

Root Resorption in Orthodontic Patients: Etiology, Prevention and Management

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Introduction

Root resorption is one of the most significant biological complications associated with orthodontic treatment and it has long been a concern for both clinicians and patients. Defined as the loss of dental hard tissue, particularly dentin and cementum, root resorption compromises the structural integrity of teeth and may impact long-term oral health. While minor resorption is relatively common and often clinically insignificant, severe cases can lead to permanent damage, reduced tooth stability and even tooth loss in rare instances. In orthodontics, root resorption is primarily induced by mechanical forces applied during tooth movement, although it is a multifactorial condition influenced by genetic predisposition, individual biological variability, systemic health and treatment-related factors. Over the years, advances in imaging technology, such as Cone-Beam Computed Tomography (CBCT) and growing insight into cellular and molecular mechanisms have enabled better understanding of root resorption. This has paved the way for preventive strategies, risk assessment and treatment modifications to minimize adverse outcomes. Since orthodontic treatment is elective in nature and aims to enhance both function and esthetics, the potential risk of root resorption poses ethical and clinical challenges. Therefore, orthodontists must balance treatment efficiency with biologic safety, ensuring patient outcomes are both stable and healthy [1].

Description

Root resorption in orthodontics is a biologically complex process that involves the interaction of mechanical forces with cellular responses in the Periodontal Ligament (PDL) and alveolar bone. It is classified into two main categories: external root resorption, which affects the outer surface of the root and internal resorption, which originates from within the pulp chamber or canal.

In orthodontics, External Apical Root Resorption (EARR) is the most frequently encountered type and it typically manifests as a blunting or shortening of the tooth apex visible radiographically. The etiology of orthodontically induced root resorption (OIRR) is multifactorial. One of the central factors is the magnitude, direction and duration of orthodontic force application. Light, controlled forces are generally considered safe, as they allow for biologic remodeling of alveolar bone and minimize excessive stress on root structures. In contrast, heavy or continuous forces can overwhelm the adaptive capacity of the periodontium, leading to hyalinization zones within the PDL, sterile necrosis and subsequent resorptive activity by clastic cells such as odontoclasts and cementoclasts. This cellular activity results in the resorption of cementum and dentin at the root apex [2].

Another important determinant is tooth morphology. Teeth with abnormal root shapes, such as dilacerated roots, pipette-shaped roots, or short, blunt apices, are more susceptible to resorption. Likewise, incisors are most commonly affected, particularly the maxillary central and lateral incisors, due to their anatomical position and the direction of orthodontic forces applied during treatment [1].

Genetic predisposition also plays a significant role. Several studies have suggested that polymorphisms in genes related to bone and cementum remodeling, such as interleukin-1 beta (IL-1 β), receptor activator of nuclear factor kappa-B ligand (RANKL) and osteoprotegerin (OPG), may influence individual susceptibility to root resorption. This explains why some patients develop extensive resorption despite light forces and well-controlled treatment mechanics, while others remain relatively unaffected under similar conditions. Systemic health conditions and patient age further modulate risk. Younger patients, who have more cellular and vascular periodontal structures, are generally less prone to severe root resorption compared to adults, in whom reduced regenerative capacity may exacerbate tissue damage. Additionally, systemic conditions such as asthma, allergies and endocrine disorders have been loosely correlated with increased resorptive risk, though the evidence remains inconclusive [2].

Conclusion

Root resorption in orthodontic patients represents a biologically complex and clinically significant phenomenon that demands careful consideration throughout the treatment process. While minor resorption is an almost inevitable consequence of tooth movement, its clinical impact can be minimized through preventive strategies, individualized treatment planning and diligent monitoring. Etiological factors such as orthodontic force magnitude, root morphology, genetic predisposition and systemic health must all be integrated into a comprehensive risk assessment framework. Advances in imaging and biomolecular research are deepening our understanding of root resorption, offering the potential for targeted interventions in the future. For practicing orthodontists, the primary goal should be to strike a balance between efficient tooth movement and biologic preservation. Patient-centered care requires transparent communication regarding risks and outcomes, alongside the implementation of strategies to reduce the likelihood of severe root damage.

References

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While resorption cannot always be eliminated, timely detection and appropriate modifications in treatment can preserve both dental function and patient confidence in the long term. Ultimately, root resorption serves as a reminder that orthodontic treatment, though highly beneficial, is not without risks. The challenge for modern orthodontics lies not only in achieving esthetic alignment but also in safeguarding the structural and biological integrity of the dentition. With the integration of personalized treatment approaches, emerging diagnostic technologies and ongoing research, the future holds promise for reducing the burden of root resorption and enhancing the safety of orthodontic care.

Acknowledgment

None

Conflict of Interest

None

2 Nambi N, Shrinivaasan NR, Dhayananth LX, Chajallani VG, George AM (2016) Renaissance in orthodontics: Nanotechnology. *Int J Orthod Rehabil* 7: 139-143.