

Iatrogenic Effects of Orthodontic Treatment: Decision-Making in Diagnosis, Treatment and Modalities of Prevention

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Abstract

The purpose of this study is to investigate the iatrogenic effects that may accompany orthodontic treatment and whether it is related to the treatment or not mainly by reviewing articles published regarding this issue. Orthodontic treatment benefits' carries improvement in function, esthetics and the patients' self-confidence. However, a number of iatrogenic effects are possible during or after orthodontic treatment that have been described here. Iatrogenic damage during orthodontic treatment is defined as deleterious effects to the dentition, periodontium or the patient that may occur as a result of orthodontic treatment. The complications associated with orthodontic treatment are a result of a multifactorial process including the patient's own biology, clinical skills of the orthodontist, orthodontic appliances, orthodontic treatment procedures and length of treatment. If orthodontic treatment is to be beneficial, the advantages it offers should outweigh any possible damage it may cause. It is important to assess the risks of treatment as well as the potential gain and balance these aspects of treatment prior to deciding to treat a malocclusion. In this article we will discuss the iatrogenic effects of orthodontic treatment as well as decision-making in management and modalities of prevention of associated complications.

White spot lesions can be a serious side-effect concerning esthetics during orthodontic treatment or after debonding although it may be self-limiting with good oral hygiene control. Root resorption is one of the major issues that may due to excessive application of certain types of forces (torque/intrusion), longer treatment times, treatment performed on malformed teeth (dilacerations) and patient's biological response) Bracket interferences on opposing brackets may cause tooth wear. Fractures or chipping of enamel during debonding process may occur. Periodontal issues could worsen during orthodontic treatment and therefore periodontal health must be achieved prior to starting treatment. Several safety protocols are necessary to avoid intra and extra oral injuries. Current literature does not provide conclusive relationship between TMJ issues and orthodontic treatment. Good clinical practice and careful patient selection is critical for minimizing iatrogenic effects of any treatment procedure. Patient education, good communication regarding pros and cons of orthodontic treatment procedures and informed consent process is crucial to avoid patient dis-satisfaction.

Keywords: *Complications; Iatrogenic Effects; White Spot Lesions; Orthodontic Treatment*

Introduction

The goal of orthodontic treatment is to develop a well-balanced, functional and esthetic occlusion. However just like any treatment consumption or modality of any medication, there needs to be a balance between advantages and disadvantages. As clinicians, we will to increase the advantages or benefits of treatment and eliminate or minimize the side effects. Iatrogenic effects of orthodontic treatment are defined as the deleterious effects to the dentition, periodontium or the patient that may occur as a result of the orthodontic treatment

performed. The complications due to ortho. treatment are a result of a multifactorial process including the clinical skills, patient's own biology, of the orthodontist, orthodontic appliances, orthodontic treatment procedures and length of treatment. If orthodontic treatment is to be beneficial, the advantages it offers should outweigh any possible damage it may cause. It is important to assess the risks of treatment as well as the potential gain and balance these aspects of treatment prior to deciding to treat a malocclusion. In this article we will discuss the possible iatrogenic effects of orthodontic treatment as well as decision-making in management and patterns to prevent such possible complications.

Enamel demineralization (white spot lesions)

Enamel demineralization is a common negative consequence of orthodontic treatment in the absence of appropriate oral hygiene maintenance. It is the loss of calcified tooth substance due to the attack by acidic-by-products of plaque metabolism. An early recognition is sentient to prevent permanent damage. Occurrences during active treatment necessitate a shortened treatment plan or in severe cases; early termination of treatment. The increase in food stagnation and increase in the retentive sites of bacteria lead to a change in the microflora (low Ph environment). Decalcification may occur within one month due to prolonged accumulation of plaque next to the bracket [1]. White Spot Lesions caused by the decalcification process can be distinguished from the developmental hypocalcified lesions on the basis of location, shape, and dimensional stability with time [2]. Figure 1 Poor oral hygiene, sugar rich food, long treatment time and interproximal caries are good predictors for the development of white spot lesions in a patient. The incidence of enamel demineralization is high in the maxillary and mandibular canines and premolars [3]. The maxillary laterals had the highest incidence rate, almost three times as frequent as that found for the centrals. One in every two individuals wearing fixed orthodontic appliances develops a non-developmental enamel opacity [4].



Figure 1: Minor WSL on incisal edges first day after debonding.

Management of enamel demineralization

Management of enamel demineralization comprises dietary counselling and education and tooth brushing instructions. Robinson., *et al.* 2005 concluded that only powered toothbrushes with a rotation action achieved a reduction in plaque [5]. Fluoride rinses were associated with a 25% reduction in the number of patients having white spot lesions in the home fluoride rinse program [2,6]. Interdental cleaning and periodic hygiene recall is highly recommended. It is also advisable for fluoride gels and varnishes that contain not less than 22,300 ppm of fluoride be applied once during the first eight weeks after the fixed orthodontic appliance removal [7]. Chlorohexidine is the one of the most widely used broad-spectrum antimicrobial agents in dentistry. It has proven to be effective in the maintenance of plaque control and gingivitis without developing resistance to micro-organisms. It has been suggested that chlorhexidine combined with thymol in a varnish could have excellent adsorption to the tooth surface and is well tolerated [8].

Management of Orthodontic appliances

Based on the initial exam and patient's oral hygiene and diet; if we suspect an increased risk for demineralization, following strategies could be utilized. Smaller size of brackets should be selected and excess composite during bonding should be removed from the area around the brackets. A complete coverage of enamel with cement when banding is recommended to prevent voids and plaque accumulation. Minimal use of looped archwires are recommended when possible. Anticariogenic effects of fluoride releasing adhesive glass ionomer cements is favorable and Large amounts of fluoride were found in the oral fluid [9]. Chung, *et al.* evaluated the features of fluoride releasing and non fluoride releasing materials and he discovered that the fluoride releasing material were clinically strong enough to withstand ortho mechanics [10].

External apical root resorption

EARR is the most common and frequent iatrogenic consequence of ortho. treatment. Its etiology is multifactorial involving both the patient's genetics and epigenetics/environmental factors. The resorption happened when the pressure on the cementum exceeds the reparative capacity and dentin is exposed. Radiographs can only depict resorption to a certain degree. On average 1 - 2 mm is lost during ortho. treatment with maxillary incisors being most involved in apical root resorption [11]. Less than one mm root resorption was found on premolars and molars according to Sinclair, *et al.* [12] Risk factors for external apical root resorption can be divided into biological and mechanical factors. Biological factors include familial predisposition, age ≥ 11 , hyperthyroidism, Paget's disease, previously traumatized or non-vital teeth as well as teeth with short, blunt or thin roots. Furthermore there are mechanical factors predisposing external apical root resorption such as heavy orthodontic forces, distance in tooth movement (for examples: extraction cases, ectopic canines), longer treatment duration, fixed appliance treatment and types of orthodontic tooth movement (for example: intrusion) [13]. It is pertinent to obtain good quality initial records including panoramic radiograph and when required periapical radiographs of maxillary incisors. A progress (approximately after a year into treatment) panoramic radiograph and additional periapical radiographs (when needed) should be obtained after active tooth movement for all patients. In patients with additional risk factors, additional radiographs should be obtained (Figure 2). Caution should be applied in moving abnormally shaped teeth. The orthodontic forces should be intermittent, light and well distributed. Studies have shown that L-thyroxine hormone drugs and bisphosphonates can increase the resistance of cementum and dentin to osteoclastic activity but clinicians would rarely prescribe these solely for orthodontic purposes [14]. After completion of orthodontic treatment, follow-up visits should be scheduled every 6 months although the resorption ceases with the removal of active forces [15].

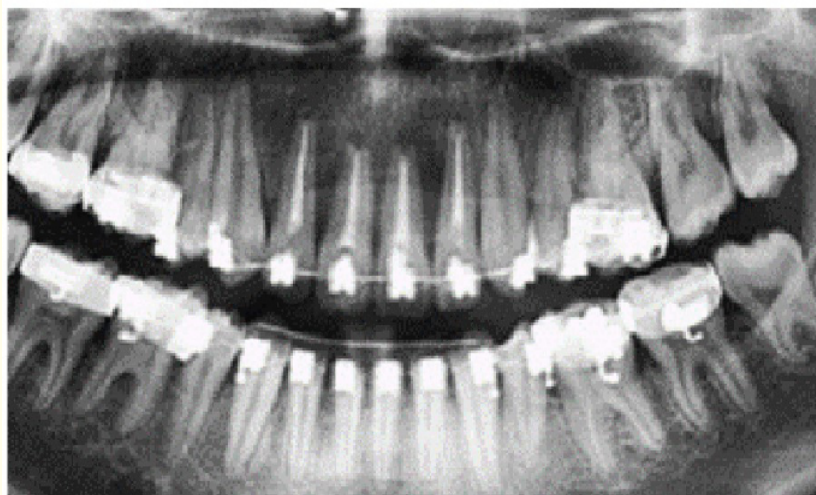


Figure 2: Panoramic X Ray showing resorption of the upper anterior teeth apical roots.

Root resorption in more than one-quarter of the root length may have adverse effects on the longevity of the tooth [16]. Early detection by treatment screening, Orthopantomogram and periapical x-rays as well as knowledge of the risk factors prior to treatment is mandatory to the dental care provider.

It is necessary to inform the patient as soon as we detect any signs of root resorption wither at the beginning or during the treatment. Revise treatment goals by holding treatment duration to the minimum and use light forces orthodontic techniques. Retaining the teeth with fixed appliances should be done with caution since occlusal trauma of the fixed teeth or segments might lead to extreme EARR [17].

Enamel wear, abrasion and fractures

Abrasion of enamel against both metal and ceramic brackets may occur (Figure 3). Ceramic brackets have low fracture resistance and high bonding strength which can cause difficulties during repositioning or debonding. Stainless steel (SS) brackets induce less enamel abrasion than the ceramic ones [18]. Enamel damage can occur during contacts of ceramics with occluding teeth. It is critical to document presence of enamel erosion/wear prior to the start of treatment. Consuming high amounts of carbonated drinks and/ juices is one of the most common causes of erosion and therefore should be restricted in patients with fixed appliances. Clarity® brackets were mostly affected in relation to the surface topography and to the release of mineral particles of enamel [19]. Enamel fractures were observed only in the samples bonded with ceramic brackets, and the type of pliers did not influence the incidence and extent of enamel damage. The burs at low speed removed the remaining adhesive more effectively during cleanup procedures [20].

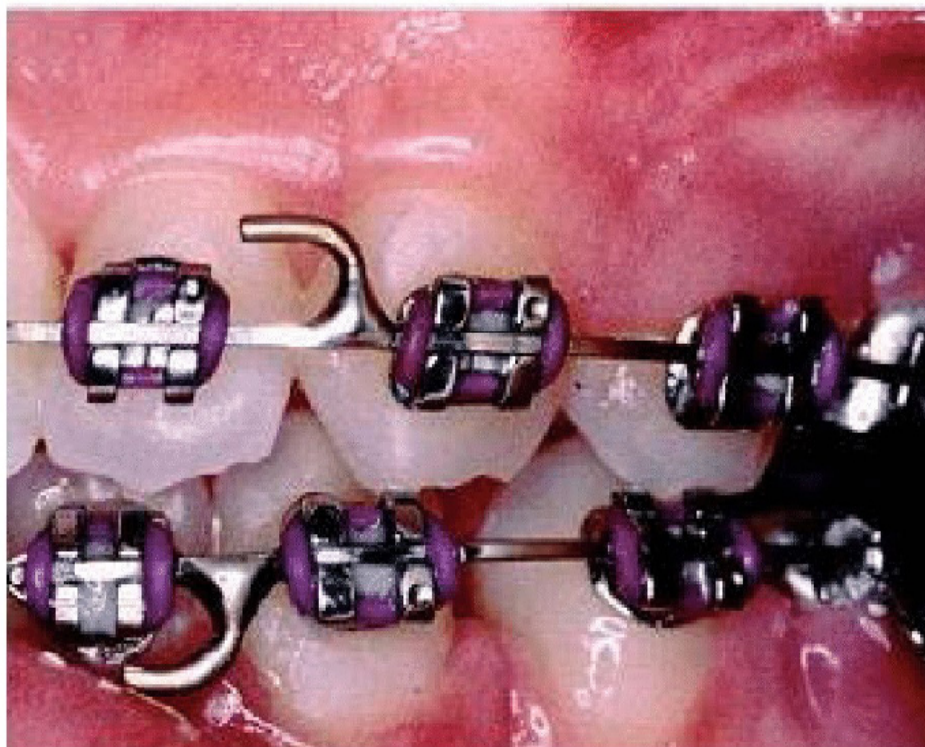


Figure 3: Upper canine tip showing abrasion from the lower canine metal bracket *British Dental Journal.

Management: Decreasing the consumption of low pH drinks could minimize the tendency for enamel erosion during ortho treatment. To minimize debonding fractures it is recommended that practitioners use specific debonding pliers such as Weingart pliers, Clarity Bracket Removing Pliers and carbide burs rotating at slow speeds as well as CO₂ super pulse laser for debonding [21,22].

Periodontal disease

With good oral hygiene practices, healthy periodontal tissue does undergo inflammatory processes when orthodontic forces are kept within the optimum limits. Dorfman suggested that mandibular incisors are most likely to express gingival recession in response to orthodontic mechanical therapy [23,24]. Huser, *et al.* studied longitudinally the microbial flora in plaque of patients undergoing orthodontic treatment [25]. There were definite increases in plaque scores and probing depths in these patients when compared with controls. The study found that adult patients present a challenge because they often have conditions, like tooth wear, excessive restorations, and pre-existing periodontal disease (Figure 4) [25,26]. Some adults develop black triangular spaces between anterior teeth. Open gingival embrasures could occur as a complication in about one third of all adult patients due to the gingival and papillary recession as a process of aging. It should be discussed with patients before initiating ortho treatment since this may pose esthetics concerns to the patient after removal of appliances.



Figure 4: (Gingival inflammation) Patient requested early debonding and had failed to appear for orthodontic visits for 2 years. This photo was taken at the same day of debonding. Rutgers SDM 2017.

Patients with pre-existing periodontal diseases needs special attention, documentation of probing depths, bleeding points, full mouth periapical radiographic series prior to starting orthodontic treatment. Bone loss during treatment is not necessarily related to previous bone loss. If the patient is sufficiently motivated and the disease is controlled, three month periodontal check-ups and light orthodontic forces can be practiced. Bone loss alters position of center of resistance for the tooth. Teeth may extrude easily and may cause occlusal interference, leading to increased mobility and trauma from occlusion. Special precaution is necessary when applying orthodontic forces to such teeth. Bonds rather than bands on molars and premolars may be more appropriate to eliminate potential areas of plaque accumulation. Permanent retention, patient motivation and dexterity are of paramount importance in the success of oral hygiene and in regress of periodontal disease. However, there will always be cases where oral hygiene is unsatisfactory and shorter treatment plans are recommended.

Injuries from orthodontic appliances

Head-gear eye trauma: The elastic traction of a head gear may cause the face bow to recoil and hit the patient on the face, head or neck. The appliance could also get dislocated during sleep and cause damage or injury to the soft tissues. Safety products and guidelines have been implemented such as safety bows, ridged neck straps, snap release products preventing disengagement. A survey among British orthodontists found a 4% incidence of facial injury with headgear. Of these injuries, 40% were extra-oral and 50% were in the mid face. Figure 5a, 5b Two patients were blinded as a result of headgear trauma. Eye injury is uncommon, but a serious risk and all available methods of reducing the risk of penetrating eye injury must be used. Every headgear and Kloehe bow must incorporate a safety feature. Failure to observe safety guidelines on the use of headgear is medico legally indefensible [27]. Laceration to the gingiva and mucosa causing areas of ulceration or hyperplasia during treatment by arch wires, unsupported stretches of wire, brackets, hooks and auxiliaries have been reported. Figure 6 Dental wax may be applied either by the orthodontist or the patients themselves to any sharp protruding portion of an appliance. In lingual orthodontics, practitioners can use pliable light-cured single-component materials to help bruises heal. In certain cases of relatively serious injury, the orthodontist may decide to remove the damage inducing apparatus until complete healing has taken place. Patients who participate in sports where there is a risk of orofacial trauma or who play wind instruments should wear custom made mouth guards or commercial products such as Comfort Cover® and Lip Protector®. Sports stores also sell generic plastic mouth guards that patients can customize by soaking them in hot water before biting on to them. Burns, either thermal or chemical are possible both intra-orally and extra-orally with inadvertent use of chemicals or instruments. Acid etch, electro-thermal debonding instruments and sterilized instruments which have not cooled down all have the potential to cause burns and care should be taken in their use.



Figure: 5a

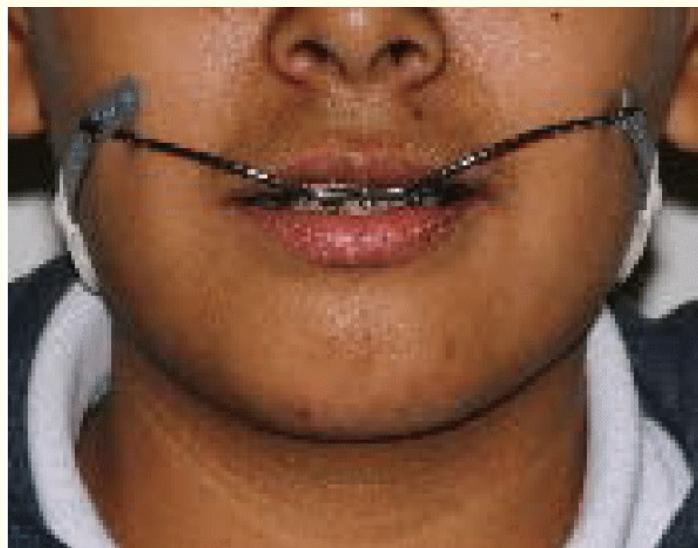


Figure: 5b

Figure 5 (a, b): Intra and extra oral photo for cervical head gear.



Figure 6: Cheek trauma from the hook of upper right seven bracket.

Temperomandibular disorders (TMD) and Orthodontics

TMD is common in certain populations whether orthodontic treatment is carried out or not. There is no evidence to support the theory that orthodontic treatment causes TMD or cures it. McNamara in 1995 noted that signs and symptoms of TMD increase with age [28,29]. Orthodontic treatment does not increase or decrease the risks of developing TMD. Extraction of teeth does not increase risk of TMD. And there is no elevated risk for TMD associated with any particular type of orthodontic mechanic. Although stable occlusion is a goal, not achieving ideal occlusion does not result in TMD. O'Reilly and Rinchuse, *et al.* concluded that class II elastics and extractions have little or no effect on general TMD signs and symptoms [30,31]. Mohlin, *et al.* demonstrated that associations between specific types of malocclusions and development of significant signs and symptoms of TMD could not be verified [32]. Sadowsky, *et al.* demonstrated that clinical examination in a group of 75 subjects between 25 and 55 years of age who had been treated orthodontically with full fixed appliances at least 10 to 35 years ago, during adolescence were as follows. The findings were compared to those of a control group of adults with untreated malocclusions. These findings show that patients' who underwent orthodontic treatment many years ago prevalence of TMJ signs and symptoms is similar to that of a control group of adults with untreated malocclusions [31].

Esthetics

There were no significant differences in profiles treated by extraction or non-extraction means. Changes in the dentition resulted in some slight proportional changes in the soft tissue profile. Soft tissue changes occur naturally with age, regardless of orthodontic intervention. Proper diagnosis should take into account skeletal form, tooth position and soft tissue profile prior to the start of treatment to minimize the possibility of any detrimental effect on profile by treatment mechanics [33].

Conclusions

Orthodontic treatment is similar to any other treatment that may be related with unwanted outcomes. Recognition of these side effects is critical to the orthodontist and the patient.

It is essential to obtain thorough medical, dental and family history before starting treatment. Progress diagnostic records during the treatment such as radiographs and monitoring of the periodontal status is of great importance for success of therapy. Clear communication with the patient regarding the risks and benefits of the planned orthodontic treatment is important to avoid any future misinterpretations. Clinicians must obtain a signed consent for treatment and the risks involved.

The etiology of iatrogenic effects of orthodontic treatment is multifactorial. Patient's genetics, oral hygiene, type of orthodontic treatment and treatment duration are some of the most common causes.

Financial Disclosures

None.

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