



Orthodontic Treatment of Endodontically Treated Teeth: A Review of Literature

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Abstract

Orthodontic treatment is often necessary for patients with endodontically treated teeth, with the objective of effective tooth movement while minimizing biological risks and discomfort. However, the impact of orthodontic forces on these teeth remains a source of clinical uncertainty, as they can trigger inflammatory responses and structural changes in both the periodontal ligament and pulp tissue. Despite well-established principles of interdisciplinary management of these cases, there is a lack of consensus on best practices particularly in relation to sequencing, timing, and managing potential complications. This review aims to address key considerations for orthodontic treatment in endodontically treated teeth, providing evidence-based guidelines to minimize risks and improve treatment outcomes.

Subject Areas

Dentistry, Orthodontics

Keywords

Orthodontic Treatment, Orthodontics, Endodontically Treated Teeth, Endodontics, Management

1. Introduction

Orthodontic treatment may be needed for patients with teeth that have been endodontically treated or are in the process of receiving endodontic care. The primary objectives of orthodontic therapy in these cases are to facilitate effective tooth movement while minimizing any biological harm and discomfort [1] [2].

However, orthodontic movement of endodontically treated teeth has long been a source of clinical ambiguity, as it can elicit significant biological responses in both the periodontal ligament and pulp tissue [2]. These responses—ranging from

inflammatory reactions to structural alterations—can complicate the treatment process and potentially affect the long-term health of the tooth [3].

While the interactions between various dental disciplines are well understood, the specific relationship between endodontics and orthodontics remains underexplored: Despite its clinical relevance, research focused on the orthodontic management of endodontically treated teeth is limited, and a clear consensus on best practices is yet to be established [1]. This lack of comprehensive data poses challenges for clinicians, making it difficult to predict and address potential complications during orthodontic treatment. Furthermore, the absence of clear guidelines contributes to uncertainty regarding the appropriate sequencing of treatments, the timing of interventions, and the management of potential adverse effects [4].

Thus, this review aims to explore key factors to consider in planning orthodontic treatment for endodontically treated teeth and to provide guidelines for minimizing risks and optimizing treatment outcomes.

2. The Relationship between Orthodontics and Endodontics

2.1. Anatomical and Physiological Aspects

Anatomically, the pulp tissue enters the root canal through a neurovascular bundle connected to the apical foramen at the tip of the tooth's root. This bundle, composed of blood vessels, nerves, and connective tissue, is continuous with the surrounding periodontal ligament (PDL) and periapical tissues.

The apical foramen, located at the root tip, plays a crucial role in maintaining pulp vitality by allowing the passage of blood vessels and nerves that provide signals, oxygen and nutrients while also removing metabolic byproducts [5].

Physiologically, the dental pulp is a highly active tissue that requires a constant blood supply to support its cellular functions and repair mechanisms. The neurovascular bundle passing through the apical foramen plays a critical role in maintaining this supply, providing the pulp with essential nutrients and facilitating waste removal [5]. When orthodontic forces are applied to the tooth, they can momentarily impair this circulation, leading to reduced blood flow and hypoxia (lower oxygen levels) within the pulp [6]. This can disrupt normal cellular activity and alter the pulp's ability to respond to external stimuli [5] [6].

Typically, these changes are transient, with blood flow gradually restored through reactive hyperemia, a compensatory mechanism to restore oxygen levels. However, excessive or prolonged forces may cause more significant damage, such as inflammation, fibrosis, or necrosis, especially if the pulp is already weakened by other factors. As such, careful modulation of orthodontic forces is essential to avoid detrimental effects on pulp health and ensure favorable treatment outcomes [5]-[7].

2.2. Pulp Modifications and Orthodontic Movements

Insufficient scientific evidence exists to prove the interrelation between orthodontic forces and the impact on the dental pulp [8].

Considering this, it has been shown that under typical clinical conditions, orthodontic forces do not alter the morphology or aging process of the dental pulp, nor do they affect the cellular or tissue mechanisms responsible for tooth movement [9] [10].

They have demonstrated that orthodontic tooth movement may induce temporary changes in the dental pulp, such as alterations in the expression of key proteins like vascular endothelial growth factor (VEGF), fibronectin, and collagen I. These changes occur within the first 7 days of force application and are followed by a recovery phase, with expression levels returning to baseline after 30 days [10].

This transient nature of the pulpal response suggests that orthodontic forces do not cause permanent or irreversible damage to the pulp. In fact, the reversibility of these changes supports the safety of applying pre-calibrated orthodontic forces, as long as the forces remain within the physiological tolerance of the tissues [11].

Overall, while there is no conclusive evidence linking orthodontic forces to long-term pulpal damage, the potential risks associated with pre-existing pulp vulnerability—such as from trauma—should be carefully considered [9] [11]. This highlights the importance of comprehensive evaluation and monitoring of endodontically treated teeth or teeth with a history of trauma before and during orthodontic treatment to minimize potential complications [12].

3. Orthodontic Movement of Endodontically Treated Teeth

3.1. General Considerations

Orthodontic tooth movement is primarily facilitated by the periodontal ligament, which responds to mechanical forces by inducing local bone remodeling: When orthodontic forces are applied, they compress the periodontal ligament cells, deforming their cytoskeleton and causing mechanical stress.

Simultaneously, the compression of blood vessels results in hypoxia, creating a metabolic stress that triggers the release of various mediators.

These mediators alternate between stimulating bone resorption and repositioning the bone on the ligament surface, thereby facilitating tooth movement [13].

It has been established that teeth that have undergone endodontic treatment can be moved with similar ease to teeth with vital pulp: Orthodontic movement is not significantly impacted by endodontic treatment unless ankylosis develops [1].

Some studies recommend that root canals should be thoroughly cleaned, shaped, and filled with calcium hydroxide (CH), and occlusal restoration should be performed to prevent bacterial leakage [14].

If endodontic treatment is required during orthodontic movement, several challenges may arise due to dental isolation, dental bands, and braces. To ensure optimal treatment, proper adaptation of clamps and retentive devices is essential [15].

Other specific difficulties may occur [1]:

- Lingual orthodontic braces, in particular, can present difficulties when opening the access cavity. In such cases, it may be more efficient to temporarily remove

the braces and reapply them after the endodontic procedure.

- -The presence of orthodontic attachments can affect the accuracy of radiographic evaluations and pulp vitality tests.
- -Symptoms related to endodontic or periodontal conditions may be confounded by orthodontic pain.

3.2. Orthodontic Movement in Endodontically Treated Teeth without Periapical Lesion

For several decades, up until the 1990s, there was a general belief—largely unsubstantiated by empirical evidence—that endodontically treated teeth were at a significantly higher risk of root resorption during orthodontic movement [3]. This view prevailed despite the lack of robust methodological studies to support it [3] [13].

However, following the landmark publication by Spurrier *et al.* in the 1990s [3], it was highlighted that properly treated endodontically, teeth subjected to orthodontic forces do not inherently exhibit an increased risk of root resorption, nor does orthodontic movement confer any protective effect against such resorption [16].

Hence, orthodontic treatment of endodontically treated teeth without periapical lesions does not typically require special consideration, unless external apical root resorption (EARR) is present and cannot be attributed to other factors [3] [17].

Once endodontic treatment is completed, orthodontic forces can typically be applied within a short period, as inflammatory exudates and cellular infiltration are resolved within 15 to 30 days, restoring the area to a stable condition [3].

If failure occurs in endodontically treated teeth subjected to controlled, light, and intermittent orthodontic forces months or years after treatment, such complications should not be ascribed to the orthodontic movement itself [3] [17]. The forces applied during orthodontic treatment do not alter the pathogenicity or virulence of the microbial biofilm, nor do they affect chronic periapical lesions [18]. Therefore, any observed failure should be attributed to factors other than the orthodontic forces applied [1].

3.3. Orthodontic Movement in Endodontically Treated Teeth with Periapical Lesion

Periapical lesions are typically confined to the apical region of the tooth. [19]. They are primarily inflammatory in nature and are often associated with a mixed or pathogenic microbiota present within the root canals of necrotic pulp. Alternatively, they can also result from aseptic pulp necrosis due to trauma [3] [19].

Non-inflammatory periapical pathologies are less common and include [3] [19]:

1) Cemental Dysplasia (Periapical Cemento-Osseous Dysplasia): A benign osteofibrous dysplasia affecting the periapical bone, particularly in the mandibular incisors.

2) Benign Cementoblastoma: An odontogenic tumor, predominantly located at the periapical region of the mandibular first molars.

Among these non-inflammatory conditions, periapical cemento-osseous dysplasia requires accurate diagnosis but typically does not require treatment, as it is asymptomatic and presents no significant clinical consequences. On the other hand, benign cementoblastoma necessitates surgical intervention, though it generally has a favorable prognosis [3] [20].

The inflammatory periapical diseases are generally attributed to two main etiologies: necrotic pulp with associated mixed microbial flora or aseptic pulp necrosis resulting from dental trauma [20] [21].

Inflammatory periapical lesions progress through distinct stages, beginning with acute apical pericementitis [3], which may evolve into an acute dentoalveolar abscess, potentially transitioning to a chronic state characterized by a fistula [21].

Chronic inflammation may lead to the formation of a periapical granuloma, which can persist for extended periods or evolve into an apical periodontal cyst [3].

While endodontic therapy can still achieve favorable outcomes, the risk of treatment failure remains present, especially in cases with more severe or persistent lesions, where complete microbial eradication is more difficult [3] [22].

In the context of periapical disease, orthodontic movement of teeth may affect preexisting lesions [4]. While orthodontic forces are typically light, gradual, and non-abrupt, and have minimal impact on the healing of periapical lesions [23], complications can still arise, especially in endodontically treated teeth. These mild forces compress the periodontal ligament slightly, promoting tooth movement without disrupting the tissue and cellular processes involved in apical and periapical repair. However, if forces are excessive, they can lead to complications such as apical root resorption and periodontal issues [4]. Despite the generally low risk, it is important to recognize that such complications can occur, although they are rare and can usually be managed effectively.

The timing for orthodontic tooth movement post-root canal therapy depends on factors such as the extent of periapical lesion resolution, the presence or not of external resorptions, the degree of dental trauma... [24].

When the conditions are favorable, orthodontic tooth movement can be initiated soon after endodontic treatment without impairing the healing of apical and periapical tissues [3] [23].

Even so, a recommended waiting period of 7 to 15 days, or even up to 30 days and follow-up with periapical radiographs every three months are advised [23].

In cases where orthodontic forces are applied immediately after endodontic treatment and failure occurs, the failure should be attributed to the inherent technical limitations of both specialties rather than to the orthodontic movement itself [23].

When endodontic and orthodontic treatments are performed concurrently, priority should be given to endodontic therapy, as it forms the foundation for subsequent orthodontic procedures [4] [23].

Thus, a comprehensive clinical assessment is crucial for determining the most appropriate treatment strategy and optimizing patient outcomes. A collaborative and integrated approach between the endodontist and orthodontist is fundamental to the successful management of these cases, ensuring that both specialties work synergistically to achieve the best possible results.

4. Complications of Orthodontic Movement on Endodontically Treated Teeth and Treatment Recommendations

4.1. Endodontically Treated Teeth and Orthodontically Induced Inflammatory Root Resorption (OIIRR)

Most studies have found no significant differences in the incidence or the extent of Orthodontically induced inflammatory root resorption (OIIRR) between vital and endodontically treated teeth and well-executed endodontic treatment was performed [5] [13].

The key criteria for determining the quality of the root obturation are radiographic images showing a dense, well-compacted root filling that extends as close as possible to the apical foramen [5].

Biologically, this suggests minimal microbial presence, reducing the likelihood of an inflammatory response in the surrounding tissues. While OIIRR could activate bacteria or toxins in dentinal tubules or apical areas, well-treated teeth typically have minimal bacteria, reducing the risk of harm.

Even with apical protrusion of the root filling, the risk of apical pathosis remains low in properly treated teeth [23] [25].

In contrast, poorly treated endodontic cases, where more bacteria are likely present, may be more susceptible to exposure during OIIRR [13], potentially leading to reinfection and exacerbating apical resorption. Therefore, teeth with poor-quality root fillings, especially those showing signs of apical pathosis on radiographs, should undergo endodontic retreatment prior to orthodontic movement. The overall recommendation is that root-filled teeth should be “well-cleaned, shaped, and obturated” to minimize risks [5].

When resorption is linked to infection, immediate root canal treatment should be initiated. The canal should be medicated with calcium hydroxide for a period of three weeks, with the medication being replaced every three months until radiolucencies associated with the resorptive lesions resolve. Final root canal obturation can be performed once radiographic evidence of bone repair is observed. Orthodontic movement should only begin after the infection is under control and the clinical results are stable. Continuous radiographic monitoring is essential throughout the treatment. At the outset of treatment, the objectives of orthodontic therapy may need to be adjusted or limited. Whenever possible, it is beneficial to exclude the affected teeth from orthodontic forces, whether partially or entirely [21].

4.2. Periapical Lesion Recurrence and Orthodontic Treatment

Other factors, independent of orthodontic forces, may contribute to the persistence,

partial regression, or worsening of the periapical lesion. They require a reassessment of the initial endodontic treatment, particularly regarding its ability to completely eliminate the microbiota and seal the spaces occupied by it [17] [23]. Anatomical irregularities, such as apical deltas, dilacerations, and developmental grooves, could also hinder the effectiveness of endodontic treatment in eradicating bacteria, making the presence of these factors critical to the overall success of the therapy [23] [26].

It is important to note that attributing failure solely to orthodontic movement is not appropriate: Orthodontic forces do not affect the pathogenicity or virulence of the microbiota involved, nor do they interfere with microbial biofilms or the biology of chronic inflammatory periapical lesions. The soft tissue in the apical and periapical regions, formed by the old granuloma or new granulation tissue, is not susceptible to compression by orthodontic forces. The periodontal ligament, while delicate, does not obstruct the movement of orthodontic forces through the broader area of soft tissue repair [23] [27].

From a biological standpoint, orthodontic forces do not negatively impact the repair of chronic periapical lesions following appropriate endodontic treatment. In fact, a waiting period of 15 to 30 days post-endodontic treatment allows for the absorption of exudate and the migration of inflammatory infiltrate, leaving only macrophages and repair cells in the area. After this period, orthodontic tooth movement can be safely initiated without compromising the healing process [23] [27].

5. Conclusions

- Orthodontic treatment for endodontically treated teeth requires careful planning and coordination between the endodontist and orthodontist to ensure optimal outcomes.
- Properly executed endodontic therapy, including thorough cleaning and sealing of the root canal, minimizes the risks of complications such as root resorption and infection.
- Close monitoring and radiographic evaluation are essential to manage and address any complications that may arise during treatment.

Ultimately, a collaborative approach between the two disciplines is key to ensuring the success of orthodontic interventions in endodontically treated teeth.

Conflicts of Interest

The authors declare no conflicts of interest.

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