

Assessing Root Resorption: A Comprehensive Review of Self-Ligating Vs. Conventional Bracket Systems In Orthodontics

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ABSTRACT

Orthodontic treatment is a widely practiced method for correcting malocclusions and enhancing dental aesthetics. Root resorption is one of the side effects of orthodontic therapy that can cause irreversible harm to the structure of the tooth. In-depth analysis of the literature on root resorption during orthodontic treatments is the goal of this review article, which also compares the prevalence and extent of root resorption that occur between self-ligating and traditional brackets. We discuss the fundamental causes of root resorption in patients receiving orthodontic treatment as well as risk factors and prophylactic measures.

Keywords: Orthodontics, root resorption, self-ligating brackets, conventional brackets, incidence, severity, risk factors, prevention, ethical considerations.

INTRODUCTION

Orthodontic treatment is a widely embraced approach for correcting malocclusions, improving dental aesthetics, and enhancing oral health. This transformative process involves the application of mechanical forces to reposition teeth within the dental arch, ultimately achieving a harmonious and functional occlusion. While orthodontic treatment offers a multitude of benefits, it is not without potential risks and complications.¹ Among these, orthodontically induced root resorption (OIIRR) stands as a notable concern, because it may result in irreversible harm to the tooth structures and jeopardise the teeth sustainability. Resorption of roots is a biological phenomenon characterized by the loss of root structure through the resorptive activity of specialized cells known as odontoclasts. In orthodontics, OIIRR refers to root resorption directly resulting from orthodontic forces and movements.² Although not a universal outcome of orthodontic treatment, OIIRR is a topic of considerable interest and concern within the orthodontic community. The complex realm of resorption of root during orthodontic treatment is explored in this review paper, which compares the frequency and severity of this issue across two widely accepted bracket systems: conventional brackets and self-ligating brackets. The bracket system is a pivotal component of orthodontic treatment, serving as the medium through which forces are applied to teeth. Self-ligating brackets are becoming increasingly common, however, conventional brackets have been the mainstay of orthodontic practice for decades.³ As orthodontists and researchers continue to explore the merits and drawbacks of these bracket types, it becomes crucial to consider their potential influence on OIIRR. Thus complete Understanding of a bracket system may help guide treatment planning as it is related to increased or decreased risk of root resorption. help orthodontists make informed decisions, and improve patient outcomes.^{4,5} The goal of this thorough analysis is to present a comprehensive viewpoint on resorption of roots due to orthodontic brackets treatment, highlighting the differences and similarities between the self-ligating and traditional brackets..

ROOT RESORPTION: MECHANISMS AND ETIOLOGY

One intricate and varied phenomena that results from orthodontic treatment is called orthodontically induced root resorption (OIIRR). Understanding the

underlying mechanisms and etiological factors contributing to OIIRR is crucial for both orthodontic practitioners and researchers.⁶ OIIRR is primarily mediated by specialized cells known as odontoclasts, which are functionally similar to osteoclasts responsible for bone resorption. These odontoclasts are activated in response to mechanical forces applied during orthodontic treatment. The periodontal ligament, which surrounds the tooth root, develops areas of tension (tension zone) and compression (pressure zone) during tooth movement.⁷ Pressure zones stimulate odontoclastic activity, leading to root resorption. Mechanoreceptors in the PDL detect changes in mechanical loading. These receptors transmit signals to the odontoclasts, triggering their resorptive activity. Osteoprotegerin (OPG), its ligand, receptor activator of nuclear factor-kappa B (RANK) all play essential roles in controlling odontoclast activity and development. Mechanical forces can disrupt the balance of these molecules, leading to increased odontoclast activity and subsequent root resorption.⁸ Interleukin-1 (IL-1) and tumour necrosis factor-alpha (TNF- α) are examples of inflammatory mediators that can increase odontoclast's capacity for resorption. Some individuals may exhibit a heightened genetic propensity for root resorption, making them more vulnerable to this adverse effect.⁹ Environmental factors, such as systemic health conditions, hormonal fluctuations, and medication use, can impact the severity of OIIRR. For example, a increased risk of developing severe root resorption may exist in patients with certain systemic disorders or in people with hormonal abnormalities. Factors associated with the treatment, such as the strength and direction of orthodontic forces, the duration of the procedure and the mechanics employed, can significantly influence the development of OIIRR. High or prolonged force application and certain orthodontic techniques may increase the risk.¹⁰

OCCURRENCE AND SEVERITY OF ROOT RESORPTION

In orthodontic therapy, apical root resorption (ARR), a condition characterised by the irreversible loss of parts of root structure at the apex, is a major problem. It affects a significant proportion of orthodontic patients, however its prevalence varies greatly. While severe ARR is less common, when it does occur, it can result in a substantial reduction in root length, potentially affecting the tooth's stability and long-term health.^{11,12} Traditional orthodontic treatment relies on fixed appliances, but clear aligners, like the Invisalign system, have gained popularity due to their aesthetic and comfort advantages. However, the impact of the appliance type on the incidence of ARR remains a subject of debate. Some studies suggest that clear aligners may exhibit a similar or even lower prevalence of ARR compared to fixed appliances.¹³ However, it's essential to ensure that the complexity of cases, the extent of required tooth movement, and treatment outcomes are comparable for a fair comparison. Moreover, the accuracy of ARR assessment tools can influence the reported prevalence. While panoramic radiography may overestimate ARR, three-dimensional radiography methods, like cone beam computed tomography (CBCT), have shown higher accuracy in diagnosing and measuring ARR.^{14,15} Given the three-dimensional nature of ARR, the limitations of two-dimensional radiography methods should be considered when evaluating this condition during orthodontic treatment.^{16,17,18}

SELF-LIGATING BRACKETS VS. CONVENTIONAL BRACKETS

In orthodontics, the choice of brackets is a crucial decision that can significantly influence treatment outcomes and patient experiences. Two common types of brackets are self-ligating brackets and conventional brackets. Self-ligating brackets are characterized by their unique design, which

eliminates the need for traditional elastic or metal ligatures (ties) to secure the archwire in place. Instead, self-ligating brackets have built-in mechanisms, such as clips or doors, that hold the archwire. Self-ligating brackets typically generate less friction between the archwire and bracket, potentially leading to more efficient tooth movement and faster treatment times.^{18,19} Patients may find self-ligating brackets easier to maintain because they do not require frequent ligature changes. With no ligatures to trap food particles, self-ligating brackets may facilitate better oral hygiene during treatment.²⁰ Self-ligating brackets tend to be more expensive than conventional brackets, which can impact the overall cost of orthodontic treatment.²¹ Conventional brackets have been the standard in orthodontic treatment for many years. They consist of brackets that are attached to the teeth and secured with elastic or metal ligatures.²² Conventional brackets are typically more cost-effective than self-ligating brackets, making orthodontic treatment more accessible. The ligatures used in conventional brackets can create more friction between the archwire and bracket, potentially leading to longer treatment times.^{23,24} Oral Ligatures can trap food particles, making oral hygiene maintenance more challenging for some patients.

REVIEW OF LITERATURE

In a study by Vanessa Leite, two types of brackets were used in 19 patients with Angle Class I Malocclusion with anterior crowding underwent orthodontic treatment. Cone beam computed tomography (CBCT) scans were used in the study to evaluate the external apical Root resorption (EARR) in the upper and lower incisors both before and after six months of treatment. Patients with complete permanent dentition, ranging in age from 11-30, those who received orthodontic treatment in the past or show symptoms of EARR were not included. Ethical approval was obtained, and all patients were provided informed consent. Both groups were given

the same sequence of nickel-titanium archwires throughout the first phase of levelling and alignment, with each archwire lasting two months. At the beginning of treatment and six months later, CBCT scans were performed. Using specialised software, the scans were examined to assess EARR in the upper and lower incisors. There was no statistically significant difference in the degree of EARR between the two bracket groups, according to statistical analysis. The power analysis confirmed the adequacy of the sample size for detecting differences. Intraexaminer agreement in measuring EARR was excellent, indicating the reliability of the CBCT method used. The study found that the average EARR in all incisors was approximately 0.35 mm, which is considered small and clinically irrelevant. The findings showed that during the first six months of orthodontic treatment, the type of bracket (conventional or self-ligating) had no discernible impact on the degree of EARR. Additional extended research is required to verify these results. Based on the study findings, it can be concluded that the kind of bracket (passive self-ligating or traditional preadjusted) did not seem to have an effect on the degree of apical root shortening during the first six months of orthodontic therapy.²⁵

Jianru Yi and colleagues conducted a study with the purpose of evaluating and comparing external apical root resorption (EARR) in patients receiving fixed orthodontic treatment between self-ligating and traditional brackets. Through a comprehensive search of various databases and manual searches in relevant sources, seven studies were included in their systematic review. A meta-analysis of five of these studies showed that the group receiving self-ligating brackets had a significantly lower EARR in their maxillary central incisors than the group receiving conventional brackets (SMD -0.31; 95% CI: -0.60 to -0.01). However, when comparing the two bracket types, no discernible variations in ARR were seen among other incisors. The study concludes that self-ligating brackets do not necessarily outperform

conventional brackets in reducing EARR in specific incisors, except for their potential advantage in protecting maxillary central incisors, though further high-quality research is needed to confirm this finding.²⁶

In a study led by Tanvi Sharma and her team, the aim was to address the growing inquiry regarding whether self-ligating brackets have any distinct impact on Early Apical Root Resorption (EARR) compared to traditional brackets. To provide clarity on the advantages, disadvantages, and effects of these bracket types on EARR, a meta analysis & a critical review were carried out. Extensive manual and electronic searches were conducted, involving databases like PubMed, EMBASE, and the Cochrane library up to June 2022. The research compared the outcomes between conventional and self ligating brackets for the study participants who had undergone fixed orthodontic treatment. Data extraction and evaluation of bias risk were carried out, followed with statistical pooling using the software Review Manager 5.4. The meta-analysis and systemic review incorporated seven studies, revealing that self-ligating brackets exhibited less EARR for maxillary central incisors in comparison with conventional brackets. However, there was little disparity in values for corresponding lateral incisors. For mandibular central incisors, most studies showed no significant differences, and a similar trend was observed for mandibular lateral incisors, where EARR values remained relatively consistent for both bracket types. In conclusion, based on the gathered data and existing literature, self-ligating brackets have benefits over conventional brackets with respect to several aspects.²⁸

In a study led by Isil Aras and her team, by utilizing CBCT, the objective was to compare external root resorption (ERR) volumetrically in maxillary incisors using self-ligating brackets (Damon Q, DQ) and conventional brackets (Titanium Orthos, TO) induced by orthodontic treatment. The study conducted with

32 participants having Angle Class I malocclusion and 4–10 mm of anterior crowding, 2 groups were separated randomly: the DQ group, treated with self-ligating DQ brackets and Damon archwires, and the TO group, treated with conventional TO brackets and large Orthos archwires. Before (T1) and near to completion of 9 months after treatment initiation; T2) of orthodontic treatment, CBCT scans were taken. ERR was assessed volumetrically by Mimics software. Though significant differences were exhibited in both groups of root volume between T1 and T2 ($p < 0.05$), there was no discernible difference between the groups in terms of the amount of ERR (mm³ or relative change; $p > 0.05$). Similar volume loss ($p > 0.05$) were seen in maxillary central incisors & maxillary lateral incisors. Notably, compared to the DQ group ($p < 0.05$) TO group had a higher incidence of palatal and proximal slanted ERR. In conclusion, the study did not establish the superiority of one bracket system over the other based solely on pattern of root resorption or quantity. The higher incidence of slanted ERR observed in patients treated with the TO system warrants further investigation for identification of potential specific causes.²⁹

In a study conducted by Roberta Heiffig Handem and colleagues, during orthodontic treatment the extent of external apical root resorption (EARR) in patients with self-ligating Damon appliances and conventional preadjusted appliances were compared. The study included a sample of 52 patients, divided into 2 groups. Group 1 consisting of 25 subjects treated with Damon appliances (self ligating), with an initial age, final age and a treatment duration are 16.04 years, 8.06 years and 2.02 years respectively. Group 2 comprised 27 patients treated with conventional preadjusted appliances, with an initial age of 16.77 years, final age of 18.47 years, and a treatment duration of 1.70 years. The groups in terms of initial and final ages, treatment duration, malocclusion type, and treatment protocol without extractions were correctly matched. Periapical radiographs of the maxillary and mandibular incisors

at the conclusion of orthodontic treatment were used to assess root resorption, using the Levander and Malmgren scoring system. The study's findings reveals that degree of root resorption between the two appliance groups has no significant differences. Consequently, it can be inferred that similar levels of root resorption following non-extraction orthodontic treatment were to be expected, whether using Damon self-ligating or conventional preadjusted appliances.³⁰

CONCLUSION

This comprehensive review article provides valuable insights into root resorption during orthodontic treatment with self-ligating or conventional brackets. It highlights the importance of understanding the mechanisms, risk factors, and preventive strategies associated with root resorption to improve patient outcomes and ensure ethical orthodontic practice. Overall, the conclusions from studies reviewed suggest that while there may be certain advantages associated with self-ligating brackets in specific cases of orthodontic treatment, there is no clear consensus that they consistently outperform conventional brackets in reducing root resorption. Further research is needed to understand the nuances of these differences and to determine the best bracket choice on a case-by-case basis.

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