Root resorption in endodontically treated teeth that have been subjected to orthodontic forces

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ABSTRACT

Root resorption, also known as external apical resorption or induced apical resorption, expressed as apical rounding, is one of the most recurrent findings in orthodontic practice. This pathology, when it occurs due to orthodontic movement, is a consequence of the mechanical and physiological reactions that occur at the cellular level. These reactions are part of the apical remodeling process, and are therefore inevitable in most cases, and acceptable in orthodontic practice. The search for orthodontic treatment by adult patients is growing more and more, which leads to an increase in the number of pulped teeth subjected to orthodontic forces. In view of this fact, studies comparing the consequences of these mechanotherapies in pulped teeth in relation to vital teeth in the context of root resorption are pertinent. This study aims to evaluate root resorptions induced by orthodontic movements in teeth previously treated endodontically. Research on root resorption comparing vital teeth and pulped teeth uses animal studies, radiographic analyses, histological studies and clinical cases. Studies have shown that it cannot be confirmed that endodontically treated teeth have greater resorption, showing that they move just like vital teeth when submitted to orthodontic treatment and that root resorption is a multifactorial phenomenon. Therefore, it is recommended to wait for the success of the endodontic treatment to be proven, as well as the elimination of all inflammatory exudate, so that orthodontic treatment can begin.

Keywords: Root Resorption, Endodontics, Orthodontic Movement.

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INTRODUCTION

With the advances in modern orthodontics, the contingent of adult patients who seek a more harmonious, functional and visually pleasing smile through orthodontic treatment has grown in recent years. In contrast to the past, in which it was believed that orthodontic treatment was restricted only to children and adolescents who had perfect teeth, absent endodontic treatment (Banzatto et al. 2005)

Adult patients have oral conditions that are different from those of other age groups. Some conditions may be unfavorable to orthodontic mechanics, such as periodontal diseases, endodontically treated teeth, severe wear due to parafunctional habits, and tooth loss.

Orthodontic treatments affect the pulp and periodontal ligament, which can result in root resorption or loss of vitality. Root resorption is the result of a complex combination of factors inherent to each patient and the mechanical forces employed. It can occur in 39% to 99% of orthodontic patients. (Reukers, et al. 1998; Brezniak, Wasserstein, 1993)

Orthodontic tooth movement can cause degeneration and/or inflammatory responses in the dental pulp of teeth with complete apical formation. The impact of tooth movement on the pulp is primarily focused on the neurovascular system, where the release of specific neurotransmitters (neuropeptides) can influence blood flow and cellular metabolism. Responses induced in the pulp may have an impact on the initiation and perpetuation of apical root remodeling or resorption during tooth movement. The severity of these changes may be influenced by previous or ongoing insults to the dental pulp, such as the incidence of trauma or caries.

Considered one of the most common findings in orthodontic clinical practice, root resorption is considered a "side effect". Several studies have addressed the relationship between root resorption and orthodontic movement in vital teeth (Santos, et al. 2007; Younis et al.2008; Camargo, et al. 2008;). Despite this, the cause or prognosis of resorption has not yet been concretely elucidated, and this also applies to pulped teeth that have undergone orthodontic treatment. There is no evidence that the frequency or extent of root resorption is higher or lower in previously endodontically treated teeth (Goldner et al., 2002).

Generally, this pathology does not present symptoms, and can only be detected through radiographic examinations. Thus, it is of great importance that radiographic examinations are performed frequently so that resorption is diagnosed early, for the most favorable treatment and prognosis (Westphalen, 2002).

Wickwire (1974) reports that endodontically treated teeth are more susceptible to fractures, ankyloses and root resorption when they are subjected to orthodontic forces. However, when compared to root resorption, some claim that these teeth behave in the same way as vital teeth (Spurrier et al., 1990). Others show that endodontically treated teeth are more susceptible to root

resorption (Wickwire et al., 1974; Komorowski 1997) and yet there are studies that state that vital teeth are more sensitive to resorption than pulped teeth (Spurrier et al., 1990; Lee, 2016).

Thus, in view of the lack of concrete answers about the interrelationship between endodontics and orthodontics, the present study aims to investigate, through a literature review, whether teeth previously treated endodontically are more susceptible to root resorption, when moved orthodontically.

METHODOLOGY

The aim of this study was to perform a literature search to evaluate the relationship of external root resorption in orthodontic movement when the tooth is already endodontically treated.

The search tools were online databases, such as PubMed (www.pubmed.org) and Scielo (https://scielo.org). The search strategy included the following keywords: "orthodontic treatment" AND "root resorption" and was conducted in February 2024. The most relevant articles for the topic in question published in the last ten years were selected for bibliographic survey, as well as classic articles that the authors considered pertinent.

When the complete study was not available in the databases, the search was used using the Portal de Periódico/CAPES (www.periodicos.capes.gov.br) platform. A descriptive analysis of the articles was performed. After a broad reading of the articles of choice, the main information was selected in order to organize the references for the complete development of the objective proposed to the present work.

LITERATURE REVIEW

Root resorption is one of the most frequent complications associated with orthodontic treatment (Goultschin et al., 1982; Copeland et al., 1986 ; Spurrier et al., 1990; Brenzniak et al., 1993; Blake et al., 1995; Goldner et al., 2002). Root resorption associated with orthodontic treatment is classified as inflammatory resorption (Consolaro, 2002). It occurs during induced tooth movement due to compression of the microvessels of the periodontal ligament, leading to necrosis of the cementoblasts. After cementoblast necrosis, the root surface will be unprotected, allowing osteoclasts, originating from the neighboring bone, to migrate to this region and organize themselves into osteoremodeling units, thus initiating the resorption of exposed dentin, resulting in root resorption linked to orthodontic movement.

The predisposition to tooth resorption is directly associated with root morphology (shape, length, thickness, and crown and root angle), bone morphology (height, thickness, and shape of the alveolar crest), individual susceptibility, genetic influence, sex, age, endocrine changes, hormonal

imbalance, parafunctional habits, previous trauma (Consolaro, 2002; Samesshima and Sinclair, 2001; Al-Qawasmi et al., 2003).

In most cases, the resorption resulting from orthodontic movement is minimal and of no clinical significance, reaching mean values of 0.5 to 3 mm of root shortening. These resorptions affect the majority (90.5%) of the vital teeth treated orthodontically, especially incisors, which are always repaired by cellular cementum. Therefore, orthodontics coexists peacefully with root resorption during treatment (Brezniak, Wasserstein, 1993a, Brezniak, Wasserstein, 1993b; Harris, 2000; Henry, Weinmann, 1951; Spurrier et al., 1990).

According to Malmgren et al. (1982), apical tooth resorption can be associated with orthodontic movement, on a progressive scale according to its magnitude, where: Grade 0 represents no root resorption, Grade 1 or minimal resorption only irregular apical contour; Grade 2 resorption or moderate resorption, resorption presents with less than 2mm reduction in root length; Grade 3 or severe resorption, where the apical region has resorption greater than 2 mm to a third reduction from the original length; Grade 4 or extreme resorption when the reduction is greater than one-third of the original root length.

According to Remington et al. (1989), teeth that had previously undergone endodontic treatment would have a slower response to the absorbtive capacity of root resorptions, since endodontic treatment increases dentin density.

According to the morphology of the tooth structure and the existence of previous root resorption, individuals predisposed to root resorption can be identified. Lavander, Malmgren and Eliasson (1994) presented a study in which they evaluated radiographs of the dental roots taken prior to orthodontic treatment, after 6 to 9 months after treatment and after its completion. It was found that the degree of resorption was significantly higher in teeth that already had a small resorption or irregular apex prior to treatment than in teeth without resorption.

Mirabella and Artun (1995) evaluated the prevalence and severity of root resorption of maxillary anterior teeth in a sample of 343 adult patients. It was hypothesized that teeth that were treated endodontically had less apical resorption, to make this evaluation, periapical radiographs were taken before and after orthodontic treatment. It was concluded that the endodontically treated teeth showed a lower degree of resorption than the vital teeth.

In 1997, Bender et al. reported two cases, the first of which was a 7-year-old and 2-month-old female patient, who suffered a trauma to the left upper central incisor. The patient underwent an apicification treatment using calcium hydroxide and she was referred to an orthodontist in order to correct her class II malocclusion with horizontal overjet. After about 9 months, the left maxillary central incisor was filled. After 4 years, periapical radiographs for control were taken, where root resorption could be observed in the right maxillary central incisor and in the maxillary lateral incisors

on both sides. The pulped tooth did not show any sign of resorption at its root. When the patient turned 14 years old, the orthodontic apparatus was removed and new radiographs were taken, where a greater resorption in the vital tooth and a slight resorption in the pulped tooth were found. After 6 years, control radiographs revealed a distinct resorption process in the vital teeth, with rounding of the resorbed roots. A resorption process was also evidenced in the endodontically treated tooth, which revealed a rounding of the apex and an increase in bone density. The second case presents a 15-year-old individual, who at the age of 7 years suffered a trauma to the maxillary central incisor, in which endodontic treatment was performed, where a radiolucent region was maintained due to the non-closure of the apex, due to the interruption of root development. So the apicification treatment was chosen with the objective of inducing the formation of a calcified barrier. Orthodontic treatment was initiated after the first dressing change, and two more were performed later. Apical maturation occurred after 10 months of treatment, thus showing that orthodontic treatment does not interfere in the process of apical maturation of the central incisors submitted to endodontic treatment. At the 4- and 8-year follow-up visits, periapical radiography showed root resorption in the homologous central incisor. Thus, the authors suggested that endodontically treated teeth create an alkaline environment that leads to bounded apical resorption after being exposed to orthodontic mechanics. They concluded that previous endodontic treatment should be performed when orthodontic treatment is anticipated, as the occurrence of apical resorption as a side effect is predictable.

In 2005, Banzatto et al. conducted a study with 20 Brazilian male and female individuals treated orthodontically. The criterion for sample selection was the presence of an upper incisor with endodontic treatment prior to orthodontic treatment and its vital counterpart. The samples were divided into group 1, composed of endodontically treated teeth, and group 2, their vital counterparts, for control and subsequent comparison. Initial periapical radiographs were taken, these prior to orthodontic treatment, and final periapical radiographs. Both radiographs were compared in a negatoscope. After comparisons of the samples evaluated, it was observed that endodontically treated teeth had a lower degree of resorption than their vital counterparts, but the difference between the two groups was not statistically significant.

Sampaio et al. (2006) evaluated incisor and premolar roots of 2 adult crossbred dogs in order to histomorphologically evaluate the consequences of orthodontic movement on the healing process of chronic periapical lesions. The lesion was formed in an induced manner, through coronary opening and pulpectomy up to the cementodentin junction with exposure of the canals for six months. After this period, these teeth were X-rayed and filled in two sessions. The control group was composed of five mandibular premolars, which were also submitted to the same process. In the first session, two mandibular central incisors were extracted to make it possible to perform orthodontic movement, which was performed for 5 months and 15 days, following a protocol of changing elastics

every 21 days. At the end of this period, the device was removed and the samples were prepared for histological analysis. The results revealed that the roots of the control group presented several areas of apical resorption, of diversified extensions and depths. In the group that was subjected to orthodontic forces, seven treated teeth showed biological closure at the apical foramen level. In the group exempt from orthodontic movement, seven teeth presented closure of the foramen through newly formed cementum. In half of the cases, a well-organized periodontal ligament could be found. A mild inflammatory reaction can be seen in four cases. This experiment concluded that the healing of chronic periapical lesions was more efficient in the group that did not undergo orthodontic movement. However, the authors of the experiment call attention to the fact that orthodontic movement of teeth with chronic periapical lesions, after endodontic treatment with calcium hydroxide, delays but does not prevent the healing process.

La Fuente Chavéz (2009) evaluated external root resorption in endodontically treated teeth after undergoing orthodontic mechanics. The analyses were performed by means of final digitized panoramic, conventional periapical digitized and direct digital radiography, as well as comparing the radiographic methods that were used. After evaluating orthodontic documentation, 20 teeth were selected from patients with complete orthodontic documentation, good health conditions, aged between 25 and 50 years of both sexes and who had central and lateral incisors, treated endodontically prior to the beginning of orthodontic treatment. From the orthodontic documentation, the initial and final panoramic radiographs were selected, and current periapical radiographs were also taken, one through the conventional technique and the other direct digital. The radiographs were evaluated by 3 specialists (endodontist, orthodontist and radiologist). The specialists had the function of evaluating whether or not external apical root resorption was present in the endodontically treated teeth that were submitted to orthodontic treatment, as well as comparing the methods applied and verifying their reliability. The following parameters were taken into account: periapical lesion, pericentary space, and endodontic treatment limit. According to statistical analyses, the authors concluded that most orthodontists do not use periapical radiographs to evaluate teeth treated endodontically before the beginning of orthodontic treatment, which can compromise the progress and final result of the treatment, since the resorption in the treatment has a symptomatological character in its diagnosis. Regarding external root resorption, the examiners pointed out that there was an increase in this, mostly of the mild and localized type located in the apical region. The most efficient technique for determining this diagnosis by the examiners was direct digital radiography.

In 2012, Llamas Carreras conducted a study with the aim of evaluating external root resorption in endodontically treated teeth and their vital counterparts. A sample of 38 individuals, 14 men and 24 women, previously selected according to the selection criteria, having an upper incisor treated endodontically before the placement of orthodontic bands, having the vital homologous

incisor, evaluated with thermal test, orthodontic therapy with active treatment for more than 1 year. To avoid bias, two radiology assistants were in charge of digital panoramic radiographic shots before and after orthodontic treatment. In these, the measurements were standardized by estimating the greatest distance from the amelodentin junction in each patient. In order to allow intra-patient normalization, a proportion of the resorption of pulped teeth and vital teeth was calculated. In view of the analyses, the authors found that vital teeth had a higher mean resorption, but without statistical relevance when compared to pulped teeth. In addition, 68.4% of the patients had greater resorption of the incisor treated endodontically when compared to the control group. Therefore, the authors state in their study that there is no significant difference in the amount or magnitude of external apical root resorption during orthodontic treatment between endodontically treated incisors and their vital counterparts.

Walker et al. (2013) through a systematic literature review, in order to verify whether pulped teeth are more susceptible to external apical root resorption after orthodontic movement, than their vital counterparts, determined the inclusion criteria such as: study design, sample size, population characteristics, type of radiographic image used for analysis, method of measurement of external root resorption and the results of the study. The selected articles were published between 1990 and 2010. As a result of this review, it was found that the sample sizes ranged from 16 to 77, with a mean population of 13.9 to 32.7 years and a mean orthodontic treatment time of more than 20 months. In all studies, external apical root resorption was measured by periapical radiographs before and after, with the exception of one study that used panoramic radiographs and another that was not evaluated by radiographs. It was found through the study that pulped teeth had a lower resorption after orthodontic treatment when compared to their vital counterparts. The authors concluded that endodontically treated teeth do not have a higher risk for root resorption during orthodontic treatment, when compared to vital teeth. Thus, the authors were able to conclude that there is a low number of studies and all with different methodologies, so it is necessary to carry out more clinical trials with methodologies that are standardized, so that the analysis of such comparison becomes better.

DISCUSSION

The periodontal ligament is the only one involved in orthodontic movement and a consequence of the force that this movement exerts on the supporting tissues is root resorption (Capelli Junior, 2004). This resorption is considered clinically acceptable in orthodontic practice, since it is part of the apical remodeling process (Reitan, 1985; Consolaro, 2005).

The endodontically treated tooth can be subject to different types of forces, a functional or parafunctional overload can cause an inflammatory process and lead to external root resorption

(Weiland, 2006). Artun et al (2005) stated that if any tooth in active treatment in the first 6 months presents any degree of root resorption, it will be more likely to suffer more resorption in the next 6 months.

With respect to endodontically treated teeth and orthodontics-induced external resorption, published studies have reported controversial results. Some researchers argue that the tooth treated endodontically presents more external root resorption compared to the tooth with vital pulp when involved in orthodontic movement (Wickwire et al, 1974; Iglesias et al, 2013), other researchers report less resorption in endodontically treated teeth (Mirabella, 1995; Lee, 2016) and others show that there are no significant differences in external root resorption in teeth with vital pulp and endodontically treated teeth (Esteves et al. 2007; Castro et al 2015) (Banzatto et al., 2005, Walker et al., 2013).

Agreeing with this, Llamas-Carreras et al., (2012) analyzed 38 individuals who underwent orthodontic treatment, these were divided into 3 groups: traumatized teeth, teeth with endodontic treatment and control group. It was observed that there was no significant difference in the severity of external root resorption between the groups. Although the prognosis of traumatized teeth is unfavorable, endodontic treatment should be performed (Tanaka et al., 2013) with care in measuring the forces correctly. Due to the chance of early root resorption occurring in these teeth, it is important to perform periapical radiographs every 3 months (Consolaro and Consolaro 2013).

Consolaro and Consolaro (2013) argue that one should wait 15 to 30 days to start orthodontic movement of teeth that have undergone endodontic treatment, so that the inflammatory infiltrate migrates from the site and the exudate is reabsorbed. From a biological point of view, movement does not interfere with the repair of periapical lesions as long as endodontic treatment has been performed satisfactorily.

A meta-analysis published by Alhadainy et al (2019) evaluated 7 studies and its result had moderate statistical strength, which proved that endodontic treatment does not increase external root resorption in orthodontic movement; However, the authors point out the need to conduct further studies with a larger sample to verify this relationship. Walker et al. (2013) state that more studies with standardized methodologies are needed, since the findings are scarce and each one follows a different methodology, making it difficult to compare in some studies.

Steadman (1942) stated in his study that the root of endodontically treated teeth acts as a foreign body causing chronic irritation and consequently resorption, it can also suffer the process of ankylosis, which can prevent orthodontic tooth movement. Another study by Huettner and Young (1955), when evaluating the root structure of monkeys, teeth with vital pulp and endodontically treated, observed that after orthodontic movement, root resorption was similar in both conditions. However, the authors argue that the monitoring of orthodontic forces, an aseptic endodontic

treatment and an intact periodontal membrane were preponderant factors for the result found (Huettner, Young, 1955).

In another study conducted by Esteves et al (2007), when analyzing 2500 treatment records, they selected 16 patients with endodontic treatment in the maxillary central incisor before orthodontic intervention, when analyzing the periapical radiographs performed before and after orthodontic treatment, they came to the conclusion that there was no significant difference in apical root resorption of endodontically treated teeth and vital teeth (Esteves et al. 2007).

CONCLUSIONS

The scarcity of studies on the subject associated with the fact that they do not have standardized methodologies showed that the relationship of greater root resorption in teeth that underwent endodontic treatments when undergoing orthodontic movement is not conclusive. It is necessary that more studies be carried out and that they have standardized methodologies so that they allow comparative analyses with greater significance.

It is important to wait 15 to 30 days, after the end of endodontic treatment, to start orthodontic treatment so that all the resorption of the inflammatory exudate and the migration of the inflammatory infiltrate from the site can first occur. For satisfactory results, it is necessary that the endodontic treatment is well filled and with a good prognosis.

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