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ROOT RESORPTION IN ORTHODONTICS

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ABSTRACT

Root resorption is a common concern in orthodontics that has been widely studied. It can be caused by various factors such as the mechanics used during treatment, the type and intensity of force applied, and other treatment-related factors like malocclusion and tooth movement. Root resorption may occur at any stage during orthodontic treatment, leading to a compromise in the tooth's prognosis and the stability of treatment outcomes. A thorough evaluation of predisposing factors, including radiographic assessment of root morphology, followed by careful planning and execution of orthodontic mechanics can help reduce the incidence of root resorption. Detectability is crucial for the clinical importance of root resorption. Therefore, various imaging methods are employed to evaluate the orthodontic and biological factors that may contribute to root resorption. In this review, root resorption in orthodontics is examined from different perspectives with classification, treatment, and prevention.

Keywords: Orthodontics, root resorption

INTRODUCTION

Root resorption is the loss of cementum and dentine, which can be caused by pathological or physiological processes[1]. Root resorption is a common problem that occurs as a result of orthodontic treatment. It has been a concern for clinicians and patients since 1914 when it was first reported by Ottolengui. It has been shown that applied orthodontic mechanics are a prominent risk factor for root resorption. Abbas and Hartsfield reported that approximately one in 20 patients undergoing orthodontic treatment were susceptible to at least 5mm of root shortening. Root resorption is the second most common side effect of orthodontic treatment, following white spot lesions in tooth enamel.[2]

HISTOPATHOLOGY OF ROOT RESORPTION

Root resorption in orthodontics is a type of pathological root resorption induced by orthodontic forces. It occurs when hyalinized areas are removed from the periodontal area. The removal of hyalinized tissues also leads to the removal of cementum[3]. Dentinoclasts initiate the resorption process while osteoclast-like cells called odontoclasts cause resorption. Odontoclasts are usually multinuclear and have a pleomorphic shape.[2,4]

CLASSIFICATION OF ROOT RESORPTION

Grade	Definition
0	No evidence for resorption
1	Irregular root contour
2	Apical root resorption less than 2 mm
3	Apical root resoption > 2mm and < 1/3 of original root length
4	Root resorption exceeding 1/3 of original root length

ETIOLOGY OF ROOT RESORPTION

The pathogenesis of root resorption can be affected by a patient's dental history, history of trauma and dental treatments, related systemic conditions, and medical details. While the reasons for root resorption[5] are complex and multifactorial, it is believed that a combination of a person's biological variability, genetic predisposition, and mechanical factors contribute to it. Many studies have classified the possible reasons for root resorption into the following categories:

Factors related to the patient: Various factors can affect dental health, including genetic factors, age, gender, ethnicity, certain syndromes, psychological stress, increased force on the teeth, tooth vitality, type of teeth, dental invaginations, features of dentoalveolar and facial structures, existing root resorption before treatment, proximity of the root to the cortical bone, nutrition, systemic factors such as illnesses that cause inflammation, asthma, allergies, and hormonal irregularities.

Factors related to orthodontic treatment: According to Jacobson[6], the loss of 1mm in the apex of a tooth may not be significant, since it has the smallest diameter. However, Kalkwarf et al.[7] argued that the length of the root and the connection to the periodontal tissue can be crucial, meaning that even a slight loss in the root can have an important impact.

The magnitude of orthodontic force: Harris et al.[8], Barbagallo et al.[9], Cheng et al.[10], and Paetyangkul et al.[11] stated that with an increasing force, root resorption also increases. Paetyangkul et al. found that root resorption increases with an increase in the application time, even with light force.

Type of orthodontic force: Fixed orthodontic treatment can be challenging when applying intermittent forces. However, research has indicated that using intermittent forces is better than continuous forces[12]. This is because continuous forces may lead to severe root resorptions. A study conducted by Aras et al.[13] found that intermittent forces cause less root resorption when compared to continuous forces.

Direction of tooth movement: Based on the type of movement applied, areas with high-pressure points are more susceptible to root resorption. In cases of intrusive movements, the pressure is concentrated at the root apex, which increases the risk of resorption due to root anatomy[14]. Extrusive movements, on the other hand, occur easily but may cause root resorption in the cervical third of the root in interdental areas. Studies indicate that root resorption is four times more likely to occur during intrusion than extrusion.[15]

Sequence of the archwire: Currently, there is no clear information about the relationship between root resorption and the archwire sequence in orthodontic treatment. The archwire sequence is mainly determined by the clinician's preference and technique. Although some studies have investigated this relationship, there is still no conclusive evidence to support a significant correlation between the two[16].

Type of orthodontic appliance: According to a study, the straight wire group experienced an average decrease in root length of 8.2%, while the conventional edgewise group experienced a decrease of 7.5%. However, there was no significant difference in the prevalence of apical root resorption between the two groups[17]. Another study by Scott et al.[18] found that the amount of root resorption in Damon-3 self-ligating braces and conventional brackets is similar. Further, some studies have found that rapid expansion might induce root resorption in the unattached second premolar tooth[19].

Factors related to the patient:

Genetic factors:

The process of resorption, which varies among patients and cannot be attributed to orthodontic or environmental factors, has prompted researchers to examine the presence of genetic factors that may increase the likelihood of resorption[20]. Some studies suggest that personal predisposition to root resorption may be more influential than the amount and duration of orthodontic force applied[21].

Abnormal root morphology:

It is important to note that the shape of roots can affect how force is distributed through the alveolar bone and root. In trigonal sharp apexes, the force is more concentrated on localized areas compared to roots with a normal shape. Additionally, teeth with root dilacerations, particularly maxillary lateral incisors[22], are more prone to root resorption.

Chronological age:

According to studies, the likelihood of root resorption is more likely to increase with age due to a decrease in the blood supply to the periodontal membrane and an increase in bone density. However, some studies, including those conducted by Cheng et al[10]. and Baumrind et al.[23], have suggested that there is no significant connection between a person's chronological age and the occurrence of root resorption.

Visualization and Diagnosis of Root Resorption:

Although orthodontic professionals can carefully determine the direction and amount of force needed, it's not possible to predict where and how root resorption will occur. In cases where surface resorption is located in the buccal, palatal/lingual, mesial, or distal areas in the apical region, it may not result in a decrease in root length[24]. When orthodontic force is applied for longer periods and at higher levels, resorption lacunae may extend to the dentine, but root length remains unchanged[25]. Recently, computed tomography (CT) and micro-CT have become more popular, and cone-beam CT (CBCT) has emerged as a promising new tool in this field.[26]

Conventional Radiological Evaluations:

Conventional methods can detect root length shortening, but cannot detect or measure the location, depth, and width of resorption in different parts of the root (Figure 1 A and B).

The reliability of the results of several studies may be questionable due to problems with magnification in two-dimensional radiographs[26].

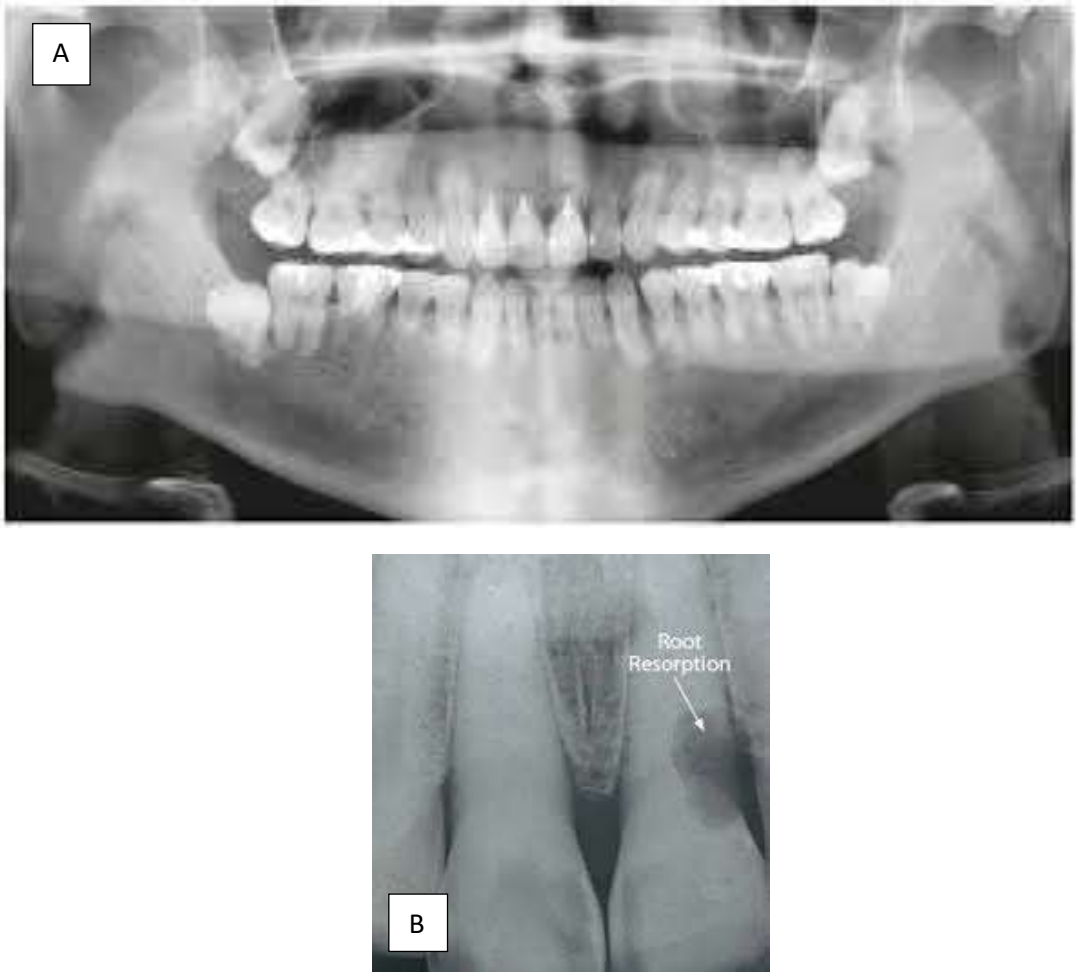

Figure 1:

A. The evaluation of roots using ortopantomograph in detail. The length and the shape of the roots cannot be assessed clearly.
B. Root resorption in three planes of the space which affect the diagnosis and treatment planning

When conducting evaluations with lateral cephalometric X-rays, it's necessary to consider a magnification factor that can range from 5% to 12%.[27] This is because the roots of central incisors are superimposed which makes it challenging to visualize root resorption accurately. As a result, the reliability of such evaluations decreases. Chan and Darendeliler[28] suggest that while two-dimensional views can be useful during the diagnosis of root resorption, they should not be relied upon for quantitative evaluation of resorption.[29,30]

Cone Beam Computed Tomography:

Cone beam computed tomography revolutionized the viewing of the maxillofacial region by introducing three-dimensional methods, replacing the traditional two-dimensional methods.[31]

CBCT can capture images with lower radiation doses, has a shorter scan time, and produces sharper images[32]. Dudic et al.[33] utilized CBCT to detect and measure root resorption. However, they were unable to conduct a proper three-dimensional evaluation with linear measurements instead of volumetric assessments. Although CBCT is effective in identifying resorption cavities, few studies determine material loss in the root by volumetric calculations. Since CBCT is dependable in volumetric calculations of teeth[34], it can be utilized to measure root resorption.

Repair of root resorption:

Active orthodontic forces are believed to play a crucial role in root resorption. Once the orthodontic force is released or reduced to a certain level, the repair process begins. The resorption lacunae are the first to show signs of repair, which is similar to early cementogenesis during tooth development[35]. The resorption cavities are recovered through the accumulation of new cementum and the formation of a new periodontal ligament[36]. According to Owmann-Moll et al.[37], the possible repair level observed histologically in resorption cavities can be summarized as follows:

I- **Partial Repair:** Part of the resorption cavity is covered by reparative cementum, which may be cellular or acellular cementum.

II- **Functional Repair:** The resorption cavity's total surface is covered with reparative cementum, but the original root contour (cellular cementum) is not re-established.

III- **Anatomic Repair:** The resorption cavity is covered with reparative cementum, which re-establishes the original root contour.

MANAGEMENT AND TREATMENT

Effect of a pause in active treatment on teeth that had experienced apical root resorption during the initial 6-month period with fixed appliances. The results 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).

CONCLUSION

The cause of root resorption related to orthodontic treatment is not fully understood and is likely influenced by several factors. It can occur due to a single or a combination of these factors, and the extent of the resorption can affect the functionality and survival of the affected tooth. However, root resorption typically halts after orthodontic treatment has ceased. This article provides a comprehensive overview of root resorption from various perspectives.

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