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The Effect of Orthodontic Therapy on Periodontal Health

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Abstract

Orthodontic therapy plays a pivotal role in correcting malocclusions and enhancing dental aesthetics. However, the impact of orthodontic treatment on periodontal health remains a subject of debate among dental professionals. This review aims to provide a comprehensive overview of the effects of orthodontic therapy on periodontal health, highlighting both positive and negative outcomes. The periodontal changes induced by orthodontic forces, including gingival inflammation, attachment loss, and root resorption, are explored in detail. Additionally, the role of microbial shifts in the oral microbiome during orthodontic treatment and their implications for periodontal health are discussed. Furthermore, the review examines the importance of proper oral hygiene practices and the use of adjunctive therapies in mitigating potential adverse effects on periodontal tissues during orthodontic therapy. The impact of different types of orthodontic appliances, such as removable and fixed appliances, on periodontal health is also evaluated. Finally, the review outlines recommendations for clinicians to optimize periodontal health outcomes in orthodontic patients, emphasizing the importance of multidisciplinary collaboration and personalized treatment approaches. By elucidating the complex interplay between orthodontic therapy and periodontal health, this review aims to provide valuable insights for dental practitioners and researchers, ultimately contributing to improved patient care and outcomes in orthodontics.

Keywords: *Orthodontic Therapy, Periodontal Health, Pathological Changes, Root Resorption, Safe Orthodontics.*

Introduction

Orthodontic treatment is commonly utilized to correct malocclusion and improve dental esthetics and function. However, it can also affect periodontal tissues, leading to various pathological changes[1][2]. Understanding the impact of orthodontic therapy on periodontal health is crucial for both orthodontists and periodontists to ensure optimal treatment outcomes and long-term stability [3]. Orthodontic treatment assures proper tooth alignment and optimizes the jaw and soft tissue relationships. This not only improves mastication, speech, and facial esthetics, but it also benefits general and oral health, increasing quality of life [4]. Orthodontic treatment, like all other treatment options, has risks and complications. However, treatment has been shown to have significantly lower risk and complication rates than other interventions aimed at the same intention [5]. In this direction, the most frequently reported side effects of the said orthodontic therapy can both be local or systemic.

Major local side effects include tooth discolourations and decalcification, resorption of root and periodontal changes [6] It has also been demonstrated that orthodontic forces are a physical agent inducing a response of inflammation in the periodontium [7]. However, This inflammatory reaction is essential for the tooth movement [8]. The major challenge faced by orthodontics is to complete the therapy procedure with minimal impact on the root and periodontium. The purpose of this

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overview review is to underscore the risk issues in orthodontics, such as periodontal complications and root resorption.

Periodontal Changes during Orthodontic Treatment

Periodontal means around the tooth, precisely it refers to the structures surrounding and supporting the teeth such as gums, periodontal ligament, cementum, and the alveolar bone. When orthodontic forces are exerted, the compression side is the side where the tooth is being pushed, technically compressing the periodontal ligament causing bone resorption. Conversely, The tension side is where the tooth is being pulled, applying tension to periodontal ligament leading to the formation of bone. Interdental papillae are the pyramidal portions of gum tissue present between teeth, acting to prevent food impaction and caries.

Orthodontic forces exerted on teeth during treatment can lead to alterations in the periodontium. These changes are a result of the mechanical forces applied by orthodontic appliances and can have both beneficial and detrimental effects on periodontal health [9]. These changes include gingival inflammation, periodontal ligament remodelling, and alterations in alveolar bone density [10]. Prolonged orthodontic treatment may exacerbate these changes, resulting in periodontal attachment loss and gingival recession. Understanding these periodontal changes is essential for orthodontists and periodontists to ensure optimal treatment outcomes and long-term stability [11]. Here, we provide a detailed account of the periodontal changes observed during orthodontic treatments.

1. Gingival Changes

One of the most common periodontal changes associated with orthodontic treatment is gingival enlargement or inflammation [12]. This can occur due to the accumulation of plaque and bacteria around orthodontic brackets and wires, leading to gingivitis. Poor oral hygiene practices and inadequate plaque control exacerbate this condition, resulting in gingival bleeding, swelling, and discomfort [13]. Gingival changes can also occur in response to mechanical irritation from orthodontic appliances, especially in areas where brackets and wires come into close contact with the gingival tissues [14].

2. Periodontal Ligament Remodeling

Orthodontic forces applied to the teeth during treatment lead to remodelling of the periodontal ligament [PDL]. Compression forces on the side of tooth movement result in PDL compression, while tension forces on the opposite side cause PDL stretching [15]. This remodelling process facilitates tooth movement by allowing the alveolar bone to undergo controlled resorption and deposition. However, excessive or unbalanced forces can lead to PDL injury and compromise periodontal health[16].

3. Alveolar Bone Changes

Orthodontic tooth movement involves changes in the alveolar bone surrounding the teeth. Bone remodelling occurs in response to mechanical forces exerted by orthodontic appliances, leading to bone resorption on the compression side and bone deposition on the tension side [17]. These changes are essential for facilitating tooth movement and achieving proper occlusal relationships. However, inappropriate force application or prolonged treatment duration can result in localized bone loss or dehiscence and fenestration defects [18].

4. Gingival Recession

Gingival recession, characterized by the apical migration of the gingival margin, can occur as a consequence of orthodontic treatment [19]. Factors contributing to gingival recession during orthodontics include thin gingival biotype, inadequate keratinized tissue width, inappropriate force application, and poor oral hygiene [20]. Bracket placement, archwire

engagement, and orthodontic mechanics can also influence the occurrence and severity of gingival recession[21].

5. Root Resorption

Root resorption is a common pathological change observed during orthodontic treatment, particularly in cases of extensive tooth movement or prolonged treatment duration [22]. Orthodontically induced root resorption [OIIRR] occurs due to the mechanical forces transmitted to the root surface, leading to the loss of root structure [23]. While mild to moderate OIIRR is considered a normal response to orthodontic forces, severe resorption can compromise tooth stability and long-term periodontal health [24].

6. Interdental Papilla Changes

Orthodontic tooth movement can affect the morphology and position of the interdental papillae, leading to changes in their height, contour, and thickness [25]. These changes may result from alterations in tooth inclination, root proximity, and gingival architecture. Proper orthodontic treatment planning and careful management of interdental spaces are essential for preserving the esthetics and health of the interdental papillae [26].

In summary, orthodontic treatment exerts various effects on the periodontal tissues, including gingival changes, periodontal ligament remodelling, alveolar bone changes, gingival recession, root resorption, and interdental papilla changes. While some of these changes are essential for achieving proper tooth alignment and occlusal function, others can pose risks to periodontal health if not managed appropriately. Therefore, a comprehensive understanding of the periodontal changes associated with orthodontic treatment is crucial for delivering safe and effective care to patients. Close collaboration between orthodontists and periodontists is essential to monitor periodontal health during orthodontic treatment and mitigate potential complications [27].

Pathophysiology of Periodontal Changes During Orthodontics

The pathophysiology of periodontal changes during orthodontic treatment involves a complex interplay of mechanical forces and biological responses. Orthodontic forces induce cellular and molecular changes in periodontal tissues, leading to tissue remodelling and adaptation [28]. However, excessive or uncontrolled forces can cause tissue damage, inflammation, and bone resorption. Orthodontic treatment exerts mechanical forces on the teeth, which induce various periodontal changes. Understanding the pathophysiology of these changes is essential for orthodontists and periodontists to ensure optimal treatment outcomes and periodontal health. When Osteoclasts are activated they remove bone and conversely, when osteoblasts are activated they deposit bone. So, when resorption is needed former is activated and deposition is needed latter is activated, Here, we delve into the pathophysiological mechanisms underlying periodontal changes during orthodontic therapy.

1. Mechanical Forces

Orthodontic appliances, such as brackets, wires, and elastics, apply mechanical forces to the teeth, leading to tooth movement. These forces generate tension and compression within the periodontal ligament [PDL] and surrounding alveolar bone, initiating a cascade of cellular and molecular events [29].

2. Periodontal Ligament Remodeling

The PDL plays a crucial role in anchoring teeth to the surrounding alveolar bone. Orthodontic forces induce PDL remodelling, characterized by cellular activities such as osteoclast-mediated bone resorption and osteoblast-mediated bone formation [30]. Compression forces on the side of tooth movement lead to PDL compression and bone resorption, while tension forces on the opposite

side cause PDL stretching and bone deposition [31].

3. Cellular Responses

Orthodontic forces stimulate various cell types within the periodontium, including fibroblasts, osteoblasts, osteoclasts, and cementoblasts. Fibroblasts in the PDL produce collagen fibres and extracellular matrix components in response to mechanical stimuli, contributing to tissue remodelling [32][33]. Osteoblasts and osteoclasts participate in bone remodelling processes, facilitating tooth movement by resorbing bone on the pressure side and depositing bone on the tension side.

4. Inflammatory Response

Orthodontic treatment can trigger an inflammatory response in the periodontal tissues, particularly in areas of mechanical stress. This localized inflammation is characterized by increased vascular permeability, immune cell infiltration, and cytokine release [34][35]. While acute inflammation is necessary for initiating tissue remodelling processes, chronic inflammation can lead to periodontal tissue breakdown and gingival pathology if left unchecked [36].

5. Vascular Changes

Orthodontic forces induce changes in the vascular supply to the periodontal tissues, altering blood flow and nutrient delivery [37] Blood vessels within the PDL undergo remodelling in response to mechanical stress, leading to changes in vessel density, diameter, and permeability [38]. Proper vascularization is essential for supporting tissue repair and maintaining periodontal health during orthodontic treatment.

6. Extracellular Matrix Remodeling

The extracellular matrix [ECM] of the periodontal tissues undergoes remodelling in response to orthodontic forces [39]. Collagen fibres, glycoproteins, and proteoglycans within the ECM are reorganized to accommodate tooth movement and stabilize the dentition [40]. Dysregulation of ECM remodelling processes can lead to periodontal tissue laxity, loss of attachment, and gingival recession.

In summary, the pathophysiology of periodontal changes during orthodontic treatment involves a complex interplay of mechanical forces, cellular responses, inflammatory processes, vascular changes, and ECM remodelling. While these changes are essential for facilitating tooth movement and achieving proper occlusal relationships, they can also pose risks to periodontal health if not carefully managed. Close monitoring of periodontal status, appropriate force application, and comprehensive oral hygiene practices are essential for minimizing adverse effects and ensuring optimal treatment outcomes. Collaboration between orthodontists and periodontists is critical for addressing periodontal concerns and optimizing patient care during orthodontic therapy. Pathological changes are summarised in table 1 and root resorption is summarised in table 2.

Root resorption is a potential complication of orthodontic therapy that requires careful monitoring and management. By understanding the underlying mechanisms of resorption, implementing preventive strategies, and collaborating with other dental professionals, orthodontists can minimize the risk of root resorption and optimize treatment outcomes for their patients.

Safe Orthodontics to Prevent Pathological Changes

To minimize adverse periodontal effects during orthodontic treatment, several strategies can be employed:

1. Proper diagnosis and treatment planning to assess periodontal health before initiating orthodontic therapy.
2. Use of light and controlled forces to minimize tissue damage and root resorption.

3. Regular monitoring of periodontal status during treatment to detect and address any adverse changes promptly.
4. Maintenance of good oral hygiene practices, including regular brushing, flossing, and professional cleanings.
5. Collaboration between orthodontists and periodontists to manage complex cases and mitigate potential complications.

Table 1. Pathological Changes Induced by Orthodontic Appliances and Methods to Prevent Them

Type of Appliance	Pathologic Changes Induced	Methods to Prevent Pathology
Traditional Braces	Gingival Inflammation, Root Resorption, Gingival Recession	Proper force application, Regular monitoring, Oral hygiene education
Clear Aligners	Soft Tissue Irritation, Gingival Inflammation	Interproximal Reduction, Smooth Aligner Edges, Oral Hygiene Instructions
Palatal Expanders	Palatal Tissue Discomfort, Gingival Recession	Proper Activation Protocol, Oral Rinses, Soft Diet
Lingual Braces	Lingual Tissue Irritation, Gingival Recession	Customized Bracket Design, Patient Education, Periodic Adjustments

Table 2. Root Resorption During Orthodontic Treatment

Serial Number	Classification	Force Level	Aetiology	Histologic Features
1	External Root Resorption [ERR]	High force levels	Excessive orthodontic force	Cementum loss, dentin lacunae, hyalinization
2	Internal Root Resorption [IRR]	Moderate force levels	Trauma, orthodontic force	Pulp obliteration, dentin resorption, pulp canal calcification
3	Surface Root Resorption [SRR]	Low force levels	Mechanical trauma, inflammation	Cemental resorption, periodontal ligament disruption

Conclusion

Orthodontic therapy can have significant effects on periodontal health, including gingival inflammation, root resorption, and other pathological changes. Understanding the pathophysiology of these changes and implementing safe orthodontic practices are essential for preserving periodontal tissues and achieving successful treatment outcomes.

Conflict of interest

There is no conflict of interest.

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