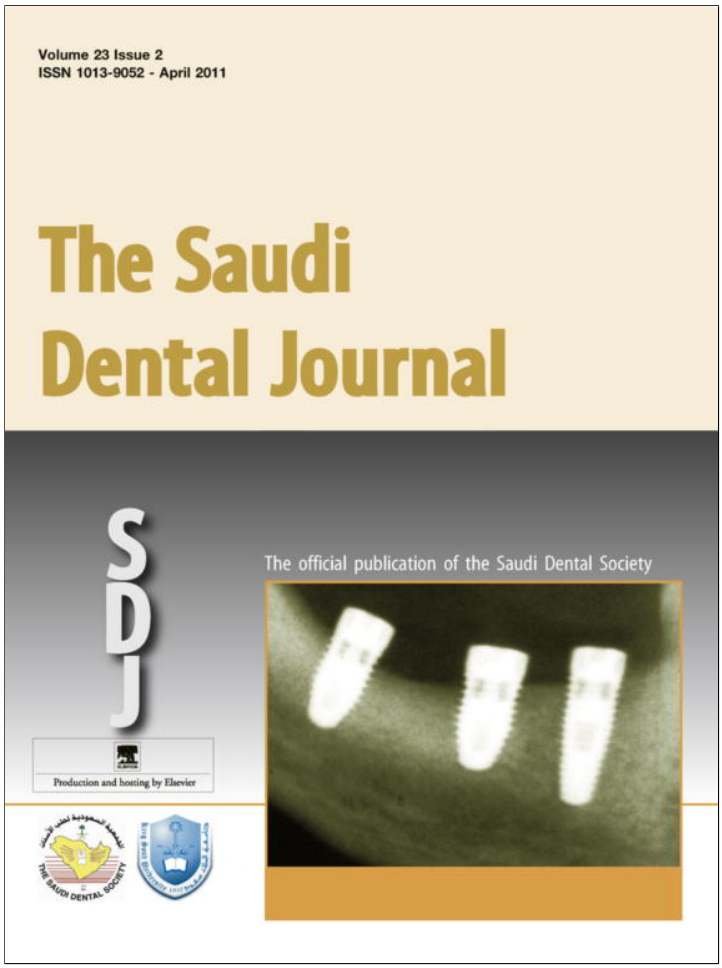

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REVIEW ARTICLE

Adverse effects of orthodontic treatment: A clinical perspective

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Abstract Orthodontic treatment is associated with a number of adverse effects, such as root resorption, pain, pulpal changes, periodontal disease, and temporomandibular dysfunction (TMD). Orthodontists should be aware of these effects and associated risk factors. Risk factors linked to root resorption include the duration of treatment, length, and shape of the root, trauma history, habits, and genetic predisposition.

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1. Introduction

Orthodontic treatment is a discipline in dentistry, like many other disciplines in this field, it can have adverse effects associated with the execution of treatment. These effects can be related to the patient or practitioner. Some of these effects are not fully understood, such as root resorption, and others are associated with orthodontic treatment without supporting evidence. Consideration of risk factors prior to treatment is important. Only risk factors that have been supported by previous evidence will be reviewed in this article. These adverse effects include root resorption, pain, pulpal changes, periodontal disease, decalcification, and temporomandibular dysfunction (TMD).

2. Root resorption

Root resorption is common during orthodontic tooth movement (Krishnan, 2005). Limited root resorption, involving a number of teeth, can be considered a consequence of orthodontic treatment (Ketcham, 1927). If the patient develops additional pathosis, such as periodontal disease, this may further compromise the support of the tooth and the patient can eventually loose that tooth (Ketcham, 1927). However, no reports in the literature have documented tooth loss caused by root resorption. A long-term case report documented a follow-up of a case of severe root resorption that occurred for 33 years, and the affected teeth were found to be functional (Parker, 1997). However, lack of reports in the literature on tooth loss due to root resorption does not exclude this as a potential risk.

The problem of root resorption as a consequence of orthodontic treatment was first discussed by Ketcham (1927). He was also the first to indicate other factors, such as hormonal disturbance and dietary deficiency in addition to orthodontic treatment variables, which may be contributing factors in root resorption (Davidovitch et al., 1996). The etiology of root resorption still remains unclear and is complex, including genetic predisposition and environmental factors (Al-Qawasmi et al., 2003; Abass and Hartsfield, 2007). The genetic predisposition makes root resorption associated with orthodontic treatment more predictable (Abass and Hartsfield, 2007).

The best approach toward root resorption is to consider the risk factors, discuss the identified factors with the patient seeking orthodontic treatment, and include these factors in the treatment consent form. These risk factors include the duration of treatment. The risk for root resorption increases with the length of treatment (Krishnan, 2005; Brezniek and Wasserstein, 1993; Baumrind, 1996). Treatment of impacted canines can extend treatment time or the movement of these canines may lead to an increase in the risk for root resorption (Krishnan, 2005). Thin, tapered, and dilacerated root morphology, results in roots that are more prone to resorption (Mirabella and Artun, 1995; Levander et al., 1998; Killiany, 1999; Sameshima and Sinclair, 2001). Additionally, history of trauma associated with the anterior teeth increases the risk for root resorption (Malmgren et al., 1982). Therefore, documentation of the condition through pre-treatment periapical radiographs of the maxillary and mandibular incisors is necessary. Potential extraction of maxillary and mandibular first or second premolars as well as the use of intermaxillary elastics during treatment should also be considered (Mirabella and Artun, 1995; Sameshima and Sinclair, 2001). Root resorption from previous orthodontic treatment is a risk that may result in further root shortening (Brezniak and Wasserstein, 2002). Orthodontic re-treatment of such cases should be performed with caution and treatment objectives should be limited. Some habits, such as thumb sucking, occlusal trauma, or history of chronic bruxism, may increase the risk for root resorption (Linge and Linge, 1991; Harris, 2000).

Assessment of the condition through a progress radiograph at 6–12 months after the initiation of orthodontic treatment is recommended. These could be either periapical or panoramic radiographs. The patient must be informed that if root resorption is observed, then active treatment must be stopped for at least 3 months (Levander et al., 1994). The reparative process of root resorption begins two weeks after active treatment is stopped (Krishnan, 2005). At this stage, an alternative treatment plan should be considered and treatment should be discontinued when severe root resorption is observed.

3. Pain associated with orthodontic treatment

Pain and discomfort is a common adverse effect associated with orthodontic treatment (Pollat, 2007). Previous studies have shown that 70–95% of orthodontic patients experience pain (Lew, 1993; Scheurer et al., 1996; Firestone et al., 1999). This pain could be a reason for discontinuing treatment; previous studies have indicated that 8% and even upto 30% of orthodontic patients discontinue treatment because of pain (Pollat, 2007). The pain and discomfort associated with orthodontic treatment is characterized by pressure, tension, or soreness of the teeth (Ngan et al., 1989). Pain in the anterior teeth is greater than the posterior teeth (Scheurer et al., 1996). Pain has been reported to begin 4 h after the placement of separators or orthodontic wire, and the worst pain was found to occur on the second day of treatment (Ngan et al., 1989; Lew, 1993; Scheurer et al., 1996; Firestone et al., 1999). Usually, pain lasts for seven days (Ngan et al., 1989). Clinical anticipation of the need to use fixed appliances makes the risk for pain and discomfort greater (Stewart et al., 1997; Sergl et al., 1998). Management of pain should include informing the patient of the possibility of experiencing pain to reduce anxiety. Furthermore, the clinician can ask the patient to chew on plastic wafers or chewing gums containing aspirin (White et al., 1984; Hwang et al., 1994; Ngan et al., 1994). Chewing on plastic wafers theoretically increases the circulation in the periodontal ligament, which reduces the pain and discomfort. Additionally, clinicians are recommended to prescribe Ibuprofen or acetaminophen analgesics preoperatively and for a short duration after the placement of separators and initial wires (Ngan et al., 1994; Law et al., 2000; Polat and Karaman, 2005).

4. Pulpal changes during orthodontic treatment

Pulpal reaction to orthodontic forces is minimal. This reaction is in the form of transient mild inflammatory response, which has no long term significance (Anstendig and Kronman, 1972; Kvinnsland et al., 1989). The possibility of pulp vitality loss during orthodontic treatment does exist (Yamaguchi and Kasai, 2007). The risk factors for loss of pulp vitality include a history of trauma associated with the teeth. Pre-treatment periapical radiographs of previously traumatized teeth are essential for comparative purposes. Additionally, the use of heavy uncontrolled, continuous forces by the orthodontist or round tripping of the teeth may lead to loss of pulp vitality. Therefore, orthodontist should use optimal light forces during their treatment (Yamaguchi and Kasai, 2007).

5. Periodontal disease and orthodontic treatment

Periodontal disease includes gingivitis, alveolar bone loss (periodontitis), and loss of attached gingival support (Brägger and Lang, 1996). The periodontal reaction toward orthodontic appliances depends on multiple factors, such as host resistance, the presence of systemic conditions, and the amount and composition of dental plaque. Lifestyle factors, including smoking, can also compromise periodontal support (Safkan-Seppala and Ainamo, 1992; Clarke and Hirsch, 1995; Genco, 1996; Sanders, 1999; Krishnan et al., 2007). Additionally, the negative effects of uncontrolled diabetes on periodontal support are well established (Safkan-Seppala and Ainamo, 1992). Orthodontic treatment in uncontrolled diabetic individuals is contraindicated.

Bacteria present in dental plaque are the primary causative agent of periodontal disease (Sanders, 1999). Orthodontic treatment with fixed appliances is known to induce an increase in the volume of dental plaque. However, fixed orthodontic appliances cause a shift in the type of bacteria (Petti et al., 1997). Therefore, fixed orthodontic treatment may result in localized gingivitis, which rarely progresses to periodontitis (Van Gastel et al., 2007).

The factor that determines the condition of the periodontium during orthodontic treatment is the level of oral hygiene. Therefore, oral hygiene instructions should be given before the initiation of orthodontic treatment and reinforced during every visit. Regularly brushing the teeth is the first line of defense in controlling dental plaque. The use of electrical and ultrasonic tooth brushes has been shown to be superior to manual brushing in controlling bacterial plaque on the buccal surfaces and reducing gingival inflammation (Costa et al., 2007). The use of an interproximal brush in addition to the orthodontic brush is necessary (Arici et al., 2007). The fluoride concentration in the toothpaste used for brushing should not be less than 0.1%. The use of toothpaste with stannous fluoride produced a higher inhibitory effect on dental plaque and gingivitis development (Ogaard et al., 2006). The use of fluoride and chlorohexidine varnishes reduces the levels of bacterial plaque (Beyth et al., 2003). Oral hygiene during orthodontic treatment is the key to maintenance of a healthy periodontium (Alstad and Zachrisson, 1979).

Orthodontic treatment of patients with active periodontal disease is contraindicated as the risk for further periodontal breakdown is markedly increased (Zachrisson and Alnaes, 1973; Cardaropoli and Gaveglio, 2007). Complete evaluation of the periodontal status, especially in adult patients, is required and control of the periodontal status is necessary prior to initiation of orthodontic treatment.

Careful examination of the level of attached gingival prior to comprehensive orthodontic treatment is necessary. The level of attached gingival is measured from the free gingival margin to the mucogingival junction minus the depth of the gingival sulcus. Dental movement in the labio-lingual direction can be performed within the envelope of the periodontium without harmful effects on the level of attached gingiva (Wennstorm, 1990). If an inadequate level of attached gingiva is present prior to orthodontic treatment, a periodontic consultation should be performed, especially if labial movement of the teeth is anticipated (Wennstorm, 1990, 1996).

6. Decalcification and caries associated with orthodontic treatment

Decalcification of enamel (white spots) is a common adverse effect of orthodontic treatment. Decalcification is considered to be the first step toward cavitation. Decalcification of enamel occurs in 50% of orthodontic patients and the most affected teeth are the maxillary incisors (Gorelick et al., 1982). Additionally, these lesions can develop within four weeks, which is the typical time span for orthodontic follow-up (Ogaard et al., 1988a,b).

The prevention protocol for decalcification includes plaque control through brushing of the teeth with fluoridated tooth paste. Daily rinsing with a 0.02% or 0.05% sodium fluoride solution can also minimize decalcification of enamel. Additionally, fluoridated solutions may delay the progression of lesions (Ogaard et al., 1988a,b, 2006; Geiger et al., 1992). Application of fluoride varnish twice a year or a combination of antibacterial and fluoride varnish may reduce the incidence of decalcification (Ogaard et al., 2001).

If decalcification is observed after removal of the orthodontic appliances, the practitioner should not rush into the management of these lesions. Time should be given for possible re-mineralization of these white spots. In these cases the patient should be instructed to continue with the plaque control protocol, which includes daily rinsing with fluoridated solutions. No fluoride varnish should be applied to the lesion at this stage, because it will arrest the lesion and the chance for re-mineralization will be diminished.

7. TMD and orthodontic treatment

TMD is a condition that can include masticatory muscle pain, internal derangement of the temporomandibular joint (TMJ) disc, and degenerative TMJ disorders as separate problems or can be a combination. In the general untreated adult population, 26–59% have been shown to report at least one symptom of TMD. Additionally, 48–86% of the general population shows at least one clinical sign (Osterberg and Carlesson, 1979; Solberg et al., 1979; Swanljung and Rantanen, 1979; Pullinger et al., 1988). The etiology of TMD is complex and cannot be explained on a cause-and-effect basis. Malocclusion may be considered in some cases as a contributing factor, but it is not the sole etiological factor. Skeletal anterior open bite, reduced overbite, and increased overjet are associated with osteoarthritic TMJ patients. There is no evidence that overbite or overjet plays a role in the pathophysiology of non-arthritic

disorders. A Loss of molar support may be associated with osteoarthrosis presence and severity. Additionally, the presence of posterior crossbite does not seem to provoke TMJ symptoms or disease (Seligman and Pullinger, 1991). Certain features, such as anterior open bite in osteoarthrosis patients, were considered to be a consequence of TMD rather than etiological factors of the disorder (Pullinger et al., 1993). A combination of a minimum of two to five occlusal variables contributed to the TMD found in patient groups. Significant increases in risk occurred selectively with anterior open bite, unilateral maxillary lingual crossbite, overjet of more than 6–7 mm, more than 5–6 missing posterior teeth, and retruded cuspal position (RCP) to initial cuspal position (ICP) slides of more than 2 mm (Pullinger et al., 1993). The overall contribution of occlusal factors to TMD is considered to be 10–20%, while 80–90% is related to other factors (Pullinger et al., 1993).

Orthodontic treatment during adolescence does not increase the risk for TMD (Sadowsky and Begole, 1980; Sadowsky and Polson, 1984; Kremenak et al., 1992a,b; Rendell et al., 1992; Egermark et al., 2005). Also, extraction of teeth for orthodontic treatment purposes does not increase the risk for the development of TMD signs and symptoms (Sadowsky et al., 1991; Kremenak et al., 1992a,b). Additionally, there is no elevated risk for TMD due to the use of any particular orthodontic mechanics or appliances (Dibbets and Van der Weele, 1987, 1992; Mohlin et al., 2007).

Orthodontic treatment should not be started in patients with acute signs and symptoms of TMD. The orthodontic treatment should be postponed after the attack is controlled. If the patient develops signs and symptoms during the orthodontic treatment, then all active forces must be discontinued without the need for the removal of the fixed orthodontic appliances. Then, the signs and symptoms of TMD must be controlled using a conservative approach. Once the signs and symptoms are under control, then the practitioner must re-evaluate the objectives of treatment. In some cases, the orthodontic treatment must be terminated if the signs and symptoms cannot be controlled.

8. Conclusion

Orthodontic treatment is like any other treatment that can be associated with unfavorable side effects. Knowledge of these side effects is essential to the orthodontist and the patient willing to have orthodontic treatment. Obtaining an informed consent from the patient is as important as executing the treatment plan.

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