

# Research Journal of Pharmaceutical, Biological and Chemical Sciences

## Iatrogenic Damage Caused During Orthodontic Tooth Movement: A Review.

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### ABSTRACT

In orthodontic treatment, teeth are moved in to new positions and relationships and the soft tissue and underlying bone are altered to accommodate changes in esthetics and function. Orthodontics has in addition to its benefits, complications as well as risks associated with its procedures. However the benefits outweigh the risks & complications in most of the treatment cases. The unwanted iatrogenic side effects associated with the treatment may be subdivided into hard tissue and soft tissue injuries. A few examples of iatrogenic damage caused during orthodontic tooth movement are tooth discolorations, enamel decalcification, periodontal complications like open gingival embrasures, root resorption, allergic reactions to nickel & chromium as well as treatment failure in the form of relapse.

**Keywords:** Iatrogenic, side effects, orthodontic treatment.

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## INTRODUCTION

Improved socio-economic conditions, tremendous growth in discreet orthodontic treatment with the advent of esthetic brackets, arch wires and invisalign which provide a superior combination of functional and esthetic benefits, adjuncted by a desire for improved self-esteem have resulted in an increase of adult population seeking orthodontic treatment. The movement of teeth into their new positions to correct malocclusion and accommodate changes in aesthetics and function, cause drastic changes to the soft tissue and the underlying bone resulting in an increased potential for unwanted side effects.

### HARD TISSUE DAMAGE:

#### ENAMEL DEMINERALISATION AND WHITE SPOT LESIONS:

Enamel demineralization is an undesirable common complication of orthodontic fixed appliance therapy, with a prevalence rate ranging from 2–96% of orthodontic patients [1].

The teeth most commonly affected are maxillary lateral incisors, maxillary canines and mandibular premolars[2]. However, any tooth in the mouth can be affected, and often a number of anterior teeth show decalcification. Whilst the demineralized surface remains intact, there is a possibility of re-mineralization and reversal of the lesion. In severe cases, frank cavitation is seen which requires restorative intervention[3].

Opaque white appearance of enamel often termed as white spot lesions are due to subsurface demineralization with a decrease in porosity and consequent changes in the optical properties of enamel and can be arrested or reversed while the surface is intact. In a study on white spot lesions in children treated with fixed appliances, found that half of the patients had a minimum of one white spot lesion post completion of the treatment which was most commonly seen on the maxillary lateral incisors [4]. The length of treatment did not alter the incidence or number of white spot formations, although it was found that demineralization can occur rapidly, within the first month of fixed appliance therapy [5,6] Good oral hygiene adjuncted with dietary control of sugar intake proved vital in aiding the prevention of white spot lesions. Fluoride mouthwashes used throughout the course of the treatment can prevent white spot lesions. Other fluoride release mechanisms include fluoride releasing bonding agents, elastic ligatures containing fluoride, and depot devices on upper molar bands. [7,8]

#### ENAMEL TRAUMA AND WEAR:

When placing appliances careless use of a band seater can result in enamel fracture. Care is required when large restorations are present since these can result in fracture of unsupported cusps [9]. Debonding can also result in enamel fracture, both with metal and ceramic brackets [10,11.] Care must always be taken to remove brackets and residual bonding agents appropriately to minimize the risk of enamel fracture. The use of debonding burs has the potential to remove enamel, especially in air turbine fast handpieces. Care and attention is needed when adhesives are removed. Wear or abrasion of enamel against both metal and ceramic brackets may occur. It is common on upper canine tips during retraction as the cusp tip hits the lower canine brackets. It may also be seen on the incisal edges of upper anterior teeth where ceramic brackets are placed on lower incisors [12].

#### PULPAL DAMAGE:

Pulpitis in orthodontic tooth is usually reversible or transient. There is increased incidence of loss of vitality in teeth that were previously subjected to trauma, in such cases the force applied on the tooth must be minimal and vitality tests must be conducted triennially. Some studies show the occurrence of pulpal side effects such as altered pulpal respiration rate, internal root resorption, pulpal obliteration by secondary dentin and pulpal necrosis, although present studies have determined that the risk of pulp damage to be minor.

#### EXTERNAL APICAL ROOT RESORPTION

External apical root resorption is the most common & frequent iatrogenic consequence of orthodontic treatment, although it might also occur in the absence of any orthodontic treatment. The etiology,

severity & degree of root resorption is multifactorial, involving both host & environmental factors. Orthodontically induced root resorption starts adjacent to hyalinized zones and occurs during and after elimination of hyalinized tissues. Root resorption occurs when the pressure on the cementum exceeds its reparative capacity and dentin is exposed, allowing multinucleated odontoclasts to degrade the tooth substance. It has been shown that root resorption is highly correlated with longer treatment duration, fixed appliance treatment, individual susceptibility, orthodontic forces & the type of orthodontic tooth movement. Microscopic changes which are difficult to detect on routine radiographic images appear on teeth roots. Root resorption causes root shortening & weakening of teeth arch [34]. Root resorption of greater than 1-2 mm is considered as clinically significant [35].

It has also been demonstrated that heavy forces are more likely to produce root resorption than light forces [36]. In a study conducted on the direction of force and tooth movement in the occurrence of root resorption, showed that compressive forces cause more resorption than tensile forces [37]. Another study showed that intrusion of teeth causes about four times more root resorption than extrusion. However extrusion of teeth might also lead to root resorption in susceptible individuals. Intrusive force together with lingual root torque & jiggling movement are correlated with significantly more root resorption [38,39]. Factors associated with the duration of active treatment might result in increase in apical root resorption and intrusive forces and total treatment duration are highly correlated with mean apical root resorption. It was suggested that avoiding active force for 2-3 months which can be achieved with a passive archwire minimizes root resorption [40,41]. Another study showed that the amount of root resorption is significantly less in patients who are treated with less action of active treatment than those treated with continuous forces [50].

Certain studies indicated that the application of intermittent forces results in less root resorption than does the application of continuous forces. This can be explained by the fact that a pause in the force allows the resorbed cementum to heal and prevents further resorption [51]. Among all teeth, maxillary incisors are most frequently involved in apical root resorption followed by mandibular incisors and first molars [52]. While another study concluded that maxillary incisors are more frequently affected and to a more severe extent than the rest of the dentition [53].

Apical root resorption does not progress after active orthodontic treatment ends. Reparative processes in the form of smoothing & remodeling of sharp edges starts after cessation of treatment. Teeth with severely resorbed roots function in a reasonable manner & apical root resorption does not progress after orthodontic intervention [54].

Literature states that the apical part of the root has relatively minor importance for total periodontal support & approximately 3 mm of apical root loss is equivalent to 1 mm of crestal bone loss [55].

Root resorption is usually seen in patients with fixed appliances affecting the apical 1-2 mm. Such resorption does not compromise on the long term health of the periodontium and the teeth [56]. More so ever, resorption where more than 1/3rd of root length is lost is rare and occurs in only 3% of the patients. Risk factors for increased incidence & severity of root resorption are the pretreatment root form or root length, previous history of trauma to teeth, & treatment mechanics. Teeth with blunted roots are at increased risk of root resorption [57].

SOFT TISSUE DAMAGE:

POTENTIAL ADVERSE EFFECTS TO THE PERIODONTAL TISSUES:

Plaque is considered as the major etiological factor in the development of gingivitis [13]. Experimental animal studies have shown that orthodontic forces & tooth movements do not induce gingivitis in the absence of plaque [14]. However similar forces can induce angular bone defects in the presence of plaque. Orthodontic tooth movements like tipping & intrusion can cause attachment loss in the presence of plaque [15]. Healthy areas with reduced periodontal support do not cause gingival inflammation when orthodontic forces are kept within the optimum limits [16]. Plaque is considered as the most important factor in the initiation, progression and recurrence of periodontal diseases in reduced periodontium [17]. In most patients a transient gingival inflammation occurs after placement of fixed appliances which usually does not lead to attachment loss [18,19]. Gingival hyperplasia can develop around orthodontic bands leading to pseudo pocket formation.

However this condition resolves after few days of debanding. The importance of plaque control and good oral hygiene must be stressed to the patient before starting the fixed appliance treatment and adequate patient compliance must be ensured throughout treatment to prevent gingival inflammation.

In many orthodontic patients, mechanical irritation caused by the bands or cement is the principal reason for the associated gingival and periodontal inflammation along with plaque [20]. Attachment loss can be a major risk in the presence of iatrogenic irritants [21]. Histological study conducted on human periodontal tissues confirmed that orthodontic banding have to be performed with great care along with excellent oral hygiene in order to avoid permanent periodontal destruction [22].

A review of the evidence-based literature conducted in the field of periodontics & orthodontics showed that with optimum forces, good oral hygiene and the absence of pre existing periodontal disorders can reduce periodontal risk to the patient. [22,23]. However poor oral hygiene & preexisting untreated periodontal disorders can lead to significant & permanent periodontal damage with fixed appliances & various tooth movements [24]. Adult patients with some pre-existing periodontal disease are at a higher risk of developing periodontal problems [25]. Orthodontic treatment is not contraindicated in this group of patients if they are motivated to maintain good oral hygiene & the disease is kept under control throughout the duration of treatment [26]. Assessment of periodontal status prior to fixed appliance treatment is of utmost importance and any pre-existing problems must be treated before initiating the treatment. Regular periodontal checkups and routine oral prophylaxis are advisable to keep the periodontal disease under control .Orthodontic forces may lead to the destruction of periodontal bone support through the induction of pro inflammatory cytokines and also by decreasing the expression of matrix proteins and osteogenic protein [27]. Gingival and Periodontal changes related to orthodontic treatment are, in general transient with no permanent damage. Loss of attachment and alveolar bone loss are known to occur during orthodontic treatment, but are reported to be temporary [28]. But if long term orthodontic treatment continues in the absence of oral hygiene, then gingival and periodontal damage takes place. Deleterious effects includes gingivitis, mucosal trauma , gingival hyperplasia, marginal periodontitis, gingival recession mostly at extraction areas, loss of attachment, interdental clefts, mostly at the vestibular aspects of extracted mandibular first premolar site, reduced width of keratinized gingiva and marginal bone and apical root resorption. An adequate width of attached gingiva is necessary for healthy periodontal tissues to prevent adverse periodontal complications due to orthodontic forces [29]. With labial bodily movement there is a chance that the incisors develop apical migration of marginal gingival [30]. Loss of connective tissue results in the presence of preexisting untreated gingival inflammation [31]. Therefore, there is a chance of gingival recession if the tooth movement is likely to result in reduction of soft tissue thickness [32]. Experimental studies have shown that as long as the tooth is moved within the alveolar process envelope, it is likely to result in minimal harmful side-effects on marginal soft tissues [33].

#### IATROGENIC DAMAGE FROM ELASTICS:

During different phases of orthodontic treatment, elastics are used for generating a continuous force to achieve individual tooth movement. Elastics have long been used for the correction of orthodontic problems such as diastema, crossbites, and malposed teeth [58]. Elastics are also used for the intentional non-surgical removal of teeth in cases of hemophilia and also in patients treated with bisphosphonates, or some other anticoagulant medication [59, 60 ] The improper use of elastics can lead to severe periodontal destruction and tooth loss [61].

Periodontal lesions induced by elastic bands are complex to diagnose but have quite a few features in common that may assist in diagnosis and treatment. This could be due to the absence of local etiologic factors, lack of information gathered from the patients and no history of recent trauma or history of orthodontic treatment. Elastic rubber bands because of their elasticity, have a tendency to creep toward the narrower portion of the tooth and the roots, especially when there is no specific attachment mechanism [62,63,64]. As the band moves apically, it causes periodontal ligament destruction [65], resulting in extrusive movement of the tooth. The elastic band acts as a foreign body resulting in inflammatory reaction in the soft tissues, thereby weakening the periodontal attachments [66]. A study reported that the inflammatory reactions close to subgingivally extending rubber bands are independent of the degree of plaque colonization [67]. Roots of the teeth taper towards the apex and a rubber band around the cervical area of two adjacent teeth will tend to move along the root surface, eventually causing a bloodless extraction of the teeth concerned [68].

**EXTRACTION:**

Orthodontic treatments that include extraction of dental units and movements of adjacent teeth in to the extraction sites can lead to attachment loss, bone loss, gingival clefts, gingival recession and root resorption.

**TRAUMA:**

Teeth with adequate attached gingiva seldom develop gingival recession during orthodontic treatment. This may occur due to application of excessive forces which prevent the repair & remodeling of the alveolar bone.

Large forces which are produced by rapid palatal expansion have been shown to create a slight degree of attachment loss and some loss of alveolar bone height particularly in older patients. Excessive orthodontic force is also believed to increase risk of root resorption [69]

**SOFT TISSUE TRAUMA AND ALLERGIC REACTIONS:**

Laceration and ulcerations to the lips and mucosa may be seen as a result of trauma from brackets, unsupported arch wire.

**ALLERGIC REACTION:**

Certain orthodontic materials can cause allergic reactions in some individuals. Nickel which is commonly found in stainless steel wires, brackets, bands and head gear, cause a hypersensitivity reaction among three in ten individuals of the general population.<sup>34</sup> For hypersensitive individuals bands must be covered with tape and head gear use discontinued. Nickel hypersensitivity reaction manifests in the form of erythematous areas or severe gingivitis in areas free of plaque. <sup>35</sup> ,<sup>36</sup>,<sup>37</sup> Latex sensitivity may occur in response to contact with latex gloves or elastomeric ligatures (modules) and intra- and extra-oral elastics. In such cases steel ligatures or selfligating brackets may be preferred. Other orthodontic materials that may cause allergic reactions are composite and acrylic. Toxicity is due to unpolymerized material and is greatest immediately following polymerization, .38 No-mix adhesives are more toxic than two-paste adhesives.<sup>39</sup>

**CONCLUSION**

Apart from the benefits of orthodontic treatment like improvement in general & oral health, function, appearance, individual comfort & self esteem, the risks associated with its treatment are a reality. The complications associated with orthodontic treatment are a result of multifactorial process, with the patient, orthodontist & orthodontic appliances & procedures playing a vital role.

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