malocclusion, the greater the amount of movement, increasing the risk and severity of resorption.[7, 10] Freitas et al[20]observed a great degree of resorption for correction of great amount of overjet.

10. Extraction Vs Non-extraction

Root resorption develops more often after extraction of four first premolars if compared to the patients with non-extracted teeth or with extracted of just maxillary first premolars[21].

11. ANB and WITS

In a study by Harris, Kineret and Tolley, these two variables (ANB and Wits) were evaluated and it was observed that both have strong relationship with the occurrence of resorption, as higher maxillomandibular discrepancies tend to require greater retraction of anterior teeth and therefore enhance the risk of resorption.[22]

12. Self-ligating vs conventional orthodontic bracket systems

Studies carried out by Scott et al[23], Leite et al[24], Liu et al[25] compared the amount of root resorption when orthodontic treatment was done using self-ligating brackets and conventional brackets. They concluded that although root resorption occurred in both the groups, the bracket design (self-ligating or conventional) did not demonstrate any influence on the results observed.

II. Conclusion

Thus, orthodontic treatment-related risk factors include treatment duration, magnitude of applied force, direction of tooth movement,amount of apical displacement,and method of force application (continuous vs intermittent, type of appliance and treatment technique. Individual susceptibility is considered a major factor in determining root resorption potential with or without orthodontic treatment.Patient-related risk factors include: previous history of root resorption; tooth-root morphology, length, and roots with developmental abnormalities; genetic influences; systemic factorsincluding drugs (nabumetone),hormone deficiency, hypothyroidism, hypopituitarism; asthma; root proximity to cortical bone; alveolar bone density; chronic alcoholism; previous trauma; endodontic treatment; severity and type of malocclusion; sex and patient age.

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