# REVIEW ON EXTERNAL APICAL ROOT RESORPTION ASSOCIATED WITH ORTHODONTIC TOOTH MOVEMENT

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**Abstract**

External apical root resorption (EARR) is a known, undesirable effect associated with orthodontic tooth movement. Many factors have been investigated to explain differences seen among individuals in their susceptibility to EARR. However, orthodontists are unaware of the exact cause of resorption and measures to prevent its occurrence during treatment have yet to be elucidated. Based on orthodontic practice and experimental tooth movement studies using continuous force, it has been reported that root resorption is related to age, gender, nutrition, genetics, extraction or non-extraction, force magnitude, duration of treatment, direction of tooth movement and treatment techniques such as Begg, while no significant association was found between duration of treatment and degree or amount of root resorption. Generally, the causes and mechanism of resorption are still unclear. The purpose of this article was to review factors related to root resorption and its prevention during orthodontic treatment.

**Keywords:** Root resorption, Orthodontic tooth movement, Force, Orthodontic treatment.

## Introduction

Orthodontics tooth movement is the most common cause of EARR (External apical root resorption) that results in root apex of tooth completely deficited. It is seen on routine dental radiographs as permanent shortening of end of the tooth root. A number of treatment related factors have been implemented in the pathogenesis of root resorption. One factor that causes external root resorption is orthodontic load during tooth movement[1]. It may be present in any tooth but most commonly seen in maxillary incisors.

Factors other than orthodontic treatment can also lead to EARR. 1-3 mm external apical root resorption seen in 7% to 13% of individuals who have not had orthodontic treatment

## Diagnosis

1. Conventional radiographs: panoramic and periapical views
2. 3-D Cone Beam Computed Tomography

## Classification

### Root Resorption

1. Physiologic
2. Pathologic
   - Internal
   - External - Orthodontic tooth movement
   - Trauma Induced
   - Pressure from adjacent unerupted teeth
   - Inflammatory Root resorption

## Etiological Factors

Root resorption may occur as a result of

- Dental trauma / surgical procedures / Infections
- Orthodontic treatment
- Pressure from tumors / cysts
- Irritation from chemicals (eg. $H_2O_2$ during bleaching)

## Pulpal infection root resorption

The most common stimulation factor for root resorption is pulpal infection.

Following injury to the precementum or predentin, infected dentinal tubules may stimulate the inflammatory process with osteoclastic activity in the periradicular tissues or in pulpal tissues, consequently initiating external or internal root resorption.

## Periodontal infection and root resorption

Infrequently, external root resorption may occur after injury to the pre-cementum, apical to the epithelial attachment, followed by bacterial stimulation originating from the periodontal sulcus.

Injury may be caused by dental trauma, and chemical irritation may be caused by bleaching agents, eg hydrogen peroxide 30 %, orthodontic or periondontal procedures.

Bacteria from the periodontal sulcus may penetrate patent dentinal tubules, coronal to the epithelial attachment, and exit apical to the epithelial attachment without penetrating the pulpal space. Consequently, the damaged area of the root surface is colonized by hard tissue resorbing cells, which penetrate into dentin through a small denuded area causing the resorption inside the root to spread.

At first stage, the resorptive process does not penetrate the pulp space because of the protective layer of predentin, but rather spreads around the root in an irregular fashion. With time, the process may penetrate into the roo t canal. Additionally, periodontal infection

resorption will include the alveolar bone adjacent to the resorption lacuana in the tooth. If the resorptive process reaches a supragingival area of the crown, the vascularized granulation tissue of the resorption lacuna may be visible through the enamel showing a pink discoloration at the crown.
Radiographically, periodontal infection resorption can be seen as a single resorption lacuna in the dentin usually at the crestal bone level, expanding to the coronal and apical direction. With progression of the process, radiolucency may be observed at the alveolar bone adjacent to the resorption lacuna of the dentin.

**Orthodontic pressure and root resorption**
The injury originating in the orthodontic root resorption is from the pressure applied to the roots during tooth movement. Continuous pressure stimulates the resorbing cells in the apical third of the roots, a possibility of significant shortening of the root.
Teeth are asymptomatic and the pulp is usually vital unless the pressure of the operative procedure is high, which disturbs the apical blood supply. Radiographically, orthodontic pressure resorption is located in the apical third of the root and no signs of radiolucency can be observed in the bone of the root.

**Impacted tooth / tumor pressure and root resorption**
Pressure root resorption can be observed during the eruption of the permanent dentition, especially of maxillary canines (affecting lateral incisors) and mandibular third molars ( affecting mandibular second molars). Tumors and osteosclerosis impingning on the root of the tooth could also be an etiological factor for pressure resorption, which includes both the injury and the stimulation phases. Stimulation is related to the pathological process that activates the resorptive cells, tumors that produce root resorption are most frequently those in which growth and expansion are not rapid such as cysts, ameloblastomas, giant cell tumors, and fiber-osseoseous lesions.
This type of root resorption is asymptomatic with vital pulp through –out the process unless the impacted tooth or tumor is located near the apical foramen, disturbing the blood supply to the pulp. Radiographically, the resorption area is located adjacent to the stimulation factor, the impacted tooth or the tumor. There are no radiolucent areas as no infection is involved in the process.

**Ankylotic root resorption**
In severe traumatic injuries (intrusive luxation or avulsion with extended dry time), injury to the root surface may be so large that the healing with cementum is not possible, and the one may come into contact with the root surface without an intermediate attachment apparatus. This phenomena is termed dentoalveolar ankylosis.
The process may be reversed if less than 20% of the root surface is involved. Because there is no stimulation factor and the process proceeds as a result of the direct bone attachment to dentin, the term ‘ankylotic resorption’ is adequate.
Brezniak and Wasserstein[2,3], discussed extensive review of root resorption following orthodontic treatment.
A number of factors that increased levels of EARR for example, Biological, Mechanical or combined factors.
EARR also occur from risk factor, it may occur from patient-related and treatment-related problems. [4,5]

***Patient-related***
- Genetics
- Systemic and allergies diseases
- Extent of malocclusion
- Tooth-root morphology
- Alveolar bone density
- Age and sex.

***Orthodontic treatment***
- Duration of treatment
- Direction or duration of tooth movement
- Apical displacement
- Method or magnitude of force application.

Owman - Moll & Kurol[6] discussed some local and systemic factors which might be associated with the risk of root resorption during orthodontic treatment: Root morphology, Endodontically treated teeth, Gingivitis, periodontal disease, Medical compromised patient (Allergies, asthma, arthritis, hypothyroidism and diabetes, Phosphorous, calcium metabolic alteration) Nail and lip biting ,tongue posture.

**Biomechanical Aspect of EARR**
Tooth movement is occurring by orthodontics force-induced initially in periodontal ligament and alveolar bone. bone resorption occur by osteoclast activity on pressure side that cause periodontal ligament necrosed (cell-free hyaline zone) and bone apposition by osteoblasts on the tension side. Which is clearly seen histologicaly The Activity of cytokines also affect resorption process of dental hard tissues .[7]
Rygh and co-workers have shown that cementum adjacent to hyalinized (necrotic) areas of the PDL is "marked" by this contact and that clast cells attack this marked cementum when the PDL area is repaired. This observation helps explain why heavy continuous orthodontic force can lead to severe root resorption. Even with the most careful control of orthodontic force, however, it is difficult to avoid creating some hyalinized areas in the PDL. It is not surprising; therefore, that careful examination of the root surfaces of teeth that have been moved reveals repaired areas of resorption of both cementum and dentin of the root. It appears that cementum (and dentin, if resorption penetrates through the cementum) is removed from the root surface; cementum is restored in the same way that alveolar bone is removed and then replaced.

**Severity of EARR**

Depend on surface

1. In Cemental- In this process, only the outer cemental layers are resorbed, and they are later fully regenerated or remodeled. This process resembles trabecular bone remodelling
2. In Dentinal resorption - In this process, the cementum and the outer layers of the dentin are resorbed and usually repaired with cementum material. The final shape of the root after this resorption and formation process may or may not be identical to the original form.
3. In Circumferential apical root resorption.- In this process, full resorption of the hard tissue components of the root apex occurs, and root shortening is evident. Different degrees of apical root shortening are, of course, possible.

When the root loses apical material beneath the cementum, no regeneration is possible.

External surface repair usually occurs in the cemental layer. Over time, sharp edges may be gradually leveled. Ankylosis is not a common sequel of orthodontically induced root resorption.[8]

**Extent of Root Resorption on Radiographs**

According to Sharpe et al [9] it divied in to four categories:

0= no apical root resorption

1= mild blunting of root apex resorption

2= 1/4 root length resorption occur

3= beyond 1/4 of root resorption occur of it total length of root.

**Influence of Orthodontic Force on Root Resorption**

Jarabak and Fizzell analyzed effect of the force system applied during mechanotherapy who concluded that the magnitude of force, as well as rigid fixation of the arch-wire with brackets or the use of full-size rectangular wires in bracket slots, could be the most important factors predisposing a tooth to the resorptive process.[10-12]

Regarding root resorption among different malocclusions based on Angle's classification, two studies[13,14] reported no significant difference. But Taner et al [15] observed a statistically significant difference between Class I and Class II Division 1 malocclusions, with the latter exhibiting more resorption.

Jan-son et al[16] reported a higher resorption potential for Class II Division 2 cases in comparison with Class I, Class II Division 1, and Class III patients. The rationale was that the intrusion mechanics necessary to correct deep overbite in these cases, as well as the excessive labial torque needed to correct the palatal inclination of the incisors, were the cause. It can be inferred from the published literature that all types of malocclusion are prone to root resorption when exposed to orthodontic treatment.[17-20] (Table 1)

| Factor | Author | Result |
|---|---|---|
| Discontinuous vs continuous force | Acar et al (1999) | Significantly more RR was seen in teeth experiencing orthodontic tooth movement than control group. |
| Removable thermoplastic appliance vs fixed light and heavy force | Barbagallo et al (2008) | significantly more RR was seen in teeth experiencing orthodontic tooth movement than control group. |
| Light vs heavy continuous forces | Han et al (2005) | When extrusive force was applied no significantly difference in resorption was seen whereas 4 fold increase in root resorption with intrusive force. |
| Straight wire vs standard edgewise | Reukers et al (1998) | The amount of tooth root loss or prevalence of RR between the groups was not statistically significant. |
| Archwire sequence | Mandall et al (2006) | Difference between the proportion of patients with and without RR between archwire sequence groups was not statistically significant. |
| Trauma vs no trauma | Mandall et al (2006) | No evidence of incisor trauma and RR. |
| Two-phase vs one-phase Class II treatment | Brin et al (2003) | The difference was not statistically significant. As treatment time increased, the odds of OIIRR also increased. |
| Self-ligating vs conventional orthodontic bracket Systems | Scott et al (2008) | When mandibular root resorption evaluated there was not significant different between systems. |
| Different orthodontic forces | Harris et al (2006); Barbagallo et al (2008) | Significantly more root resorption with heavy forces. |

*Table1: Influence of orthodontic force on root resorption as given by different authors*

**Long- term outcomes of EARR**

More resorption was seen in maxillary incisors than rest of dentition.[21] In a recent study Johnson observed moderate, severe and severe root resorption. 5 to15years follow up was done following orthodontic treatment for quantitative assessment of tooth mobility. The results shown that there was increased mobility with respect to teeth with extremely resorbed roots (Root length < 1mm). With longer root length mobility was minimal and insignificant. Results suggest that resorption process does not progress following termination of the treatment.[22]

**Prevention and Management Strategies**

1. Collecting good medical history focusing on allergic predisposition
2. Family history of root resorption should be evaluated
3. Genetic susceptibility should be checked

4. Application of light forces
5. Routine periapical radiographs to assess early development of root resorption
6. Fixed appliances for retention should be carefully designed
7. Proper oral hygiene instruction should be given to prevent periodontitis
8. In case of extreme resorption endodontic treatment may be considered.

**Conclusion**

EARR is one of the most undesirable complications found in patients after orthodontic treatment. It results in permanent loss of tooth structure from root apex. However, it can be avoided with more accurate diagnosis, treatment planning and proper management of orthodontic patients.

**Refrences**


1. Brudvik P, Rygh P. Root resorption beneath the main hyalinized zone. Eur J Orthod. 1994;16:249–63.
2. Brezniak N, Wasserstein A. Root resorption after orthodontic treatment: Part 1. Literature review. Am J Orthod Dentofacial Orthop. 1993;103:62–6.
3. Brezniak N, Wasserstein A. Root resorption after orthodontic treatment: Part 2. Literature review. Am J Orthod Dentofacial Orthop. 1993;103:138–46.
4. Shaza K. Abass and James K. Hartsfield, Jr Orthodontics and External Apical Root Resorption. Semin Orthod 2007;13: 246-56.
5. Weltman B, Vig K, Fields H, Shanker S and Kaizare E. Root resorption associated with orthodontic tooth movement: A systematic review. Am J Orthod Dentofacial Orthop 2010;137:462-76.
6. Owman-Moll P, Kurol J. Root resorption after orthodontic treatment in high- and low-risk patients: analysis of allergy as a possible predisposing factor. Eur J Orthod. 2000 Dec;22(6):657-63.
7. Abuabara A. Biomedical aspect of External Root Resorption in Orthodontic Therapy. Med Oral Patol Oral Cir Bucal.2007; 22(8):610-3.
8. Brezniak N, Wasserstein A. Orthodontically induced Inflammatory Root resorption. Part I: The Basic Science Aspects. Angle Orthod 2002; 72: 175- 9.
9. Sharpe W, Ree B, Subtelny J. Orthodontic relapse, apical root resorption and crest alveolar bone levels. Am J Orthod. 1987. 91: 252-58.
10. Harris DA, Jones AS, Darendeliler MA. Physical properties of root cementum: part8. Volumetric analysis craters after application of controlled intrusive light and heavy orthodontic forces: a microcomputed tomographic scan study. Am J Ortod Dentofacial Orthop 2006; 130:639-647.
11. Barbagallo LJ, Jones AS, Petocz P, Darendeliler MA. Physical properties of root cementum: part 10. Comparison of the effects of invisible removable thermoplastic appliances with light and heavy orthodontic forces on premolar cementum. Amicrocomputed-tomography study. Am J Ortod Dentofacial Orthop 2008; 133:218-227.
12. Jarabak JR, Fizzell JA. Technique and Treat ment with Light-Wire Edgewise Appliances (ed 2). St Louis: Mosby, 1972
13. Baumrind S, Korn EL, Boyd RL. Apical root resorption in orthodontically treated adults. Am J Orthod Dentofacial Orthop 1996:110: 311-320.
14. Horiuchi A, Hotokezaka H, Kobayashi K. Corre lation between cortical plate proximity and api cal root resorption. Am J Orthod Dentofacial Orthop 1998:114:311-318.
15. Taner T, Ciger S, Sencift Y. Evaluation of apical root resorption following extraction therapy in subjects with class I and class II malocclu- sions. Eur J Orthod 1999:21:491-496.
16. Janson GRP, DeLuca Canto GDL, Martins DR, Henriques JF, De Freitas MR. A radiographic comparison of apical root resorption after orthodontic treatment with 3 different fixed appliance techniques: Am J Orthod Dentofacial Orthop 2000:118:262-273.
17. Brezniak N, Wasserstein A. Orthodontically induced inflammatory root resorption—Part II— The clinical aspects. Angle Orthod 2002;72: 180-184.
18. Taitongchai R, Sookorn K, Killany DM. Facial and dentoalveolar structures and the predic tion of apical root shortening. Am J Orthod Dentofacial Orthop 1996:110:296-302.
19. Beck BW, Harris EF. Apical root resorption in orthodontically treated subjects-Analysis of edgewise and lightwire mechanics. Am J Orthod Dentofacial Orthop 1994:105:350-361.
20. Sameshima GT, Sinclair PM. Predicting and pre venting root resorption—Part II—Treatment factors. Am J Orthod Dentofacial Orthop 2001;119: 511-515.
21. Remongton DN, Joondelph DR, Artun J, Reidel RA, Chapko MK. Long-term evaluation of root resorption occurring during orthodontic treatment. Am J Ortod Dentofacial Orthop. 1989; 96:43-46.
22. Jonsson A, Malmgen O, Levander E. long-term follow-up of tooth mobility in maxillary incisors with orthodontically induced apical root resorption. Eur J Orthod 2007; 29: 482-487.



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