

Orthodontic treatment-related risks and complications: part I dental complications

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ABSTRACT

Introduction: Orthodontic treatment is a complex medical intervention carried out over an extended period. During this time, risks may turn into complications. It is necessary to identify the risks that are associated with the orthodontic intervention to be applied, as there are numerous complications possibly linked to that treatment. The occurrence of these complications depends on the orthodontic technique, medical knowledge in this field, patient's general and oral health, and oral hygiene habits. These must be considered even from the start because it might influence the treatment objectives, phases, and goals.

Aim: of this study is to present a contemporary attitude of the main risks and complications linked to orthodontic interventions in clinical practice.

Materials and methods: Classification presented by Graber et al. in publication, "Risk management in orthodontics: expert's guide to malpractice," is used as a starting point for the development of this review. A complex search was performed (Pubmed, Google scholar, etc.), with the restriction upon of publication date (beginning with 2004) to find relevant current studies. Search keywords were combinations of words: complication, orthodontic treatment, risks, side effects.

Concluding remarks: According to contemporary literature, there are a lot of conditions to which orthodontic treatment can be linked. There is a medico-legal obligation to inform our patients about side effects of any medical intervention what will be undertaken.

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INTRODUCTION

The benefits of a medical intervention must outweigh any potential harm. Apart from its benefits, orthodontic treatment can cause certain complications. During clinical orthodontic procedures, the use of various methods, devices, and materials can cause unwanted side effects, both local (e.g., tooth discoloration, decalcification, root resorption, and periodontal complications) and systemic (e.g., allergic reactions and cross-infections). The legislation governing medical behavior requires that each patient undergoing treatment must be informed of the benefits and risks of the treatment. If side effects occur and a patient has not been properly informed about the risks

and possible complications of the treatment, the result can be complaints of abuse or even lawsuits. It is recommended that each patient makes a serious analysis of the risks and potential complications of treatment, which can be followed by signed informed consent.¹

According to numerous authors, there are a lot of conditions to which orthodontic treatment can be linked. Even if there are no proofs of direct cause/effect relationships for most of them, we must still consider them seriously and inform our patients about them. The possible risks and complications associated with orthodontic treatment, according to their effects, can be divided into two main groups: the risks and complications of systemic effects and the risks and complications of local effects.^{2,3}

Risks and complications of orthodontic procedures with local effect are:

Dental complications

Potential complications on the crown level during orthodontic

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intervention are: decalcifications, decay, tooth wear, enamel cracks and fractures, discolorations, damage to the prosthetic crown(s), such as fracturing of a ceramic crown during debonding.^{4,5} On the root level, there may appear to be root resorption, early closure of root apex, or ankylosis.⁶⁻⁸ Pulpal complications during orthodontic procedures can be ischemia, pulpitis, or even necrosis.⁹⁻¹²

Periodontal complications

Periodontal complications that may appear during orthodontic treatment are gingivitis, periodontitis, gingival recession or hypertrophy, alveolar bone loss, dehiscences, fenestrations, interdental folds, and dark triangles.¹³⁻¹⁵

Soft tissue alterations

Soft tissue alterations are a common side effect of orthodontic treatment. It can be seen as a laceration of the gingiva or oral mucosa, chemical burns (etching related), thermal injuries (overheated burs), or stomatitis. In some cases, more serious problems like ulceration or tissue hyperplasia around the bracket, end of wire or loop, may appear. The most serious injuries are those of the face or neck.^{16,17}

Temporomandibular joint (TMJ) disorders

TMJ disorders condylar resorption, temporomandibular dysfunction.^{18,19}

Unsatisfactory treatment outcomes

Unsatisfactory treatment outcomes are inadequate morpho-functional, aesthetic or functional final result, relapse, failure to complete treatment course, incorrect diagnosis, incorrect management.^{16,20,21}

BACKGROUND

The classification was presented by Graber et al. (2004) in the publication Risk management in orthodontics: experts' guide to malpractice and was used as a starting point for the development of this study. A complex search was performed (Pubmed, google scholar, etc.), with the restriction upon of publication date (beginning with 2004) to find relevant current studies. Search keywords were combinations of words: complications, orthodontic treatment, risk, systemic, local, and side effects.

This part will discuss dental complications.

Dental complications

Enamel damages

Bonding of orthodontic appliances may induce irreversible changes of a tooth surface. The enamel changes depend on numerous factors: the acid type and concentration, time of application, and enamel surface characteristics. The most

severe modifications appear when conventional resins are used as bonding materials. The self-etching adhesive resin bonding technique is safer and better than conventional resins which separate the phase of etching. This technique produces less enamel damage but has the disadvantages of lower bond strength. Also, resin-modified glass ionomer cement is preferred as a bonding material. This bonding material reduces enamel damage thanks to fluor releasing, and it has a bond strength similar to resins.²²⁻²⁵ The debonding and removal phase of orthodontic treatment may cause tooth damage as enamel loss or cracks. The frequency of enamel loss depends on the brackets, bonding materials, and debonding technique. Enamel damage is usually less with metallic braces and bonding materials, depending on if glass ionomer cement is used. Using ceramic brackets and conventional adhesive resins and bonding materials cause more severe enamel modification. The proper debonding technique is to break the link between bracket and adhesive. The presence of horizontal enamel cracks after debonding are associated directly with the orthodontic technique. A high frequency of the vertical enamel cracks is present in the population without previous orthodontic treatment.²⁶⁻²⁹

Caries

Recent studies of this unwanted side effect show white spot prevalence of 70%, 5% cavity prevalence, and more than 30% of the maxillary incisors' decalcification after fixed orthodontic treatment.^{4,30,31} Demineralisation around brackets occurs as a result of improper oral hygiene. In orthodontic patients, the plaque index is higher compared with patients without orthodontic treatment. Evidence shows a decrease of salivary pH during orthodontic treatment. It is also observed an increased level of two main caries favoring factors such as *Streptococcus mutans* and *Lactobacillus*.^{14,32-34} It is mandatory to evaluate carioactivity and oral hygiene habits before starting orthodontic therapy. In some situations, a high frequency of dental caries and poor oral hygiene may be reasons to postpone or even cancel the orthodontic treatment. It is recommended that primary prevention methods be used to avoid this complication (i.e., educate patients about proper oral hygiene and diet), together with fluoride-releasing materials for brackets, bands or tubes. In some cases, a secondary prevention method is recommended: fluorination. Studies have shown that a daily fluoride mouth rinse or a fluoride-containing cement reduces tooth decay during treatment with fixed orthodontic appliances.^{35,36} When white spot lesions are present at the end of treatment, we can wait for spontaneous remineralization, and the chewing of sugar-free gums is recommended to improve salivation.^{37,38} The other options are the use of fluorine- or casein phosphopeptide-based products (tooth mousse) or performing microabrasion of the front teeth's labial surfaces.³⁸

Color alterations

Color alterations after orthodontic treatment are the result of several factors. More severe alterations occur when chemically-cured resins are used as bonding materials rather than light-cured composites.^{22,39}

The resin tags cannot be removed by cleaning procedures without altering the enamel's surface. Irreversible changes occur to the enamel's surface morphology, rugosity, and texture, with negative consequences on its reflective properties, luminosity, and optical perception. Evidence shows that the adhesive resins used for bracket bonding do not present good color stability with time. Ultraviolet light and corrosion products from the orthodontic appliance combined with food dyes induce color alterations, with a tendency to move toward the yellow tones.^{29,40} Orthodontic forces induce variations in pulp vascularization. It is a possible factor for the premature aging of teeth, and it is an endogenous factor for discoloration too.⁹⁻¹¹ In situations where white spots and lesions are present, even if remineralization occurs, the outcome may be different from the initial enamel structure. This is because of the differences in the minerals in the treated enamel surface compared to the untreated enamel.^{4,5,22}

Enamel abrasion

The tooth wear (enamel abrasion) is another dental alteration which may occur in the orthodontic patients caused by contact between the teeth and brackets or tubes. A higher frequency of this was noticed in the patients with ceramic brackets compared to the patients with metallic brackets.^{2,21,29,41}

External apical root resorption

External apical root resorption is an unavoidable consequence of orthodontic treatment. The etiology is multifactorial: individual biologic characteristics, genetic predisposition and the effect of orthodontic forces.⁶ Studies based on microscopic analysis show a prevalence of 100% after the orthodontic treatment.⁴² Apical root resorption occurs in different degrees. A Severe level is defined as a tooth shortening more than 4 mm or one-third of the root length. The root shortening more than 2 mm is present in 5-18% of cases, and more than 4 mm or 1/3 of tooth length in 1-5% of the cases.^{43,44} Risk factors for apical tooth resorption can be present as patient characteristics-related and orthodontic technique-related. Patient-related factors include genetics, general health factors, the type of malocclusion, tooth-root morphology, a previous history of root resorption, alveolar bone density, root proximity to cortical bone, endodontic treatment, and patient age and sex. One of the genetic factors in root resorption presence is polymorphism of the IL-1beta gene.^{45,46} Apical tooth resorption is different between ethnic groups. Asians show a less frequency of root resorption compared to Caucasians or Hispanics.⁴⁴ The severe tooth resorption is more frequently associated with

health conditions such as allergies, asthma, diabetes, arthritis and endocrine disorders.¹ Apical root resorption is associated with an abnormal direction of tooth eruption (pressure of the third molar may induce tooth resorption of the second molar, or tooth resorption of lateral incisor or bicuspid because of canine pressure). Among the patients with different malocclusions, there is a different amount of tooth resorption.⁴⁷ The skeletal open bite is more frequently associated with apical root resorption than malocclusion without hyperdivergent facial patterns. During the years before treatment starts, the frontal teeth do not participate in an occlusion. The periodontal tissues of those teeth are insufficient for submitting the orthodontic forces during treatment. Patients with Angle Class II or III malocclusion present more severe apical root resorption than those with Class I malocclusion.

Among Class I malocclusion patients, those with therapeutic tooth extraction are more at risk of apical root resorption.⁴⁸ Root morphology is one of the most important factors linked to apical root resorption. Teeth with long, narrow roots; abnormal root shapes in the apical parts' or curved, eroded, peaked, or barrel-shaped roots are marked as high-risk ones. The next important factor is tooth topography. Maxillary teeth are more susceptible to root resorption compared to mandibular ones. The frontal teeth have a bigger chance for root resorption than the posterior teeth.^{49,50} Orthodontic treatment-related risk factors include treatment duration, the magnitude of applied force, the direction of tooth movement, the amount of apical displacement, the type of force application, and the method of force application.^{51,52} Treatment duration is one of the most important factors directly linked to apical root resorption. The optimal period of treatment duration is less than 18 months to prevent severe root resorption.^{8,53} The tooth's direction of movement may cause an increased risk of root resorption and tooth intrusion. The type of force application is an extremely important factor. Continuous and heavy forces during orthodontic tooth movement are linked with apical root resorption.⁵⁴ When the patient with a high risk of root resorption is identified, it is recommended to avoid teeth extractions, if it is possible, to avoid heavy and continuous forces, disjunction, and long treatment duration. Also, it is necessary to check root resorption signs, analyzing the periapical space on the radiograph six months after orthodontic treatment was started.^{42,44,55}

CONCLUDING REMARKS

There is a medico-legal obligation to inform our patients about side effects of any medical intervention what will be undertaken. The orthodontic procedures of any dental-medical treatment should provide maximum benefit with minimal side effects. To ensure safer medical care, orthodontic treatment, as a part of dental-medical science, must be performed with great precaution.

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