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Tooth Root Resorption Conditioned by Orthodontic Treatment

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ABSTRACT

The objective of the paper is to analyze the risk factors of root resorption, conditioned by orthodontic treatment, in order to eliminate them, as well as to prevent complications and achieve positive treatment outcome. The scholarly literature analysis was carried out using PubMed, Scopus, ScienceDirect, Google Scholar, and Research Gate database and it totally involved 60 papers published over the period of 2001-2019. The keywords were 'root resorption; orthodontic treatment; tooth movement; orthodontic force'. The analysis revealed that development of the root resorption conditioned by orthodontic treatment is a common phenomenon which depends on a number of risk factors that are divided into host factors and treatment method factors. Host risk factors crucial for root resorption in the course of orthodontic treatment include teeth with existing root resorption during pretreatment, anterior open bite, abnormal root shape and teeth undergone root canal therapy. Significant risk factors for treatment methods include longer treatment duration, heavy force applied, intrusion and extrusion of premolars. The paper also presents the biomarkers of root resorption. Apical resorptions which are as a rule not infected are mostly stopped by discontinuing orthodontic forces. Cervical resorptions with a bacterial component require surgical intervention with curettage and restorative build-up of the resorbed area. Inflammatory root resorption conditioned by orthodontic treatment is inevitable, though, its progression into severe stage can be prevented in case early measures are taken and provided that the orthodontist is aware of the host factors, treatment risks and biomarkers involved.

Keywords

Root resorption, Orthodontic treatment, Tooth movement.

Introduction

The term 'orthodontically induced inflammatory root resorption' (OIIRR) is used in orthodontics to distinguish other causes of root resorption in permanent teeth [1]. The force applied in the course of orthodontic treatment which is necessary for moving the tooth, inevitably leads to the development of inflammatory process and occurs to be the main causative factor of root resorption. Periodontal ligaments, restructuring bone and cementum are generally involved in therapeutic procedures [2].

Alteration or loss of the protective cementum layer due to inflammation can be the main factors which contribute to the development of external pathological inflammatory root resorptions [3]. The function of the cementum, with its potential for repair, is to protect the underlying dentin from resorption [4]. On condition the dentin is not affected, the process is not considered physiological or pathological, but it's a controlled orthodontic therapeutic process. When the cementum is attacked by a stimulus and its capacity for recovery is suppressed, dentin is exposed. Histologically, pathological process begins when dentin is exposed to osteoclast precursor cells, which originate in the periapical ligament and differentiate into odontoclasts [5].

Actually, repairing potential is the property of cementum only, so in case the dentine suffers the attack and gets resorbed, the loss of root structure becomes irreversible. Both apex and the neck can be affected in this kind of resorptions. In non-infected apical resorption, even if the dentin is not a subject to reconstruction, resorbed area can be covered by newly formed cementum [6]. Resorption makes the root shorter. In cervical resorption, the resorption site is fertile ground for bacteria to breed.

To reduce the severity of tooth resorption, an optimal force of 20-150g is needed to move the tooth [7]. The excess force can cause periodontal ischemia particularly in adults, since in this case a higher apical load occurs due to a thicker layer of cement as compared to those in adolescents [8]. The apical area is more susceptible to resorption than the cervical one since it is softer, less mineralized and contains fewer Sharpey's fibers. Compression of periodontal ligaments which appears in course of tooth movement increases the risk of tooth root resorption. Root resorption is a side effect of orthodontic treatment, but it can reduce or recover after the orthodontic forces are removed. Although, OIIRR is inevitable in orthodontics, it usually occurs at a lesser extent, i.e. with radiographic mean resorption of less than 2.5 mm [9]. In pronounced cases of root resorption, the tooth becomes loose thus risking the whole process of treatment. Therefore, it is crucial to assess the risk factors of root resorption before the treatment is started [10,11]. Thus, treatment methods can be modified in order to reduce the development of root resorption in the course of orthodontic treatment. However, many aspects of OIIRR as a complex and mostly sterile inflammatory process still remain unclear.

The factors predisposing to the root resorption should be analyzed before the orthodontic treatment is started [12]. In fact, certain patients are predisposed to developing root resorption during orthodontic treatment more than others, and it is important to inform them. There are numerous factors which contribute to the OIIRR occurrence, generally related to the patient's genetic predisposition or to their general health status. The development of apical root resorption might be also associated with single nucleotide variations in human genome, which allows the opinion that orthodontic treatment is not the only factor to be blamed [13,14]. Risk factors can involve local ones, such as the patient's prior dental history. Eventually, there are risk factors specific to the orthodontic treatment of the teeth that are involved. Thus, appropriate clinical management for minimizing root resorption during orthodontic treatment should be considered. Taking into account multiple predisposing factors which might lead to the development of root resorption during the orthodontic treatment, the objective of the paper is to analyze the risk factors of root resorption, conditioned by orthodontic treatment, in order to eliminate them, as well as to prevent complications and achieve positive treatment outcome.

Classification and prevalence of root resorption

There are various classifications of dental resorptive lesions - histological, etiological etc. The classification, based on the location of the resorptive lesion on the root surface, is the most widely known one. It is further sub-categorized according to the pathogenesis, accordingly there are differentiated internal (inflammatory, replacement) and external (surface, inflammatory, replacement, cervical, transient apical breakdown) types [15]. Severity of root resorption is commonly classified according to the root resorption scoring system with 0 to 4 index scores [16, 17]. Nevertheless, some studies have reported their data on root length reduction without categorizing the severity of root loss. Abnormal root shape might appear to be a risk factor for root resorption. According to this guideline, roots were differentiated between short, blunt, apical bent and pipette-shaped.

Brezniak and Wasserstein describe three degrees of OIIRR [18]. The first degree is cemental or surface resorption with remodeling, where only the outer cemental layers are resorbed, which are later regenerated or remodeled. The second degree is dentinal resorption with repair, in which the cementum and the outer layers of the dentine are resorbed and usually repaired with cementoid material. The final root shape might be or might not be identical to the original form after the resorption. The third degree is circumferential apical root resorption, in which full resorption involves the hard tissue components of the root apex and obvious root shortening is observed on radiographs. No regeneration is possible in case the apical material beyond the cementum is resorbed.

For apical resorptions, the Levander and Malmgren system distinguishes four levels of apical lesion. Level 1 is minimal resorption with simply irregular apical root contour. The resorption lesion on the hard tissues in level 2 is not more than 2 mm. The authors call it a minor resorption. In level 3, the resorption destroys up to the first third of the root. Therefore, level 4 is the resorption, qualified as severe, in which the resorption reaches beyond the first third of the root length and is regarded to be extreme. For external cervical resorption, the Heithersay system of classification suggests four levels of cervical lesion. Resorption in level 1 is a small invasive cervical lesion that presents shallow dentinal erosion. The resorption lesion of level 2 is limited and penetrates the dentin close to the pulp chamber, without far extension (or only slightly surface) onto the root dentin. In level 3, the resorption lesion presents a deep penetration into the dentin up to the first third of the root. The resorption lesion in level 4 is widely invasive and spreads apically beyond the first third of the coronal root.

Susceptibility to resorption differs for various categories of teeth. Thus, maxillary incisors and lateral incisors in particular are frequently more liable orthodontically induced apical resorption [19]. Mandibular incisors and the distal root of the first permanent molars come next. In the course of orthodontic treatment, the incidence of root resorption, according to different authors, fluctuates within 4-91% [20-22]. It has been also found out that root shortening of different degrees was observed in almost all patients and in up to 91% of all teeth, though shortening of the tooth exceeded 4mm only in few cases. It has been reported that the percentage in external apical root resorption varies on each anterior tooth, ranging from 8.5% for upper right canines, to 12.6% for upper right lateral incisors, with significantly higher root resorption in incisors than canines [23]. Another study revealed that 4% of patients were diagnosed with root resorption after 6 months of fixed dental prosthesis with only 3.1% of maxillary incisors involved.

Risk factors for root resorption

Risks factors are divided into host and treatment method. Host factor

suggest patient-originated factors, which cannot be controlled by the clinician, such as gender, race, past history, status and position of the teeth. While planning orthodontic treatment, clinician should screen high-risk patients as the risks of root resorption from host factor need to be fully considered. Treatment method factors are more of a concern of a clinician as they can manipulate and modify them in the process of orthodontic treatment in order to reduce progressive root resorption.

Host factors

Some authors have revealed that root resorption of lesser severity is found in patients who underwent treatment at the age of 11, probably as pre-dentine layer prevents underdeveloped roots. It was also noted that when tooth movement is completed before the full development of the roots there are more chances to avoid root resorption. Although orthodontic tooth movement of immature roots does not prevent root development, it might inhibit their actual potential and are found to be shorter. Most studies have not found a consistent association between chronological age and OIIRR, though in patients aged above 20, significant relation to root resorption might be observed [24].

Studies include gender differences in the risk of root resorption. Thus, male patients have been found to have a higher chance of root resorption as compared to female patents [25]. Nevertheless, there are studies that prove the absence of any significant difference in gender relation to root resorption.

Similar susceptibility to orthodontically induced resorption is observed in some ethnic groups [26]. Thus, Hispanic patients appear to be more susceptible to resorption than Asian patients [27]. The activation of the osteoclasts i.e. resorption cells can be genetically linked. The occurrence of certain external apical resorptions can be explained by genetic variations involving the interleukine-1ß gene (implicated in the inflammatory process associated with orthodontic movements). Interleukin IL-1 (IL-1B) allele 1 has 5.6-fold increased risk of external apical root resorption (EARR). Interleukin 1ß (IL-1ß) [13954] gene allows the part of cytokine in the EARR pathogenesis and for the protective mechanism of the cementum against root resorption. Qualitative and quantitative assessment of external root resorption made up 44.9% and 42.9% for monozygotic twins and 24.7% and 28.3% respectively for dizygotic twins. An overall heritability assessment constituted 0.34.

The likelihood of OIIRR development increases in chronic asthma and certain allergies. Patients suffering from chronic asthma, no matter treated or not, are definitely more susceptible to apical OIIRR of the upper molars. This takes place due to inflammation of the sinuses typical of asthma, in which it might extend to the apex of the maxillary molars and premolars. Among the risk factors some researchers mention hormonal deficiencies, such as hypothyroidism, the fact not being conclusive. There have been some reports on the effects of hyperparathyroidism on root resorption with no consistent effects described.

Mechanical trauma can lead to inflammatory root resorption. Teeth, which previously suffered trauma or are already resorbed, become more susceptible to the forces that they undergo in the course of orthodontic treatment. It is recommended to postpone exerting force on a transplanted or re-implanted toot for at least 3 months. The risk of resorption in the course of orthodontic treatment for a tooth which has undergone an internal bleaching is much higher, like in case of trauma. The conclusion, though, still needs clarification as oxygenated water and the catalyst effect of heat as a result of friction are significantly involved in process of resorption occurring after the bleaching of pulp-free teeth. Currently, application of sodium perborate mixed with water appears to be safer procedure with lower risk to cause resorption.

Physiological root resorption often occurs as an effect of an adjacent impacted tooth. Resorption of the roots of the adjacent lateral incisors or premolars is the most wide spread problem for impacted canines. The study of 3D assessment of impacted canines and root resorption revealed no resorption in 40.4% of lateral incisors, slight root resorption in 35.7%, moderate root resorption in 14.2% and severe root resorption in 4.0% [28]. Risk of root resorption might increase due to the eruptive movement or migration of the impacted canine while its root develops. In case physical proximity between impacted canine and adjacent roots is less than 1mm, root resorption of the incisors and first premolars should also be foreseen [29]. Such factors as direct physical damage, increased pressure at local root cementum and dentin or concentrated resorptive molecules from the canine eruption follicle can be the cause of root resorption occurring at the adjacent roots.

Patients with an acceptable overjet and Class I occlusion at the beginning of treatment are considerably less prone to severe root resorption. This probably indicates the less tooth movement, particularly that of the maxillary incisors. Apical root shortening in Class I patients constituted an average of approximately 1mm, while a mean root shortening of more than 2 mm was observed in Class II 1-division patients. Root resorption is conditioned by the extent of displacement of incisor roots and required movement volume. Class III cases make up a great number in the group with severe root resorption, probably due to an increased chance that proclined maxillary incisors moving forward in compensation for Class III skeletal relationship have their roots forced against the palatal cortical plate. Some malocclusions lead to undesirable jiggling of the teeth once the teeth are in occlusion [30]. These patients might have shortened roots before the treatment and are hereinafter at a higher risk of root resorption in the course of treatment, possibly owing to uneven loading of the periodontium. Habits can also have their impact on the severity of root resorption. Thus, nail-biters tend to have increased root resorption before and after orthodontic treatment. The fact can be credited with increased pressure on the periodontium for long period. The same might be described in digit habits. It was also found out that anterior open bite is crucial for OIIRR, suggesting that jiggling force caused by orthodontic force and tongue pressure move the teeth in opposite direction. Most cases with an anterior open bite may finally result in extraction of premolars as the treatment plan, but it has been

found out that these two factors, anterior open bite and extractions of premolars were not related to one another. In the study, among the patients with open bite 26.1% only occurred to have OIIRR, approximately similar to open bite patients who underwent premolar extractions having 26.0% of OIIRR.

There is a direct association between abnormal root shapes and root resorption, the fact proved in recent researches [31]. Classification of the root forms suggests normal, short, blunt roots, roots bent at the apex and of pipette form. Apices that are either blunt or dropper-shaped present a higher rate of resorption compared to apices of normal shape. It was considered that abnormal root shape leads to root resorption due to reduced resistance of the root to mechanical stimuli. Abnormal root shape with hypofunctional teeth have higher prevalence of root resorption, than in functional teeth. It was suggested that the possible reason is the absence of occlusion in hypofunctional teeth which was not the cause of physiological root remodeling after the eruption and thus further occurrence of root resorption. Teeth undergone root canal treatment might be a predisposition for progressive severe inflammatory root resorption during orthodontic tooth movement [32].

Factors of treatment method

It is disputable whether or not root resorption caused by orthodontic forces only and if the applied forces should be below a threshold in order to avoid resorption. Some authors try to answer this question and agree on forces of 7 to 26 g/cm2. Decisive factors are the magnitude of the force exerted as well as its intermittent application which causes less damage than when it is continuous. Occurrence of root resorption is considered to be induced by the heavy force applied during the orthodontic treatment and hyalinisation of periodontal ligaments caused by increased activity of cementoclasts and osteoclasts [33]. The average volume of the resorption crater in the light-force group was 3.49-fold greater and heavy-force group was 11.59-fold greater than in the control group.

Long-turn orthodontic treatment tends to result in root resorption. A month of extra treatment duration leads to 0.1 and 0.2 mm of additional root resorption of the most severely resorbed central and lateral incisor, respectively. The duration of the treatment for the patients without root resorption is on average 1.5 years. The risk of severe root resorption is proven to increase if total treatment period takes more than 30 months when assessed both by number of patients and teeth. It's a proven fact that continuous force brings to a higher risk for root resorption although it produces faster tooth movement than intermittent forces. Intermittent force produces less root resorption as it gives reparative mechanism time to act. Considerably less total root resorption was observed in case of 4-day intermittent force application was followed by 3-day period of rest. The intermittent force application was obtained with a 3-day resting period followed by a 4-day force application period and found significantly less total root resorption. Histological study of root resorption craters was carried out with 4 or 8 weeks of retention after continuous light or heavy orthodontic force was applied. Resorption cavity of root was almost repaired by the new cementum layer in 8-week retention group, unlike the 4- week retention group with the presence of inflammatory infiltrates where resorption craters were still in the process of repairing with new cementum. These studies allow to conclude that the reparative cementum depends on the time, while tooth movement is efficient when the applied force is intermittent and the period of time is longer. It is preferable to activate Archwire once every 2-3 months, and not every month [34].

The compression area on root surface is more susceptible to root resorption than in tension area, depending on the force direction and root morphology of the tooth.Periodontal ligament compression was more pronounced in the apical and cervical thirds of the tooth during the tipping movement, while in buccal root torque, the root resorption was observed more in the apical region. The volume of tooth movement in the bodily tooth movement group was less than half of it in the tipping tooth movement group with the greatest tooth movement volume occurring in the 10gm tipping and 50gm bodily tooth movement subgroups. Root resorption caused by extrusive forces was limited and didn't considerably differ from the control group. The percentage of resorbed root area was 4 times increased by intrusive force which is considered to be the most harmful tooth movement since the force is directed towards the small apical region of the tooth. [35]. New approach suggested to introduce lighter and more continuous force as well as to control of force vector and labiolingual position of the tooth in order to reduce the severity of root resorption during intrusion. Several studies proved that excess heavy force applied increases the risk of root resorption. External apical root resorption is highly possible in case of apical vertical movements and incisor proclination. Scanning electron microscopy revealed many concavities resorption lacunae on the root surfaces of all rotated teeth. The main location of resorption is the medial root third i.e. in prominent zones of the roots. Cone-beam computed tomography revealed statistically significant volume loss in root resorption after rapid maxillary expansion (RME). Clinically considerable amount of expansion (approximately 3.5 mm in 8 weeks) with no apical root resorption was observed in expansion with passive self-ligating brackets [36].

Diagnosis

Root resorption frequently has discreet clinical manifestation. Symptomatology can be absent altogether, especially at the first stages of their development. External cervical resorption might be often clinically manifested with a light discomfort with a pinkish cervical discoloration during examination, while apical resorption doesn't present any symptoms at all. Taking into consideration this fact, diagnosing root resorption might be troublesome, particularly at the beginning of the process.

The assessment of the root resorption is carried out by histological and radiological methods. The benefit of histologic investigation of root resorption is that it allows direct observation of the root surface and detection even the smallest craters. Root resorption assessment with radiograph is common for clinical practice while many researchers prefer 3D images, thus cone beam CT and

micro-CT are used in the studies to detect root resorption in the course of orthodontic treatment as compared to 2D images such as periapical, panoramic and lateral cephalometric [37,38]. 3D images allow better visualization with specific tissue volume without overlapping structure and thus providing higher prevalence of root resorption. [39, 40]. According to some guidelines radiographic study is suggested to be performed in the first 3-6 months and further every year after appliance placement. No thorough study was yet carried out on practical use of radiographic assessment for the diagnosis and prediction of OIIRR in the first 6-month period.

Current approach to determination of root resorption biomarkers is regarded to be sensitive, safer and more prognostic diagnostic methods for detecting root resorption [41]. It was found out that protein markers e.g. aspartate aminotransferase, salivary sIgA and serum IgG and biomarkers representing biological changes during specific process in orthodontic tooth movement such as ALP (bone formation), TRAP5a (bone resorption), LDH (inflammation) and DSP (root resorption) potentially can detect root resorption [42, 43]. Preliminary results confirm the presence of organic matrix proteins and cytokines from the surrounding bone and dentin which are released into the gingival crevice in root resorption [44]. In case of root resorption increase in gingival fluid amount and pH change are observed [45]. Being a reliable and sensitive method to detect dentine sialophosphoprotein in gingival crevicular fluid, spectrophotometry allows to expand the lower end of detection from 5 pg per milliliter to 0.5 pg per milliliter in electrochemical results [46]. Novel biomarkers which have to do with root resorption were aimed to be identified. It was possible to identify 2789 and 2421 proteins in the control and resorption pooled samples, respectively [47] by means of protocol. High level of DSP (dentine siolaprotein) and DPP (dentine phosphoproteins) were revealed respectively on the areas with physiological root resorption [48]. The proteins constitute 10% of the organic matrix in dentine composition as non-collagenous proteins [49]. Root resorption is indicated by the presence of DSP or DPP.

Treatment

The choice of therapeutic methods depends on the location of the resorption (apical or cervical) as well as on the stage of the development (especially for cervical resorption). In the course of orthodontic treatment, the practitioner most often deals with apical resorption. Actually, resorption mostly occurs during the active phase of orthodontic treatment. Since a routine radiographic screening is performed, the orthodontist usually reveals root resorption at the initial stage, thus severe cases are relatively uncommon even if detected [50].

Temporary discontinuance of orthodontic treatment for a period of 3 months is recommended on the occurrence of the first radiographic signs [51]. Complete reduction of the root resorption progression becomes possible if the treatment is interrupted for 2 to 3 months [52]. In orthodontically induced resorption, the practitioner should follow the protocol essentially based on eliminating orthodontic displacements which occur to be causative factors [53]. Some authors claim, that endodontic treatment doesn't make any effect and is even be contraindicated if there is no infection (in other words pulpal necrosis), since the removal of the pulp of a tooth in resorption does not restrict the development of resorptive process. However, it is necessary to carry out a routine clinical examination of the pulpal vitality of the teeth under treatment since possibility of necrosis exists when OIIRR occurs, even if the pulpal disturbances are minimal. Ultrasound and anti-inflammatory medications are also recommended by other authors [54]. Not many researches have been carried out in this area and it is not possible to definitely determine which protocol is the best. When the resorption process is stabilized, orthodontic treatment can be resumed and the results should be cautiously monitored by very precise radiographic examinations, particularly CBCT.

As a rule, external cervical resorption is revealed after the competence of orthodontic treatment. Depending on its location, external cervical resorption is directly related to the oral environment and so bacterial flora, having invasive character invades quickly [55]. The symptom characteristic distinguishes them from apical resorptions, especially regarding their development and treatment. It is important to take essential measure as soon as the first signs occur clinically or are detected radiologically. The diagnosis is often made radiologically, but clinical manifestations are pink spots which can appear in the cervical area. The sign that indicates the presence of very vascularized granular tissue under the enamel and the dentin destroyed by resorption is the pinkish discoloration. The intervention therefore consists of (sometimes after lifting the periodontal flap) a complete removal of the granulomatous tissue, with the following reconstruction of the residual cavity with the application of glass ionomer or composite cement (Mineral Trioxide Aggregate or BiodentineTM). Four main goals of this therapeutic approach are the halt of the process of resorption, the restoration of the lost structure, the prevention of recurrence and the esthetic aspect [56]. A clinical case of Heithersay level 2 resorption with surgical treatment and further restoration with reverse sandwich technique combining composite and modified glass ionomere cement was presented by Vinothkumar et al. [57]. The choice of intervention depends on the severity of the lesion, the stage of development and its placement on the Heithersay scale. In case of 1- and 2-level resorption, Heithersay suggests intervention to be the right prognosis, because the pulp is still protected both by outer and inner dentinal walls. Intervention is indicated for 3-level resorption, though in this case the clinical condition is more complicated [58]. In 4-level cervical lesion, as long as it remains asymptomatic, Heithersay recommends to stop the treatment. Actually, intervention at this stage involves the risk of fracturing and therapeutic failure which might require tooth extraction. The tooth is subject to removal if when all the symptoms are present in level 4.

Various medicines are used to treat resorption, e.g. resorptive activity of isolated clastic cells is inhibited by Echistatin. It considerably decreases both the surface of root resorption and reduces the number of lacunae [59]. Local clodronate (Bisphosphonates) inhibits root resorption which occurs during the tooth movement. The local administration of risedronate, depending on the dose, brings to

a considerable inhibition of root resorption after the application of orthodontic force. The data show that calcium ions together with PGE2 stabilize root resorption. Nabumetone is found to be indispensible in reducing pulpitis, external root resorption and pain caused by intrusive orthodontic movement, without changing tooth movement as a reaction to orthodontic force applied [60]. Prednisolone and celecoxib suppress tooth movement and root resorption conditioned by orthodontic treatment. High dosage (16 mg/kg) of celecoxib suppresses root resorption quite more than low dosage (3.2 mg/kg). Anti-inflammatory properties of tetracyclines (and their chemically modified analogues) unrelated to their antimicrobial effect present a considerable reduction in the amount of mononucleated cells associated with root resorption on the root surface.

Conclusion

Orthodontically Induced Inflammatory Root Resorption (OIIRR) is an unavoidable process, though, its progression into severe stage can be prevented in case early measures are taken and provided that the orthodontist is aware of the host factors and treatment risks. It is important to appreciate the severity of root resorption and event assessment system the progress monitoring should be carried out, which should include both the apical and cervical areas of the teeth, subject to orthodontic forces. An early detection of the potential biomarkers in root resorption is thus crucial for the prevention of its progression into severe stage. It is necessary to apply a precautionary approach and to inform the patient about the risk of root resorption before starting the treatment. Root resorption is one of the complications that can endanger the successful outcome of orthodontic treatment. In case the patient has past history of trauma or root canal treatment radiographic monitoring should be carried out. Nevertheless, other factors such as blunted root, long duration of the treatment and application of heavy force in orthodontic treatment also contribute to root resorption. Numerous researches have studied the incidence of root resorption and the aim of this review is to highlight the risk factors which provoke root resorption. The methods of identifying root resorption are also considered to reveal the benefits and drawbacks of radiographic monitoring. Cone beam is a very precise diagnostic method in case of suspected root resorption, as it allows the determination of anatomical context, size and severity of the resorption. The application of biomarkers in the detection of root resorption can decrease repeated exposure to radiography in monitoring root resorption. The orthodontic treatment should be temporarily discontinued or even postponed indefinitely in case of apical resorption in order to stop the process. In cases of cervical resorption, the orthodontist should interfere as soon as resorption is revealed, as resorptive process is invasive and evolving by nature, particularly when exposed to the oral environment. Prognosis of the complicated clinical cases strictly requires collaboration of orthodontists, dentists and endodontists.

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