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COMPLICATIONS AND RISKS OF ORTHODONTIC TREATMENT

ORTODONTİK TEDAVİNİN KOMPLİKASYONLARI VE RİSKLERİ

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Abstract

Orthodontic treatment increases the quality of life of the patients by increasing mastication, phonation and facial aesthetics as well as providing proper dental and skeletal relationship. Although the possibility of harming the patient in orthodontic treatment is lower compared to other areas, there are some risks and complications. Undesirable local (coloration, root resorption, decalcification, periodontal complications) or systemic (allergic reactions, chronic fatigue syndrome) side effects may be observed as a result of the procedures applied during the treatment, the devices and materials used. The appliances used in fixed orthodontic treatment make it difficult for patients to continue their oral hygiene procedures and increase the possibility of demineralized areas on the tooth surfaces. Another common side effect of orthodontic treatment is root resorption due to force and tooth movement. In order to reduce the frequency and severity of complications related to orthodontic treatment, a special treatment plan should be made for each case and the characteristics of the patient should be taken into consideration during the treatment. Based on a review of the literature, the present article provides information about the risks and possible complications of orthodontic treatment.

Keywords: *Root resorption, tooth demineralization, complications.*

Özet

Ortodontik tedavi, düzgün dental ve iskeletsel ilişkinin sağlanmasının yanısıra, çiğneme, fonasyon ve yüz estetiğini arttırarak bireyin yaşam kalitesini de arttırmaktadır. Ortodontik tedavide hastaya zarar verme olasılığı diğer alanlara göre düşük de olsa, bazı riskleri ve komplikasyonları bulunmaktadır. Tedavi sırasında uygulanan prosedürler, kullanılan aletler ve materyaller sonucunda istenmeyen lokal (renklenme, kök rezorpsiyonu, dekalsifikasyon, periodontal komplikasyonlar) veya sistemik (alerjik reaksiyonlar, kronik yorgunluk sendromu) yan etkiler gözlenebilir. Sabit ortodontik tedavide kullanılan apareyler, hastaların oral hijyen prosedürlerini devam ettirmesini zorlaştırmakta ve bu hastalarda diş yüzeylerinde demineralize alanların görülme olasılığını arttırmaktadır. Ortodontik tedavinin sık görülen diğer bir yan etkisi de, kuvvete ve diş hareketine bağlı gelişen kök rezorpsiyonudur. Ortodontik tedaviye bağlı komplikasyonların sıklığını ve şiddetini azaltabilmek için her vakaya özel tedavi planı yapılmalı ve tedavi uygulanırken hastaya ait özellikler göz önünde bulundurulmalıdır. Literatür taramasına dayanarak, bu makale ortodontik tedavinin riskleri ve olası komplikasyonları hakkında bilgi vermektedir.

Anahtar Kelimeler: *Kök rezorpsiyonu, demineralizasyon, komplikasyonlar.*

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OVERVIEW / GENEL BAKIŞ

Orthodontic treatment increases the quality of life of the individual by increasing mastication, phonation and facial aesthetics as well as providing proper occlusal and jaw relationship.

Like other medical treatments, orthodontic treatment has benefits as well as risks and complications. In orthodontics, the possibility to harm the patient is much less than in other areas (e.g. surgery). However, undesirable local (coloration, root resorption, decalcification, periodontal complications) or systemic (allergic reactions, chronic fatigue syndrome) side effects may be observed as a result of the procedures applied during the treatment and the tools and materials used (1).

General and specific factors play a role in the occurrence of complications associated with orthodontic treatment. General factors are factors depending on the patient, factors belonging to the orthodontist and factors depending on the technique used. Specific factors effective in the emergence of complications associated with orthodontic treatment; Situations related to the position / placement of orthodontic appliances, the working mechanics of orthodontic appliances, the relationship between orthodontic appliances and oral structures, and the features of the materials used, and the technical features of the appliances used (1).

1. General factors affecting the occurrence of complications associated with orthodontic treatment

There are many patients related factors that may affect the risk development during orthodontic treatment. These include personal conditions such as age, gender, physiopathological and psychological conditions, heredity, besides malocclusion and craniofacial properties (2).

In order to minimize the incidence and severity of complications that may occur as a result of orthodontic treatment, it is necessary to know every detail of each case, and to consider the characteristics of the patient while making the treatment plan and doing the treatment. For example; Treatments applied to different age groups differ in terms of treatment timing, appliance selection, treatment duration and stability. While orthodontic treatment in young patients with malocclusions such as anterior or posterior crossbite is considered appropriate, some procedures such as enlarging the lower dental arch in mixed dentition may not always result in success in terms of stability. For this reason, delaying orthodontic treatments applied at early ages until end of mixed dentition is advantageous in terms of utilizing the Leeway space reserve, creating a skeletal effect on the jaw bones, establishing a better cooperation with the patient, and shortening the treatment time as much as possible (2).

Most adult patients have periodontal loss. In these patients, alveolar bone loss, which causes the rotation center of the tooth to change, leads to faster tooth movement; Tooth movement occurs more slowly in patients with increased bone density. However, the pain is felt more intense and for longer (3).

Some conditions related to the general health status of the patients may also increase the risk of some complications or make it difficult to continue orthodontic treatment. For example, in patients using bisphosphonates, it becomes difficult to achieve the desired orthodontic tooth movement due to systemic side

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effects. In addition, since the rate of bone healing slows down, the risk of osteonecrosis should be considered, especially when planning procedures such as tooth extraction, implant treatments or orthognathic surgery (4).

For orthodontic treatment to be as it should be, it is necessary for the patient to comply with the instructions of the orthodontist regarding oral hygiene and the use of appliances and patient needs to attend the appointments regularly. Otherwise, patients with demineralization, discoloration, caries, periodontal loss may experience bad breath, and the duration of treatment may be prolonged and may meet unexpected results.

Orthodontists have important duties in preventing complications that may occur as a result of treatment, as the person who performs and directs the treatment. Adequate practice, information and clinical experience are required to achieve well results and reduce complications. The vast majority of complications arise from errors in diagnosis, treatment plan or continuation of treatment, and errors in these steps can be prevented to a large extent with adequate training, strong theoretical knowledge and clinical skills.

Another important factor for a successful orthodontic treatment is the communication between the patient and the orthodontist. Generally, difficulties may be encountered when trying to communicate with pediatric patients and patients with disabilities. In such cases, the biggest problem arises from the patient's inability to understand the medical part of the treatment or the physician's inability to express herself in a simple language. For these reasons, the physician should explain the detailed treatment planning to the patient in plain language before starting the treatment. The vast majority of patients who receive orthodontic treatment are young children and the responsibility of the treatment is given to the parents for better cooperation. Generally, parents are more aware of the necessity of orthodontic treatment than the child and show a more positive approach to treatment. However, studies have shown that the doctor-patient relationship is little affected by the family's attitude (5). For the purpose of providing an optimal treatment, it is suggested that the orthodontist be able to analyze the family's attitude well and postpone the treatment in cases where there is negativity or indecision. Otherwise, the progress of the treatment may be interrupted, the patient's health may deteriorate, and even psychological consequences can be seen.

2. Specific factors influencing the occurrence of complications associated with orthodontic treatment

Some of the complications that occur in the time or following orthodontic treatment are the complications that develop due to the orthodontic appliance placement, working mechanics, their relationship with oral structures, the properties and parts of the material.

Orthodontic appliances can be mobile or fixed or contain both mobile and fixed parts. These appliances, which are active in some parts and passive in some parts, may dislodge, come off, break and cause local or general complications. A wide variety of materials (nickel or titanium-based components, acrylics, plaster, ceramics, composites, latex) are used in the manufacture of orthodontic appliances and the biomechanical properties of these materials differ from each other and oral tissues.

Orthodontic appliances are in contact with oral tissues and fluids in the mouth and are exposed to complex situations such as temperature changes, interaction with fluid, mastication forces, physical and chemical interactions. Therefore, orthodontic appliances should not contain any materials with toxic, allergic, or carcinogenic potential. Materials that are resistant to electrochemical corrosion and show optimal

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biocompatibility that do not allow to lay the groundwork for microbial accumulation should be preferred (6,7). In this context, it is suggested to use corrosion resistant orthodontic appliances with low nickel content. The materials used for optimal treatment should be resistant to the applied forces, should not be broken and should be suitable for any treatment desired by the orthodontist (6).

Main Complications That May Occur After Orthodontic Treatment

As with other medical treatments, orthodontic treatment can have positive effects as well as undesirable secondary consequences. In the literature, many factors that can lead to complications after orthodontic treatment are mentioned (8-10). Although a direct cause and effect relationship has not been proven for many, these factors should not be neglected under any circumstances.

1. Dental Complications

There are many identified side effects related to teeth that develop due to orthodontic treatment. The most important of these is that fixed orthodontic treatment causes both quantitative (during the bonding and debonding procedure) and qualitative (coloring) changes in the tooth enamel. In the literature, resorption that occurs in the roots of teeth is considered the most undesirable side effect. As a result of resorption, the roots of the tooth may become shorter and become unable to resist oral forces, this can even lead to premature loss of the tooth (8).

Although inflammatory reactions occurring in the pulp are usually temporary and reversible, sometimes irreversible changes such as necrosis can be seen. Serious periodontal damage has an increased risk of pulpal reactions, especially during intrusion or extrusion movements (11).

1.1. Enamel Damage Caused by Orthodontic Devices During Bonding and Debonding

Enamel damage that occurs during orthodontic treatment is too related to the technique used during bonding and debonding. Today, one of the most important goals of orthodontic treatment is to obtain a solid tooth surface during and after treatment.

Preparing the tooth surface for bonding with pumice before applying brackets, bands or tubes in the bonding process plays an important role in increasing the strength of the bond (12). Although cleaning and pumifying the tooth surface also causes a small amount of enamel loss, this loss is negligible compared to the damage seen after debonding (13,14).

During the removal of fixed orthodontic devices, also known as debonding, force is applied to remove the devices from the tooth surface. As a result of the application of this force, cohesive breakage in orthodontic resin may occur within itself, at the interface of the tooth or on the bonding surface of the device. Damage to the enamel may occur during the debonding process or during the cleaning of the adhesive. Whether the strength of the micromechanical bond among the enamel and the resin exceeds the adhesion strength of the enamel, the bracket can break and damage the enamel. Ceramic brackets that are chemically bonded to the tooth surface instead of micromechanical bonding have a high threat of damaging the enamel due to the strength of the bond (15). In the literature, the incidence of enamel fractures during debonding of ceramic braces has been reported to be between 10-35% (16). Currently, there are no methods to completely clean orthodontic resin from the surface of the tooth atraumatically (17). According as the technique used, almost 20-50 Mm of enamel is lost during resin cleaning (18), and scrapes and dents unavoidably remain on the

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enamel surface (19). Removing surface enamel will expose enamel prisms and could theoretically increase susceptibility to acid dissolution (20).

1.2. Complications of Orthodontic Treatment Related to Demineralization and Caries Formation in Teeth

An increase in the risk of demineralization of enamel around the brackets and marginal gingiva during orthodontic treatment is one of the commonly reported disadvantages of orthodontic treatment (21). Demineralization is observed as white spot lesions (WSL) on tooth surfaces. Data obtained from the literature show that decalcifications on the tooth surface are in the form of 70% WSL and 5% cavitated lesions (22). Chapman's (23) research reported that 30% of maxillary central teeth, which are especially important in aesthetic perception, have decalcifications after orthodontic treatment.

During orthodontic treatment, WSL often appears on enamel after 4 weeks of continuous use of a fixed orthodontic device cemented on the surfaces of the teeth (24). Most of the studies on the prevalence of WSLs in the literature revealed that these lesions were reported after the completion of orthodontic treatment. Gorelick et al. (25), in their study using the visual examination technique, reported that 50% of the patients had one or more WSL at the end of orthodontic treatment. Using quantitative light fluoroscopy, Boersma et al. (26) investigated the prevalence of WSLs at the end of orthodontic treatment and reported that one or more lesions occurred in 97% of subjects. WSLs are defined as "the first sign of a carious lesion detectable with the naked eye in the enamel" (27). These lesions are often associated with poor oral hygiene around retention elements, creating extra space for dental plaque to adhere (28). Arch wires, elastic ligatures and adhesive material used during orthodontic treatment make it difficult to maintain oral hygiene, often causing a decrease in patient motivation and an increase in plaque accumulation (29). It has been reported that plaque formation in adult patients receiving orthodontic treatment is 2 to 3 times higher than in untreated patients (30). Increased plaque accumulation during treatment still increases the risk of demineralization in some cases even one month after the start of treatment (31). Chang et al. (32) reported that orthodontic appliances are a retention zone for plaque, as well as preventing the tongue's ability to remove natural food, causing patients to have five times more Lactobacillus than normal.

In patients undergoing orthodontic treatment, the pH of saliva drops and becomes more acidic. Plaque contains many acidogenic bacteria, especially high levels of Streptococcus mutans and Lactobacilli (33). High levels of bacteria cause a decrease in plaque pH in patients (34). Therefore, caries progression occurs faster in patients who receive orthodontic treatment. The composition of the bacterial flora as well as the buffering capacity and cleansing properties of saliva are reduced, which increases the accumulation of dental plaque (35). During treatment, patients should use an interface brush, mouthwash, and dental floss besides the toothbrush.

WSL manifests itself as white, matte and opaque areas where demineralization occurs in the enamel layer (Figure 1) (23). These lesions are observed around the brackets on the labial surfaces of the teeth, oval or semicircular, typically seen in the area of the lower-upper lateral incisors, lower canines, and upper first molar teeth (23). The maxillary lateral incisors, mandibular canine, and premolar teeth are the most susceptible to demineralization, and the teeth in the maxillary anterior region are especially sensitive due to lower salivary flow and higher carbohydrate exposure (32). These lesions have a regular shape and are sharply separated from the surrounding enamel and appear asymmetrically. These lesions, which should be

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discriminated from fluorosis lesions, may cause the development of tooth decay if not treated (36). In the literature, high decalcification rates have been reported on the enamel surface during orthodontic treatment (37). For this reason, preventive measures that should be applied in order to reduce the risk of demineralization in enamel during orthodontic treatment are of great importance. In the literature, chlorhexidine (38), fluoride releasing varnishes (39), fluoride releasing bonding materials (40), high concentration fluorine gels (41) have been suggested to prevent enamel demineralization and reduce the level of Mutans Streptococci.

For a long time, fluoride has been recommended because of its capability to inhibit demineralization, and the use of topical fluoride has been demonsrated to help throughout orthodontic treatment (42,43). Studies have shown that the use of fluorine-containing varnish at regular intervals reduces the occurrence of demineralization, but the application should be repeated (43). Another investigation reported that applying a single high-dose fluoride varnish at the beginning of orthodontic treatment can reduce WSL depths by 40% (29). Benson et al. (44) reported that the use of daily rinses containing fluoride or fluoride-containing cements reduced tooth decay during fixed orthodontic treatment. Shungin et al. (27) showed a significant increase in the frequency of WSL at the end of treatment in patients who have passed 12 years since the end of active treatment, followed by a significant decrease.

After orthodontic treatment, different treatment alternatives can be applied in the presence of WSL, such as waiting for the enamel surface to remineralize spontaneously, using fluorine or casein phosphopeptide-based materials, chewing sugar free gums. Micro-abrasion can be applied when there are aesthetic complaints in anterior teeth (45).

To prevent WSL formation during orthodontic treatment, more hydrophobic composite resins that are more hydrophobic and tend to accumulate less plaque may be preferred in patients with high caries risk. Glass ionomer cements, which are generally used in order to for cementation of band, may cause the formation of retentive areas that can be considered an etiological factor for caries and periodontitis due to their hydrophilic character and solubility (46).

1.3. Color Changes Due to Orthodontic Treatment

The color change that occurs after the removal of the braces can negatively affect the patient's satisfaction in terms of aesthetics. Karamouzos et al. (26) reported that the color parameters of the teeth changed after orthodontic treatment and that 80% of the patients had serious discoloration in at least one tooth.

Color changes that occur after orthodontic treatment show a multifactorial etiology. The frequency and intensity of these changes are higher when using fixed mechanics compared to mobile appliances. When using resins for bracket bonding, enamel changes are inevitable. Studies show that the adhesive resins used in bracket bonding change color over time. Food dyes, ultraviolet light and corrosion substances from the orthodontic bracket cause the teeth to change to yellow tones (46,47).

Another coloration that may occur with the effect of orthodontic treatment in the teeth is the endogenous coloring that occurs by entering an early aging process of the teeth with the effect of orthodontic forces that cause differentiation in pulp vascularization (46).

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Even if remineralization occurs in WSL treatment, the enamel will be different from the original enamel structure. For this reason, patients often try to improve the aesthetic appearance of their teeth with tooth whitening applications after debonding (46).

1.4. Root Resorption in Orthodontic Treatment

Root resorption is an inevitable complication of orthodontic treatment. (Figure 2). In a Segal et al.'s review in 2004, the average root resorption following orthodontic treatment was reported as 1.421 ± 0.448 mm (48).

Lopatiene and Dumbravaite reported that the severity of root resorption is generally low, with resorption above 2 mm in 5-18% of cases and above 4 mm in 1-5% of cases (49). Root resorption usually does not give signs and symptoms, even the mobility value is rarely higher than 1 degree on the Miller scale. If the severity of root resorption is mild or moderate at the end of treatment, the prognosis of the tooth is considered good (50). Kalkwarf (50), showed that 4 mm and 3 mm root resorption are equivalent to 20% and 1mm, respectively. Because of its impact on dental prognosis, severe root resorption is one of the most controversial complications associated with orthodontic treatment.

Two factors, patient characteristics and applied technique, are effective in reducing the risk of root resorption associated with orthodontic treatment (51). Individual differences are thought to play a major role in the occurrence of root resorption. Some results have been obtained regarding the polymorphism of the IL-1beta gene, suggesting that genetic factors play an significant role in the formation of root resorption (52). Some research results show that this undesirable side effect is also varied among ethnic groups. Asians have a reduced incidence of root resorption than Caucasians (49). Changes in the overall health status of individuals such as allergies, asthma, diabetes, arthritis, and endocrine disorders can lead to more severe root resorption (8).

Open bite is accepted as another risk factor for root resorption. Anterior teeth become unable to tolerate orthodontic and occlusal forces due to lack of function, leading to inadequate growth of the periodontal tissue of the relevant teeth (49). Another dental anomalies related with root resorption are: hypodontics, class II and III malocclusion, over bite, and increased overjet (49).

Many studies have reported an accurate relationship among root morphology and resorption (53,54). It has been observed that the risk of root resorption shows abnormality in the apical section of the root, especially in teeth with long and narrow roots that are pointed, angled or bottle-shaped (53,54). However, it has been reported that the maxillary teeth are more susceptible to root resorption than the mandibular teeth, while the central teeth are also more prone to root resorption than the lateral teeth (55). Generally, the incidence of resorption is from less to greater as follows: maxillary lateral incisors, maxillary central incisors, mandibular incisors, maxillary canines, first molars, mandibular second premolars, and maxillary second premolars (49). In addition, the threat of root resorption is higher in teeth with a history of trauma (53).

Orthodontic treatment duration is reported as one of the important factors in the occurrence of root resorption in the literature. According to this, the duration of treatment should be less than 1½ years to prevent severe root resorption (56). It has been observed that the risk of root resorption increases especially in intrusion tooth movement (57).

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Periodontal Complications

Periodontal problems in various forms such as gingivitis, periodontitis, dehiscence, fenestration, gingival recessions, gingival overgrowths, and black triangles can be seen during or after orthodontic treatment (58).

Gingivitis usually occurs with inadequate oral care in the presence of conditions that increase plaque accumulation such as orthodontic appliances. The incidence is increased in some cases (for example, where bands usually placed in the subgingival area create a favorable area for plaque build-up by dissolution of the adhesive agent). Therefore, tubes may be preferred to bands during treatment. However, study has demonstrated that gingival hypertrophy occurs in most cases during orthodontic treatment, but approximately 3 months after removal of the device, the gingiva has a similar appearance to the pre-treatment.58

Predisposing factors for periodontal discomfort (e.g., diabetes or epilepsy treated with drugs that induce gingival growth) should be questioned in the patient's history prior to treatment. During orthodontic treatment, it is proposed to pay attention to the significance of good oral hygiene, to follow the periodontal condition (examination minimum every three months and to do tartar cleaning if necessary) and to take necessary precautions to control risk factors. In addition, in orthodontic treatment, for example, choosing the treatment alternative that supports less plaque accumulation, applying as simple devices as probable and applying little orthodontic forces should be preferred. In this context, it is proposed to prevent bands and elastomeric ligatures.

Temporomandibular Joint (TMJ) Diseases

There are conflicting opinions in the literature about the relationship between temporomandibular joint (TMJ) changes and orthodontic treatment. Some studies (59) claim that there is no significant dysfunction in TMJ from orthodontic treatment, while others believe that the risk of this complication is higher due to early occlusal contacts present during treatment (60).

Before orthodontic treatment, each case should be evaluated to identify TMJ diseases and determine if they are high risk patients. Conditions such as inflammation of the bone and muscle disorders (rheumatoid arthritis), trauma, excessive stress grade should be considered.8 It is not recommended to initiate orthodontic treatment if the patient shows signs of acute or severe pain of TMJ dysfunction. Precautions should be taken to prevent possible recurrence after active orthodontic treatment in the patient who shows signs of TMJ disorder. In some cases, splints as a reinforcement device can be helpful in reducing symptoms and facilitating healing (8).

Allergic reactions

Hypersensitivity reactions associated with known allergens such as nickel, cobalt, latex, polymers and chromium can occur during orthodontic treatment. The most common form of allergy is contact dermatitis reaction on the face and neck. However, lesions may also be seen on the oral mucosa and gums, and systemic reactions may infrequently occur (61).

Nickel allergies are among the most common allergies and are usually seen as type IV hypersensitivity reactions (61). Metal components of orthodontic devices are generally made of stainless steel (18% chromium and 8% nickel). An increase in the risk of allergies has been observed with the widespread use of nickel titanium alloys containing up to 70% nickel in orthodontic treatment (64). Allergic symptoms can range from

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minor redness of the skin or mucous membranes to diffuse dermatitis. Orthodontic treatment may need to be discontinued in cases where severe allergic reactions occur.

Another important allergen that should be considered and frequently encountered during orthodontic treatment is latex. This allergen is used in gloves, elastic and ligatures in orthodontics clinics. Allergic reactions due to latex are reported to be less than 1% in the general population and more than 5% among dental clinicians (64). Related to this, type I and IV hypersensitivity reactions, which are a life-threatening reaction, may occur.

Detected possible allergic diseases before orthodontic treatment is important for the safe treatment. Anamnesis and clinical data and hypersensitivity tests should be evaluated together for an accurate diagnosis. In cases where an allergic reaction to latex is detected, alternative latex-free materials should be preferred and nickel-based components should also be avoided (62).

SUMMARY / SONUÇ

The risks that may be encountered in orthodontics depend on the orthodontist, the technique used, the appliance and the patient, and these risks are of multifactorial origin. To reduce the incidence and severity of complications related to orthodontic treatment, a special treatment plan should be made for each case and the characteristics of the patient should be taken into consideration while doing the treatment.

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References / Referanslar

1. Graber TM, Vanarsdall RL Jr. Orthodontics Currents Principles and Techniques. 2ª edición. St. Louis, Missouri. Ed Mosby-YearBook Inc. 1994:627-35.

2. DiBiase A. The timing of orthodontic treatment. Dent Update. 2002;29(9):434-41.

3. Shah AA, Sandler J. Limiting factors in orthodontic treatment: 1. Factors related to patient, operator and orthodontic appliances. Dent Update. 2006; 33:43-44, 46-48, 51-2.

4. Iglesias-Linares A, Yáñez-Vico RM, Solano-Reina E, Torres-Lagares D, González Moles MA. Influence of bisphosphonates in orthodontic therapy: Systematic review. J Dent. 2010;38:603-11.

5. Daniels AS, Seacat JD, Inglehart MR. Orthodontic treatment motivation and cooperation: a cross-sectional analysis of adolescent patients' and parents' responses. Am J Orthod Dentofacial Orthop. 2009;136(6):780-7.

e-ISSN 2667-7288 Vol 3, Issue 2, (2021) Review Article / Derleme Makale

6. Atai Z, Atai M. Side Effects and Complications of Dental Materials on Oral Cavity. Am J Appl Sci. 2007;4(11):946-9.

7. Bentahar Z, Bourzgui F, Zertoubi M, EL Adioui-Joundy S, Morgan G. Dégradation électrochimique des matériaux métalliques utilisés en orthodontie. Int Orthod. 2005;3(5):5–17.

8. Graber T, Eliades T, Athanasiou AE. Risk Management in Orthodontics: Expers' Guide to Malpractice, Quintessence Publishing Co, Inc, Chicago. 2004.

9. Ellis PE, Benson PE. Potential Hazards of Orthodontic Treatment - What Your Patient Should Know. Dent Update. 2002;29(10):492-6.

10. Lau PY, Wong RWK. Risks and complications in orthodontic treatment. Hong Kong Dent J. 2006;3(1):15-22.

11. Bauss O, Röhling J, Sadat-Khonsari R, Kiliaridis S. Influence of orthodontic intrusion on pulpal vitality of previously traumatized maxillary permanent incisors. Am J Orthod Dentofacial Orthop. 2008;134(1):12-7.

12. Lill DJ, Lindauer SJ, Tüfekçi E, Shroff B. Importance of pumice prophylaxis for bonding with self-etch primer. Am J Orthod Dentofacial Orthop. 2008;133(3):423-6.

13. Øgaard B, Fjeld M. The Enamel Surface and Bonding in Orthodontics. Semin Orthod. 2010;16(1):37-48.

14. Hosein I, Sherriff M, Ireland AJ. Enamel loss during bonding, debonding, and cleanup with use of a self-etching primer. Am J Orthod Dentofacial Orthop. 2004;126(6):717-24.

15. Joseph VPRE. The shear bond strengths of stainless steel and ceramic brackets used with chemically and light activated composite resins. Am J Orthod Dentofac Orthop. 1990;97:121–5.

16. Azzeh E, Feldon PJ. Laser debonding of ceramic brackets: a comprehensive review. Am J Orthod Dentofac Orthop. 2003;123:79–83.

17. Janiszewska-Olszowska J, Szatkiewicz T, Tomkowski R, Tandecka K, Grocholewicz K. Effect of orthodontic debonding and adhesive removal on the enamel - current knowledge and future perspectives-a systematic review. Med Sci Monit. 2014;20:1991–2001.

18. Baumann DF, Brauchli L, van Waes H. The influence of dental loupes on the quality of adhesive removal in orthodontic debonding. J Orofac Orthop. 2011;72:125-32.

19. Gwinnett AJ, Gorelick L. Microscopic evaluation of enamel after debonding: clinical application. Am J Orthod. 1977;71:651-65.

20. Ozer T, Basaran G, Kama JD. Surface roughness of the restored enamel after orthodontic treatment. Am J Orthod Dentofacial Orthop. 2010;137:368-74.

e-ISSN 2667-7288 Vol 3, Issue 2, (2021) Review Article / Derleme Makale

21. Choi RJ. Effectiveness of fluoride containing bonding resins in preventing demineralization of enamel during orthodontic treatment. Doctoral dissertation, University of Louisville 2012.

22. Al Maaitah EF, Adeyemi AA, Higham SM, Pender N, Harrison JE. Factors affecting demineralization during orthodontic treatment: a post-hoc analysis of RCT recruits. Am J Orthod Dentofac Orthop. 2011;139(2):181-91.

23. Chapman JA, Roberts WE, Eckert GJ, Kula KS, González-Cabezas C. Risk factors for incidence and severity of white spot lesions during treatment with fixed orthodontic appliances. Am J Orthod Dentofac Orthop. 2010;138(2):188-94.

24. Staudt CB, Lussi A, Jacquet J, et al. White spot lesions around brackets:in vitro detection by laser fluorescence. Eur J Oral Sci. 2004;112:237-43.

25. Gorelick L, Geiger AM, Gwinnet AJ. Incidence of white spot formation after bonding and banding. Am J Orthod. 1982;81:93–8.

26. Boersma JG, van der Veen MH, Lagerweij MD, Bokhout B. Caries prevalence measured with QLF after treatment with fixed orthodontic appliances: influencing factors. Caries Res. 2005;39:41–7.

27. Shungin D, Olsson AI, Persson M. Orthodontic treatment-related white spot lesions: a 14-year prospective quantitative follow-up, including bonding material assessment. Am J Orthod Dentofacial Orthop. 2010;138:136.e1-136.e8.

28. Demling A, Heuer W, Elter C, et al. Analysis of supra- and subgingival long-term biofilm formation on orthodontic bands. Eur J Orthod. 2009;31:202-6.

29. Farhadian N, Miresmaeili A, Eslami B, Mehrabi S. Effect of fluoride varnish on enamel demineralization around brackets: an in-vivo study. Am J Orthod Dentofacial Orthop. 2008;133:95-8.

30. Klukowska M, Bader A, Erbe C, Bellamy P, White DJ, Anastasia MK, Wehrbein H. Plaque levels of patients with fixed orthodontic appliances measured by digital plaque image analysis. Am J Orthod Dentofac Orthop. 2011;139(5)463-70.

31. Heintz S, Georg P. Oral health for the orthodontic patients. Philadelphia: Mosby 1999. p.2-9.

32. Chang HS, Walsh LJ, Freer TJ. Enamel demineralization during orthodontic treatment. Aetiology and prevention. Aust Dent J. 1997;42(5):322-7.

33. Lundstrom F, Krasse B. Streptococcus mutans and lactobacilli frequency in orthodontic patients: the effect of chlorhexidine treatments. Eur J Orthod. 1987;9:109–16.

34. Chatterjee R, Kleinberg I. Effect of orthodontic band placement on the chemical composition of human incisor plaque. Arch Oral Biol. 1979;24:97-100.

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35. Jabłońska-Zrobek J, Śmiech-Słomkowska G. Ryzyko próchnicy podczas leczenia ortodontycznego aparatem stałym. Czas Stomat. 2005;58(7):514-9.

36. Zarzycka-Kogut K, Pucek M, Szymańska J. Orthodontic treatment–complications and preventive measures. Polish J Public Health. 2014;124(2):103-6.

37. Mitchell L. Decalcification during orthodontic treatment with fixed appliances – an overview. Br J Orthod. 1992;19:199-205.

38. Øgaard B, Larsson E, Glans R, Henriksson T, Birkhed D. Antimicrobial effect of a chlorhexidine-thymol varnish (Cervitec) in orthodontic patients. A prospective, randomized clinical trial. J Orofac Orthop. 1997;58:206-13.

39. Demito CF, Vivaldi-Rodrigues G, Ramos AL, Bowman SJ. The efficacy of a fluoride varnish in reducing enamel demineralization adjacent to orthodontic brackets: an in vitro study. Orthod Craniofac Res. 2004;7:205-10.

40. Donly KJ, Istre S, Istre T. In vitro enamel remineralization at orthodontic band margins cemented with glass ionomer cement. Am J Orthod Dentofacial Orthop. 1995;107:461-4.

41. Tezel H, Ergucu Z, Onal B. Effects of topical fluoride agents on artificial enamel lesion formation in vitro. Quintessence Int. 2002;33:347-52.

42. Chadwick BL, Roy J, Knox J, Treasure ET. The effect of topical fluorides on decalcification in patients with fixed orthodontic appliances: a systematic review. Am J Orthod Dentofacial Orthop. 2005;128:601-6.

43. Behnan SM, Arruda AO, Gonzalez-Cabezas C, Sohn W, Peters MC. In-vitro evaluation of various treatments to prevent demineralization next to orthodontic brackets. Am J Orthod Dentofacial Orthop. 2010;138:712el-712e7.

44. Benson PE, Parkin N, Millett DT, Dyer FE, Vine S, Shah A. Fluorides for the prevention of white spots on teeth during fixed brace treatment. Cochrane Database Syst Rev. 2004;3:CD003809.

45. Paschos E et al. Effect of different bonding agents on prevention of enamel demineralization around orthodontic brackets. Am J Orthod Dentofacial Orthop. 2009;135:603-12.

46. Preoteasa CT, Nabil Sultan A, Popa L, Ionescu E, Iosif L, Ghica MV, Preoteasa E. Wettability of some dental materials. Optoelectron Adv Mater. 2011;5(8):874-8.

47. Faltermeier A, Rosentritt M, Reicheneder C, Behr M. Discolouration of orthodontic adhesives caused by food dyes and ultraviolet light. Eur J of Orthod. 2008;30(1):89-93.

48. Segal GR, Schiffman PH, Tuncay OC. Meta analysis of the treatment-related factors of external apical root resorption. Orthod Craniofac Res. 2004;7(2):71-8.

49. Lopatiene K, Dumbravaite A. Risk factors of root resorption after orthodontic treatment. Stomatologija. 2008;10(3):89-95.

50. Kalkwarf KL, Krejci RF, Pao YC. Effect of apical root resorption on periodontal support. J Prosthet Dent. 1986;56(3):317-9.

51. Bourzgui F, Sebbar M, Abidine Z, Bantahar Z: Management of dental impaction in Bourzgui F. Orthodontics-Basic aspects and Clinical Conciserations. InTech. 2012, 219-47

52. Bastos Lages EM, Drummond AF, Pretti H, Costa FO, Lages EJ, Gontijo AI, Miranda Cota LO et al. Association of functional gene polymorphism IL-1beta in patients with external apical root resorption. . Am J Orthod Dentofacial Orthop. 2009;136(4):542-6.

53. Årtun J, Van 't Hullenaar R, Doppel D, Kuijpers-Jagtman AM. Identification of orthodontic patients at risk of severe apical root resorption. Am J Orthod Dentofacial Orthop. 2009;135(4):448-55.

54. Smale I, Artun J, Behbehani F, Doppel D, van't Hof M, Kuijpers-Jagtman AM. Apical root resorption 6 months after initiation of fixed orthodontic appliance therapy. Am J Orthod Dentofacial Orthop. 2005;128:57-67.

55. Brezniak N, Wasserstein A. Orthodontically Induced Inflammatory Root Resorption. Part I: The Basic Science Aspects. Angle Orthod. 2002;72(2):175-9.

56. Apajalahti S, Peltola JS. Apical root resorption after orthodontic treatment - a retrospective study. Eur J Orthod. 2007;29(4):408-12.

57. Weltman B, Vig KW, Fields HW, Shanker S, Kaizar EE. Root resorption associated with orthodontic tooth movement: A Systematic Review. Am J Orthod Dentofacial Orthop. 2010;137(4):462-76.

58. Kouraki E, Bissada NF, Palomo JM, Ficara AJ. Gingival enlargement and resolution during and after orthodontic treatment. N Y State Dent J. 2005;71(4):34-7.

59. Bourzgui F, Sebbar M, Nadour A, Hamza M. Prevalence of temporomandibular dysfunction in orthodontic treatment. Int Orthod. 2010;8(4):386-98.

60. Gebeile-Chauty S, Robin O, Messaoudi Y, Aknin JJ. Can orthodontic treatment generate temporomandibular disorders and pain? A review Orthod Fr. 2010;81:85-93.

61. Leite LP, Bell RA. Adverse Hypersensitivity Reactions in Orthodontics. Semin Orthod. 2004;10(4):240-3.

62. Kolokitha OE, Chatzistavrou E. Allergic reactions to nickel-containing orthodontic appliances: clinical signs and treatment alternatives. World J Orthod. 2008;9(4):399-406.