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Factors Affecting Root Resorption

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Abstract

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Introduction

Root resorption is the most common unwanted effect seen in the orthodontic treatment. External apical root resorption is most common type of root resorption. Force-induced periodontal ligament and alveolar bone remodeling is responsible for orthodontic tooth movement. Necrosis of periodontal ligament on the pressure side with formation of a cell-free hyaline zone followed osteoclast resorption of the neighboring alveolar bone and bone apposition by osteoblasts on the tension side are seen. The resorption process of dental hard tissues as well as bone seems to be triggered by the activity of cytokines[1]

External root resorption (ERR) is mainly seen related to orthodontic tooth movement. The factors relevant to ERR can be divided into both biological and mechanical factors[2].

Classification of root resorption: -

I) according to Shafer, Hine and levy[3], resorption of root is seen with the normal process associated with shedding of deciduous teeth and also with orthodontic treatment. Resorption of root can be seen on internal root surface or external root surface. Root resorption is mainly of two types,

1) External root resorption.

2) Internal root resorption.

1) External root resorption: - this resorption is the progressive loss of tooth structure from external surface of tooth by osteoclasts.

Following are the few conditions: -

A. Periapical inflammation
B. Reimplantation of teeth
C. Tumors or cysts
D. Excessive mechanical or occlusal forces
E. Impaction of teeth
F. Idiopathic.

Naphtali brezniak et al[4] have published three types of external root resorption:-

I) surface resorption: -

This type of resorption is a self-limiting process, usually involving small outlining areas followed by spontaneous repair from adjacent intact parts of the periodontal ligament.

Surface resorption is seen after orthodontic treatment

II) Inflammatory resorption: -

In inflammatory resorption, initially root resorption occurs upto dentinal tubules of an infected necrotic pulpal tissue or an infected leukocyte zone. Inflammatory resorption is divided into following-

II) Replacement resorption: -

In replacement resorption, bone replaces the resorbed tooth material that leads to ankylosis. Replacement resorption is never seen during or after treatment.

2) Internal resorption: -

According to Shafer, Hine and levy[3] internal resorption is related to inflammatory hyperplasia of pulp. This begins centrally within the tooth. The cause of the pulpal inflammation and resorption of tooth substances is not known, but an obvious carious exposure and accompanying pulpal infection are sometimes present.

Ii) According to proffit[5], shortening of roots after orthodontic treatment occurs in three distinct forms that must be distinguished when the etiology of resorption is considered.

1) Moderate generalized root resorption
2) Severe generalized root resorption
3) Severe localized root resorption

Factors related to root resorption

- Biologic factors:

1) Individual susceptibility:

This is considered a major factor in determining root resorption with or without orthodontic treatment. This potential exists in deciduous and permanent roots of all persons in varying degrees in different teeth. The root resorption process varies among persons and within the same person at different times.

2) Genetics:

Newman w.g[6] (1975) strongly suggests a genetic component for shortened roots. Although no definite conclusion was found, autosomal dominant, recessive and polygenic modes of inheritance are possible.

- Systemic factors: Becks (1939) suggested that endocrine problems including hypothyroidism, hypopituitarism, hyperpituitarism and other diseases are related to root resorption. It was reported in 1940s that a deficiency of thyroid hormone could lead to generalized root resorption, and occasional thyroid supplements for orthodontic patients are suggested as a way to prevent this, but most of the patients with generalized root resorption have no endocrine problems.

1) Nutrition: Marshall (1929) suggested that malnutrition can cause root resorption. Becks (1936) demonstrated root resorption in animals bereft of dietary calcium and vitamin D. Linge and linge[7] (1983) suggested that nutritional imbalance is not a major factor in root resorption during orthodontic treatment.

2) Chronologic age:

The apical third of the basis is more firmly anchored in adults than in young patients. Hence, when an adult tooth is tipped over a short distance there is comparatively a little movement of the apical third of the root. On the opposite hand, if the tipping is prolonged, the tooth will begin to act as a two armed lever. There may be apical resorption and frequent destruction of alveolar bone wall as well.

2) Gender:

Perreault (1954), Dougherty h.l (1968), masslerkinsella p (1971) and Newman wg (1975) showed that females are more susceptible. Females had a greater apical root resorption than males, 0.73mm and 0.67mm respectively. Dougherty (1968) speculated that this could be due to the difference in root maturity as the male is chronologically less mature than females and the male roots are less effective to the traumatic effect of orthodontic stress.

3) The root resorption before orthodontic treatment:

There is a high correlation between the two (Massler m., Malone, 1954). Goldesen L, Hensikson (1975) reported that in such cases incidence of root resorption increased from 4% to 77% after treatment.

4) Habits:

Nail-biting and tongue thrust habit leads to open bite and increased tongue pressure are related to increase root resorption. According to Harris and Butler[7] (1992), open bite cases have shown the presence of root resorption.

5) Tooth structure:

Oppenheim (1942) found that deviating root form is more susceptible to post-orthodontic root resorption. Kinsella p (1972) found that convergent apical passage is taken into account to be indicative of high root resorption potential.

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Levander E, Malmgren O (1988) showed that blunt or pipette shaped roots had a significantly higher root resorption tendency. The pipette shaped root was shown to be most susceptible.

6) Previously traumatized teeth:

Philips Jr (1955) and Andresen Jo (1988) stated that traumatized teeth can exhibit root resorption without orthodontic treatment. Teeth with prior root resorption are more sensitive to further loss of root material. The average root loss for trauma patient after orthodontic treatment was 1.07mm compared with 0.64mm for untraumatized teeth. Malmgren o et al[8] (1982) found that traumatized teeth without previous signs of resorption do not resorb more than non-traumatized teeth.

7) Endodontically treated teeth:

Wickwire a et al (1974) reported a higher frequency and severity of root resorption. However, Reitan (1985), Remington Dn et al[9] (1989), have suggested that increased dentin hardness and density made endodontically treated teeth more resistant to root resorption. According to steven w. Spurrier et al[10] in 1990, endodontically treated incisors resorb with less frequency and severity than vital incisors.

8) Alveolar bone density:

Becks (1939), tagger (1961) related increased resorption to bone architecture resulting from hormonal and nutritional imbalance during growth.

Remmelnick Hj (1984), Goldie Rs (1984) and Reitan k (1985) found that the denser alveolar bone was more prone for orthodontically induced root resorption.

Tooth movement as a results of bone resorption is facilitated by the formation of active resorptive cells, the amount of which increases consistent with the amount of marrow spaces.

According to Reitan (1974) the strong continuous force on less dense alveolar bone causes the same amount of root resorption as mild continuous forces on highly dense alveolar bone. Lamellar bone is more difficult to resorb than bundle bone.

9) Classification of malocclusion:

Tulin Taner et al[11] (1999) studied the apical root resorption following extraction therapy in patients with class I and class II malocclusion and located that was a mean of roughly 1mm of apical root shortening in class I patients while the class II division 1 patients showed a mean root shortening of more than 2 mm.

10) Specific tooth vulnerability to root resorption:

According to Philips Jr (1955), Reitan k (1985), the maxillary incisors are the most affected, because during orthodontic treatment the extent of movement of these teeth is usually greater than of other teeth because of malocclusion, function and esthetics. Their root structure and relationship to the bone and periodontal ligament tends to transfer the forces mainly to the apex.

- Mechanical factors

1) Orthodontic appliances:

It is often stated that the degree of root damage is a side effect of the appliance used.

Fixed versus removable:

Ketcham (1929) claimed that normal function is disturbed by the splinting effect of orthodontic fixed appliances and over a longer period of time this can cause root resorption.

Stuteville (1937) suggested that the jiggling forces caused by removable appliances are more harmful. However, Linge and Linge[12] (1983) concluded that fixed appliances are more detrimental to root.

Begg versus edgewise:

Kinella P (1971) stated that the light wire begg technique causes less root resorption than edgewise.

Standard edgewise versus straight-wire edgewise:

Maria Mavragani, Andrea Vergariet et al[13] (2000) did a radiographic comparison of apical root resorption after orthodontic treatment with a standard edgewise and a straight wire edgewise technique and found that standard technique showed significantly more apical root resorption than the straight wire edgewise group particularly in central incisors.

D) Magnets:

Blechman Am et al (1978) and Rawata T (1987) suggested that an increase in force as space closes with time (attraction) can stimulate more physiologic tissue response and thus decrease the potential for root resorption.

E) Intermaxillary elastics:

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Linge and Linge[14] found that class II elastics lead to root resorption and suggested that jiggling forces, the result of function combined with elastics are responsible for incisor root resorption. Class iii elastics used for anchorage preparation increased mandibular molar distal root resorption.

F) Extraction vs. Nonextraction: -

Vonder Ahe (1973) and Mcfedden[15] (1989), found no difference in the extent of root resorption between the two approaches.

2) Serial extractions:

Kennedy Jb (1983) stated that serial extractions without the complementary orthodontic treatment gave the least root resorption compared to serial extraction with fixed appliance therapy.

3) Other appliances:

Hill fj (1987) has reported severe root resorption with rapid maxillary expansion with cervical traction. Vardimon et al[16] (1992) have reported external root resorption with palatal expansion.

4) Orthodontic movement type:

Ketcham (1929), Hemley s (1941), Linge and Linge[17] (1983), McFadden et al[15] (1989), stated that probably intrusion is the most detrimental to root, but tipping, torque, bodily movement and palatal expansion can also be implicated. According to reitan, the stress distribution along the roots during bodily movement is less than its concentration at the apex resulting from tipping. Therefore the risk of root resorption is less in bodily movement.

5) Orthodontic force:

Harry and Sims found distribution of resorbed lacunae directly related to the amount of stress on the root surface and the rate of lacunae formation was more rapid with increasingly applied forces. They concluded that higher stress causes more resorption. Schwartz (1932) stated that applied forces exceeding the optimal level of 20-26gm/cm^2 cause periodontal ischemia, which can lead to root resorption.

6) Continuous versus intermittent force:

Reitan k (1964), Dougherty hl (1968), have shown that the pause in treatment with intermittent forces allows the resorbed cementum to heal and prevents further resorption.

7) Jiggling and occlusal trauma:

Jiggling forces resulting from the use of intermaxillary elastics, active removable appliances or because of occlusal trauma can cause root resorption. Occlusal forces on poorly aligned dental inclined planes can lead to root resorption during treatment.

8) Extent of tooth movement

Philips jr[18] (1955), did not find any relationship between the extent of tooth movement and root resorption. Many others like vonder (1973), Sharpe (1987), believe that net resorption is directly related to the extent of tooth movement.

Iii) Combined biological and mechanical factors:

1) Treatment duration:

According to reitan k (1964), sharpe[19] (1987), mcfadden[15] (1989), severity of root resorption is directly proportional to the duration of orthodontic treatment.

Goldin (1989) reported that 0.9mm/year of root loss was seen during treatment.

2) Root resorption detected radiographically during treatment:

Levander E Malmgren[8] (1982) stated that minor resorption or an irregular root contour seen after 6 to 9 months indicates an increased risk of further root resorption. No severe root resorption was detected at the end of treatment in teeth without resorption after 6 to 9 months of treatment.

Reitan (1964) claimed that the forces of relapse are strong enough to cause root resorption. Sharpe et al[19] (1987) found a higher frequency of root resorption in patients demonstrating relapse.

4) Root resorption after appliance removal:

Reitan (1985) claimed that additional active resorption lasts for about a week.

Reitan (1985) claimed that additional active resorption lasts for about a week after appliance removal followed by cemental repair that lasts 5 to 6 weeks of orthodontic inactivity. This supports Copeland and green's study (1986), which showed about 0.1mm apical root loss.

Conclusion

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The etiology of root resorption associated with orthodontic therapy is complex. Several factors, alone or in combination, may contribute to root resorption. Root resorption may compromise the continued existence and functional capacity of the affected tooth, depending on its magnitude. However, the process of root resorption during orthodontic treatment is usually smooth and stops when the force is removed. In this review, root resorption was discussed from different viewpoints.

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