

Root Resorption in Orthodontics – A Review

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Abstract

One of the most common complications and almost universal finding following orthodontic treatment is External Apical Root Resorption (EARR) or Orthodontically Induced Inflammatory Root Resorption(OIIRR), which usually not clinically significant and but may be devastating to both patient and operator when severe. Hence, this article deals with etiopathogenesis, factors responsible, effects, prevention and treatment options for EARR or OIIRR.

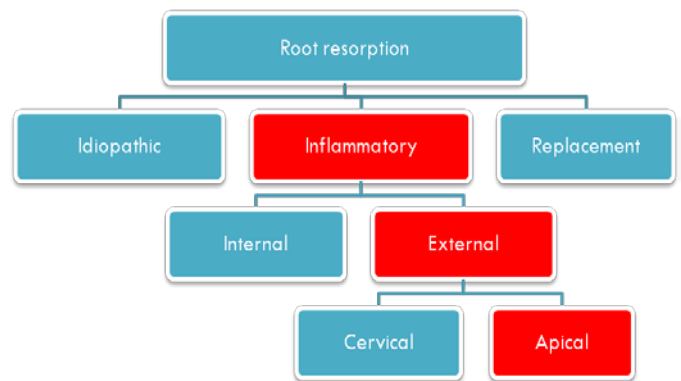
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Introduction

One of the most common complications associated with orthodontic treatment is the phenomenon known as external apical root resorption. External apical root resorption is an almost universal finding following orthodontic treatment, but this is usually not clinically significant and has no influence on long-term health of the teeth. Its occurrence may be of little significance when mild but may be devastating to both patient and operator when severe^[1].

Discussion

Classification of Root Resorption^[2]



Hence of all Orthodontically induced root resorption is inflammatory which is called as Orthodontically Induced Inflammatory Root Resorption (OIIRR) and exhibits as External Apical Root Resorption (EARR).

Etiopathogenesis of Orthodontic Root Resorption^[3]

Initial application of force, even with the most careful control of orthodontic force. however, it is difficult to avoid creating some hyalinized areas in the PDL.Compression in limited areas of the membrane frequently impedes vascular circulation and cell differentiation, causing degradation of the cells and vascular structures rather than proliferation and differentiation. The tissue reveals a glasslike appearance in light microscopy, which is termed hyalinization. For

further tooth movement hyalinized zone is to be removed. Macrophages followed by multinucleated odontoclast cells are activated by biochemical signals derived from the sterile necrotic tissue. A side effect during the removal of the necrotic hyalinized tissue is that the cementoid layer of the root is also removed. Raw unprotected cemental surfaces can readily be attacked by odontoclastic resorptive cells. As force decreases to biologic level or removed root surface is remodeled.

Profitt simply explains that cementum adjacent to hyalinized (necrotic) areas of the PDL is marked by this contact and that odontoclast cells attack this marked cementum when the PDL area is repaired.

Why apical root Resorption?

1. Majority of orthodontic movements are not translatory but tipping in nature, therefore, apical part of root more prone to hyalinization, so root resorption occurs mostly at the apical part of the tooth root.
2. Isolation of apex from the tooth as any lateral root surface resorption is remodeled as it maintain continuity with the tooth

Although both the sides and the apex of the root experience resorption, roots of tooth become shorter but not thinner as a result of orthodontic tooth movement.

Factors affecting Root Resorption:

- **Patient factors**

Genetic influences on Root Resorption:

Newman suggested family clustering of External apical root resorption.

Harris et al study of 123 sibling pairs treated with the same technique by a single operator showed that there were significantly greater variances among than within sibling pairs.

Al-Qawasmi et al ^[4] study confirmed that EARR has been linked to IL-1B gene, substantiating an important genetic predisposition to this problem. The IL-1 gene cluster on

human chromosome 2q13 includes 3 genes. Two genes (IL-1A and IL-1B) encode proinflammatory cytokine proteins IL-1 α and IL-1 β , respectively.

Third gene (IL-1RN) encodes a related protein (IL-1ra) that acts as a receptor antagonist. Increased levels of IL-1 β have been found in both the gingival crevicular fluids and the gingival tissues of patients undergoing orthodontic tooth movement. IL-1 β has been implicated in bone resorption (catabolic modeling) accompanying orthodontic tooth movement.

Data indicate that allele 1 at the IL-1B gene, known to decrease the production of IL-1 cytokine in vivo, significantly increases the risk of EARR.

Allele 2 of the IL-1B was found to be associated with adult periodontitis; this is consistent with the observation that excessive IL-1 activates the degradation of the extracellular matrix and bone in the periodontal tissues.

Another candidate gene for EARR is TNFRSF11A, which encodes a TNF receptor that mediates signaling leading to osteoclastogenesis contributing to EARR during orthodontic treatment.

Race

Asian patients had significantly less post-treatment root resorption than either white or Hispanic patients. Hispanic patients tended to have more root resorption than white patients ^[5].

Specific tooth vulnerability

Different teeth have different tendencies to root resorption. Most studies report that maxillary teeth are more sensitive than mandibular teeth.

Single-rooted teeth are at greater risk of experiencing EARR than multi-rooted teeth, probably because of the

1. Greater root surface area of molars for the dissipation of forces.

2. Teeth in the anterior segment are moved greater distances on average during treatment than other teeth in the dental arches.

Breznjak and Wasserstein ^[6] suggest that the most vulnerable teeth are in order as follows: Maxillary lateral incisors, Maxillary central incisors, Mandibular incisors, distal root of mandibular first molars, Mandibular second premolars and Maxillary second premolars

Most studies report that the maxillary lateral incisors are the most frequently affected teeth for EARR.

1. Maxillary lateral incisors demonstrate the highest percentages of abnormal root shapes (bottle, pipette and blunt)
2. Developmental anomalies include dens invaginatus are mostly seen in maxillary laterals.
3. More spindly (narrow) apical region of lateral incisor

Tooth root shape

Levander et al ^[7] conducted study on root form and its susceptibility to EARR and shown that roots with abnormal shape or size such as short, blunted, apically bent (dilacerated) and pipette shaped roots showed have a higher susceptibility to external apical root resorption than normal long and narrow root surfaces and of all pipette shaped root with highest susceptibility followed by blunt, apically bend and short roots.

Previously traumatized teeth

Historically belief, based mostly upon observational data and animal studies, that all teeth with a previous history of trauma are more susceptible to OIIRR than healthy control teeth, but Malmgren et al ^[8] in their study showed that teeth with slight or moderate trauma and an intact periodontal ligament after an observation period of at least 4 to 5 months can be moved with a prognosis comparable to that of uninjured teeth.

- Traumatized teeth without signs of root resorption when Orthodontically moved shows resorption equal to a non-traumatized teeth
- Traumatized teeth with signs of root resorption during observation period when orthodontically moved are more sensitive to further loss of root material.

Orthodontic treatment in Blunder-buss canals (immature teeth)

Root shortening as a result of external apical root resorption was a possible side effect of orthodontic treatment. But the study conducted by Mavragnani et al ^[9] showed that immature teeth showed root elongation instead of root resorption, Perhaps layer of fairly thick pre-dentine layer on underdeveloped roots provides a preventive effect as uncalcified pre-dentine is not attacked by resorbing cells. So, definite advantage for younger teeth with regard to post treatment length by initiating orthodontic correction of incisors at a young age during mixed dentition period

Root resorption in Transplanted teeth

Transplanted teeth are no more susceptible to EARR than normal teeth provided the transplant is without complication and the orthodontist waits three months as observation period before attempting tooth movement.

Predicting the risk of root resorption

Årtun et al ^[10] had shown that patients with detectable root resorption in the first six months are more likely to have root resorption in the following six months than those without. Patients with more than 1 mm of root resorption in the first six months were 3.8 times more likely to have more than 1 mm or more of root resorption in the second six months.

Endodontically treated teeth

Spurrier et al ^[11] showed endodontically treated teeth are more resistant to root resorption because of an increased dentin hardness and density.

Force levels in relation to orthodontics

According to Schwartz, applied force exceeding the optimal level of 20 to 26 gm/cm² capillary pressure causes periodontal ischemia, followed by hyalinized zone formation which can lead to root resorption. Chan et al ^[12] compared the levels of forces and risk of root resorption and showed that, more resorption measured by volumetric analysis was observed in the heavy-force group than in the light-force and control groups. The heavy-force group had 3.31-fold greater total resorption volume than the light-force group

There was significantly more resorption on the buccal cervical and lingual apical regions of the root surfaces than on other regions, suggesting that high-pressure zones are more susceptible to resorption.

Direction of tooth movement

It seems that safe tooth movement does not exist.

Intrusion and torque are probably the most harmful to the tooth involved but tipping, bodily movement, and palatal expansion can be implicated. Rotation causes least root resorption.

Bodily movements are associated with a lower risk of OIIRR because the stress is distributed more evenly along the root Therefore risk of root resorption that is due to bodily movement should be less than that of tipping

The greatest damage is observed with intrusive tooth movements because they concentrate pressure at the tooth apex .Intrusive tooth movements because they concentrate pressure at the tooth apex, the intruding force must be light and frequently interrupted by rest periods.

Kaley et al ^[13] examined maxillary central incisors; movements torquing the apex lingually are strongly correlated with the onset of root resorption. In combination, intrusion and lingual root torque are the strongest causes of root resorption than any other combination of tooth movements.

Habits and EARR

Any habit increases the load on the teeth above a physiological threshold may initiate root resorption. However habits are eliminated before definitive orthodontic treatment but habit like nail biting is often ignored, Odenrick et al ^[14] studied the effect of nail biting on root resorption during orthodontic treatment Out of the sample of 1025 13-15 year old patients, 151 or 14.3% were classified as severe nail biters and exhibited more EARR than others.

Thyroid functions and root resorption

Loberg et al ^[15] observed less force-induced root resorption lesions occurred in the thyroxine group than in the control group. Force induced orthodontic root resorption and administration of thyroxine lead to more efficient remodeling process and root resorption decreased. Hence administration of 0.5gram/daily thyroxine should be considered in some patients, especially in those who show beginning root resorption or those who have low thyroid function.

Drugs and root resorption

Bisphosphonates

Attati et al ^[16] demonstrated that Bisphosphonates produce cemental surface alterations by inhibiting acellular cementum formation, increasing the vulnerability of the dental root to the resorptive process Nabumetone. Villa et al ^[17] showed a drug belonging to the NSAID group, reduces the amount of root resorption along with the control of pain from intrusive orthodontic forces without affecting the pace of tooth movement.

- Clinicians factors

Type of appliance and root resorption

Fixed versus removable

Ketcham ^[18] compared root resorption resulting from fixed and removable appliances, by concluding that the use of fixed appliances is more detrimental to the roots, claimed

that normal function is disturbed by the splinting effect of orthodontic fixed appliances over a long period that can cause root resorption.

Begg appliance versus edgewise appliance

Mc Nab et al ^[19] showed that incidence of EARR was 2.30 times higher for Begg appliances compared with edgewise appliance. Standard edgewise and Pre-adjusted edgewise (Straight wire system) Mavragani et al ^[20] showed edgewise appliance more root resorption than straight wire system. The study concludes that the straight-wire appliance may offer more gentle and constant forces thus reducing the likelihood of root resorption.

Extraction versus Non-extraction

Earlier studies of McFadden and VonderAhe found no difference in the extent of root resorption in patients treated with or without extractions.

Sameshima and Sinclair ^[5] study showed extraction pattern was also found to be a significant factor in root resorption.

Results of their study were

1. Extraction pattern was found to be a significant factor in root resorption.
2. Patients who underwent 4 first premolar extraction therapy had greater resorption than those who were treated with non-extraction.
3. Patients with the classification of other type of extractions (4 second premolars, 2 maxillary premolars, a mandibular incisor, and asymmetric extractions) also demonstrated increased resorption.
4. Interestingly, patients with only upper premolar extractions did not have
5. More resorption than the non-extraction cases.

Severity of Malocclusion

1. The amount of orthodontic tooth movement is associated with the resulting EARR. In turn, the required amount of tooth movement is a function of the severity of the malocclusion, which makes the

presence of a severe malocclusion a risk factor for EARR.

2. The greater the overjet, the greater treatment root loss
3. Class I patients with acceptable overjets were significantly less likely to show EARR than were Class II or III patients
4. More deep bite, require more intrusion and greater root loss.

Effects of Root resorption

Teeth vitality

Teeth vitality and color do not change even in cases of extensive root resorption. Accordingly orthodontic movement can cause pulp blood flow disturbances, vacuolization and, rarely, pulp necrosis that are not related to root resorption.

Periodontal support

Kalkwarf et al ^[21] showed a nearly linear relationship between root length and percentage of periodontal attachment. Results indicated that 3 mm apical root loss equals only 1 mm crestal bone loss which is less detrimental. Therefore, patients who are susceptible to marginal periodontal break down may have a higher risk of losing teeth for EARR.

Prevention and Treatment Options for EARR

1. Patients should be informed of the risk of root resorption through the informed consent process. Particular risk factors such as pre-existing root resorption or abnormally shaped roots should be highlighted .
2. Classic approach include decreasing the treatment duration and the use of light intermittent forces, limited tooth movement of resorption prone teeth such as intrusion and torque, habit control and a thorough assessment of familial tendency and medical history.
3. It was strongly suggested that periapical radiographs should be taken at least every year to determine the

presence of root resorption. The original treatment goals must be reassessed depending on the extent of root resorption detected.

4. The results may have to be compromised depending on the amount of root resorption, or at least the force levels should be modified or a two to three month pause in treatment with passive arch wires should be implemented, interdental stripping instead of extractions, and early fixation of severely resorbed teeth
5. Administration of 0.5gram/daily thyroxine should be considered in some patients, especially in those who show beginning root resorption or those who have low thyroid function
6. Administration of low doses of systemic steroids and Doxycycline may have an inhibitory effect on EARR via reduction of mobile odontoclasts, osteoclasts, mononuclear cells from bone marrow.
7. Termination of active EARR usually occurs after appliance removal. If it does not occur, sequential root canal therapy with calcium hydroxide may be considered.
8. Bialy et al ^[22] had reported on the use of low intensity pulsed ultrasound (LIPUS) that can reduce the number of areas of root resorption in experimentally tipped teeth; this was achieved by healing of the root surface by hypercementosis.

Conclusion

EARR is unavoidable during orthodontic tooth movement. So, it is necessary to take proper measures for reducing the risk of root resorption by decreasing the treatment duration and the use of light intermittent forces, limited tooth movement of resorption prone teeth such as intrusion and torque, habit control and a thorough assessment of patient's familial tendency and medical history.

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