Risks and complications in orthodontic treatment

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ABSTRACT This article describes various aspects of risks and complications, commonly encountered in orthodontic treatment and also describes ways to minimize such risks and complications in the course of orthodontic treatment.

Introduction

Orthodontic treatment can improve mastication, speech and appearance, as well as overall health, comfort, and self-esteem. However, like many other interventions, orthodontic treatment has inherent risks and complications (Table 1). Thus, if correcting malocclusion is to be of benefit, the advantages it offers should outweigh any possible damage 1. It is also important to implement risk control procedures during and after orthodontic treatment.

The psychological aspects of orthodontic treatment should be given due consideration and must not be overlooked. Patient selection always plays a vital role in minimizing risks. Moreover, clinicians should be vigilant in assessing and monitoring every aspect of the patient's orthodontic treatment during and after treatment to achieve an uneventful, secure, and successful final result.

Enamel demineralization/caries

Caries usually occurs on smooth surfaces and is a common complication in orthodontics, affecting 2% to 96% of all orthodontic patients 2. Increased caries risk during such treatment is due to several factors:

- lesions are difficult to locate;
- lowering of resting pH;
- increased volume of dental plaque; and
- a rapid shift in bacterial flora 3.

Maxillary lateral incisors, maxillary canines, and mandibular premolars are the most commonly affected teeth 4. However, any tooth may be involved and often a number of anterior teeth show demineralization (Figure 1).

Whilst the demineralized surface remains intact, remineralization and reversal of the lesion is possible. In severe cases, however, there may be frank cavitation requiring restorative intervention.

Preventive measures to minimize damage include: patient selection, intensive oral hygiene instruction and monitoring, and dietary education. At each visit, oral hygiene and dietary education should be reinforced. At every adjustment appointment, it is crucial to inspect the teeth to avoid missing early demineralized spots. When patients use daily 0.05% sodium fluoride rinse, the occurrence of caries decreases 5. Professional cleaning of teeth is also recommended if patients cannot achieve satisfactory oral hygiene. In severe cases and as a last resort, early removal of the appliance may be required to confine the damage.

Where demineralization is present, various methods have been recommended including the use of fluoride
paste and adjunct fluoride mouthwashes (0.05% sodium fluoride daily rinse or 0.2% sodium fluoride weekly rinse) to help remineralization and reduce unsightly marking. For more severe cases, treatment involving an acid/pumice micro-abrasion technique has been advocated, but should be performed at least 3 months after debond to allow initial remineralization.

**Physical damages on enamel**

Enamel damage most commonly stems from occlusal contacts with orthodontic brackets; being worst with ceramic, metal, and composite brackets (in that order). When placing appliances, extreme care is needed to avoid direct contact between the orthodontic brackets and the opposing teeth. The incisal edge of the upper anterior teeth and the buccal cusps of upper posterior teeth are frequently affected. If direct contact between orthodontic bracket and the tooth is unavoidable, then the other teeth should properly share the occlusion loading. A night guard is sometimes required for patients who grind their teeth at night.

Careless use of an orthodontic band seater or band remover can result in enamel fracture. Care is required when large restorations are present, since these can result in fracture of unsupported cusps. Debonding can also result in enamel fracture, both with metal and ceramic brackets. Care must always be taken to remove brackets and residual bonding agents so as to minimize the risk of enamel fracture. Debonding burs have the potential to remove enamel, especially in fast air turbine handpieces. Care and attention is needed when adhesives are removed.

Wearing down of enamel due to contact with both metal and ceramic brackets (abrasion) may occur. It is common on upper canine tips during retraction, as the cusp tips hit lower canine brackets. Such wear and tear may also ensue on the incisal edges of upper anterior teeth, where ceramic brackets are placed on lower incisors. Ceramic brackets are very abrasive. Attention should be paid to the lower teeth wherever there is a possibility of the brackets occluding with the upper teeth, whilst appreciating that overbite sometimes increases in the early stages of treatment.

Any enamel erosion must be recorded prior to commencing treatment and appropriate dietary advice given to minimize further tooth substance loss. Since carbonated drinks and pure juices are the most common causes of erosion, they should be avoided in patients with fixed appliances.

**Pulpal reactions**

Studies using radiorespirometric techniques indicate that

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**Table 1** List of some possible complications related to orthodontic treatment

<table>
<thead>
<tr>
<th>Crowns</th>
<th>Decalification</th>
<th>Enamel wear</th>
<th>Enamel fracture</th>
<th>Resorption</th>
<th>Pulpitis</th>
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<td>Roots</td>
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<td>Pulp</td>
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<td>Pulpitis</td>
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<td>Periodontal</td>
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<td>Gingivitis</td>
<td>Periodontitis</td>
<td>Burns</td>
<td>Recession</td>
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<td>Bone</td>
<td>Creval bone resorption</td>
<td>Abnormal development</td>
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<td>Soft tissues</td>
<td>Direct trauma</td>
<td>Mucosal ulceration due to appliances</td>
<td>Trauma from headgear whiser</td>
<td>Clumsy instrumentation</td>
<td>Soft-tissue clefts</td>
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<td>Temporomandibular joint</td>
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<td>Temporomandibular dysfunction</td>
<td>Condylar resorption</td>
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<td>Face</td>
<td></td>
<td>Skin trauma from displaced headgear whiser</td>
<td>Eye damage from displaced headgear whiser</td>
<td>Bruising from headgear strap (uncommon)</td>
<td>Chemical burn from etchant</td>
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<td>Heart</td>
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<td>Infective endocarditis</td>
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<td>Cross-infection</td>
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<td>Operator to patient</td>
<td>Patient to operator</td>
<td>Patient to patient</td>
<td>Any source to third parties</td>
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orthodontic forces cause a depression of the oxygen utilization system within pulp cells. Disturbances in the circulation of the pulp are more severe when a greater force is used and when the force is applied for a longer time. The application of light continuous force to the crown of a tooth will produce a mild and transient inflammatory response within the pulp. Some degree of pulpitis is therefore to be expected with orthodontic tooth movement, but is usually reversible or transient and has no long-term significance. Although it rarely leads to loss of vitality, there may be an increase in pulpitis in teeth previously traumatized by fixed appliances. Thus, particularly with traumatized teeth, only light forces should be applied and vitality should be monitored every 3 months. Though there are reports of pulpal necrosis following orthodontic therapy, they are very few in comparison with the number of patients having daily orthodontic treatment.

There is a risk that removing bonding material after debonding increases local temperature and may result in pulp damage. Temperatures of 46-50°C for 30 seconds lead to thrombosis and curtail circulation. Water or air must therefore be used as a coolant.

One or more teeth that may have been traumatized by an accident or large fillings can cause nerve damage. Orthodontic tooth movement may, in some cases, aggravate this condition and necessitate root canal treatment.

**Root resorption**

Some degree of external root resorption is inevitably associated with fixed appliance treatment, although its extent is unpredictable. The tendency to root resorption is greater in dentitions, involving dental agenesis, invaginations, and taurodontic root shapes. Other predictors include: anomalous lateral incisors as well as abnormal root morphology of incisors and premolars. Resorption may occur on the apical and lateral surface of the roots, but radiographs only reveal a degree of apical resorption. In many instances no clinically significant resorption is evident or visualized by routine radiography, but microscopic surface changes are nevertheless likely to have occurred. Ketcham found that the upper incisors are more frequently involved than other teeth. Others claim that mandibular incisors are more liable to resorption than the upper ones. The buccal roots of the first maxillary molars and premolars also exhibit frequent root resorption. The degree of root resorption is usually less than 2 mm, but can be more extensive. Even idiopathic root resorption may occur. However, resorption rarely compromises the longevity of teeth. Vertical loss of bone through periodontal disease creates a far greater loss of attachment and support than equivalent losses around the apex of a tooth.

The mechanism of tooth resorption during orthodontic treatment remains unclear. According to one theory, excessive force and hyalinization of the periodontal ligament results in excessive activity of cementoclasts and osteoclasts. Be that as it may, the risk factors associated with severe resorption are well known and can be summarized as follows:

- Shorter than average roots;
- Previously traumatized teeth;
- Teeth lacking vitality after root treatment;
- Application of excessive forces to teeth; and
- Combining orthodontic and orthognathic procedures.

According to most studies, understanding the orthodontic forces in terms of their magnitude, type, direction, and duration can help explain the resorptive process. Force duration has been regarded as a more critical factor than its magnitude, especially when prolonged. The mechanical influence of the appliance also appears to be of particular importance. Linge and Linge claimed that for apical root resorption the variables that contributed significantly were: overjet, pre-treatment trauma to maxillary incisors, periods of treatment with rectangular wires and Class II elastics. Lip and tongue dysfunction, finger-sucking, habits persisting beyond age of 7 years, and impacted maxillary canines are also important.

Treatment of ectopic canines may induce resorption of adjacent teeth, because of the treatment duration and distance the canines are moved. Tooth intrusion is also associated with increased risk, as well as movement of root apices against cortical bone. Beyond the age of 11 years, treatment seems to increase the risk of resorption. Adults have shorter roots at the outset, which also increases the potential for resorption.

Opinion is divided as to whether increased treatment duration is associated with increased resorption; no correlation as well as definite correlations have been described. In a few patients systemic disorders such as hypothyroidism may contribute, but for the most part no underlying cause (other than individual susceptibility) can be identified. Familial risk is also known.

The degree of resorption can be very variable, highlighting the importance of individual susceptibility over and above other risk factors. Research to identify the mechanisms of resorption, trigger factors, and reparative mechanisms is still required, with a view to modifying future treatment modalities and minimizing root damage. Currently, no patient is immune from the risk of some root resorption. All prospective recipients of such treatment
should therefore be warned at the outset. If root resorption is to be minimized, at the outset of treatment it is important to recognize specific risk factors, and take and interpret radiographs accurately.

If and when resorption is recognized during the course of the intervention, lighter forces must be used, root length monitored 6-monthly with radiographs, and the treatment aims should be reconsidered to maximize longevity of the dentition. In severe cases, treatment may have to cease in order to prevent further resorption though this entails accepting a less-than-ideal result.

**Periodontal tissues**

Fixed appliances make oral hygiene difficult even for the most motivated patients, and almost all of them experience some degree of gingival inflammation. Gingival swelling (Figure 2) and gingival recession are common sequelae of orthodontic procedures.

Inflammatory changes (particularly bleeding) are frequently noted even in orthodontic patients with excellent tooth cleaning habits. The interproximal areas are usually more affected than the facial areas, and posterior more than anterior teeth. Signs of inflammation subside rapidly after removal of the orthodontic appliance 28.

Orthodontic appliances have the potential to damage the periodontal support of treated teeth 29. Alveolar bone loss occurs more often in orthodontic patients than in reference subjects, the difference being small but significant 30,31. Bands induce more gingival inflammation than bonds, which is not surprising since bands are more plaque retentive and their margins are often placed subgingivally. Boyd and Baumind 32 showed that values for plaque and gingival indices, bleeding tendency, and pocket depths were all significantly greater in banded teeth than in bonded ones.

For the most part, orthodontic treatment appears not to affect the periodontal status of patients over the long term. Sadowsky and BeGole 33 studied a group who had received orthodontic treatment 35 years earlier. They compared the findings with those in a reference group with untreated malocclusions. There was no significant difference in the general prevalence of periodontal disease between the two groups. No significant damage or benefit to the periodontal structures could be directly attributed to the orthodontic therapy. However, it is rare for gingivae to re-grow into the receded areas, particularly if they are interproximal (Figure 3). Labial movement of mandibular incisors may result in gingival recession. Gingival recession and loss of alveolar bone have been reported as a result of teeth moving in the presence of inflammation 34.

Patients with pre-existing periodontal disease require special attention, but bone loss during treatment does not seem to be related to previous bone loss. Compressed gingiva in extraction sites (Figure 3) may nevertheless produce a long-lasting epithelial tissue fold; most frequently this occurs on the buccal aspect of mandibular first premolar extraction sites 35.

In patients with existing periodontal disease, the need for excellent oral hygiene during treatment must be emphasized. Use of bonds rather than bands on molars and premolars may be more appropriate, in order to eliminate unwanted stagnation areas. Plaque retention is increased with fixed appliances and plaque composition may also be altered. There is an increase in anaerobic organisms and a reduction in facultative anaerobes around bands, which are therefore periopathogenic 36.
Oral hygiene instruction is essential in all cases of orthodontic treatment, and the use of adjuncts such as sonic electric toothbrushes, interproximal brushes, chlorhexidine mouthwashes, fluoride mouthwashes, and regular professional cleaning must be reinforced. However, patient motivation and dexterity are paramount in the success of hygiene. Moreover, there will always be individuals whose oral hygiene is unsatisfactory. Experience shows those who are unable to maintain a healthy oral environment in the absence of fixed orthodontics, will fail spectacularly with braces in place. In such patients, benefit may therefore significantly outweigh the risks of treatment.

Allergy

Leaching of materials from appliances is responsible for hypersensitivity reactions and may entail the release of known allergens such as nickel, chromium, and cobalt. Other allergens are components or chemical catalysts in bonding materials, cold curing acrylics, or in latex components.

Gjerde et al. found a significant release of nickel and iron into the saliva of patients just after placement of fixed appliances. However, there was no significant difference in nickel or iron concentrations between controls and subjects in whom the appliances had been in place for a number of weeks. The clinical significance of nickel release is as yet unclear, but should be considered in sensitive patients. A few patients have suffered severe latex allergies caused by elastics or operators’ gloves.

Allergy to nickel is more common in extraoral settings, usually as a result of contacts with face-bow or headgear strap. Over 1% of patients have some form of contact dermatitis to zips and buttons/studs on clothing. About 3% of the latter claim to have experienced similar rashes with orthodontic appliances. Use of sticking plaster over the areas in contact with the skin is sufficient to relieve symptoms. Allergy to latex and bonding materials have been reported although these are rare.

Trauma

Lacerations to the gingivae and oral mucosa may present as ulceration or hyperplasia (Figures 4 and 5). They often occur during treatment or between sessions because of archwire, brackets and bands, and especially where long unsupported stretches of wire rest against the lips. Excessive muscular activities of the cheek or tongue may act as triggers. The use of dental wax over the bracket may reduce trauma and discomfort, as may rubber tubing on the unsupported archwire. Careful rounding-off of sharp edges of the appliance can be helpful.

Extraoral appliances cause both extra- and intra-oral adverse reactions. Reports of injuries with extraoral appliances have shown that out of the nearly 5000 orthodontists (responsible for treating approximately 4.5 million patients), 4% reported that headgear injury had ensued in one or more of their patients; 40% were extraoral injuries. Samuels and Jones classified the types of injuries as follows:

- accidental disengagement when playing (3/11);
- incorrect handling (3/11);
- disengagement by another child (2/11); and
- disengagement while asleep (3/11).

There is a risk of damage and infection of the eye. The surface of the inner arch of the face-bow is rich in oral microorganisms and the eye forms an excellent culture medium following inoculation of microorganisms, even through a small abrasion. An infection of the eye is very hard to manage despite appropriate antibiotic therapy. No matter how prompt and suitable the treatment,
Following a well-publicized case of eye trauma in a patient wearing headgear, a number of safer products have been designed with explicit guidelines on how to use them. The latter included the use of safety bows, rigid neck straps, and snap release products to prevent the bow from disengaging from the molar tubes or acting as a projectile. Safety headgear products are strongly recommended, and the information itemized below should be provided routinely:

- not to be worn when playing;
- if grabbed by another person, take hold of the face-bow and then slowly release the headgear strap; and
- always remove headgear strap before face-bow.

**Temporomandibular dysfunction**

In the literature, much attention has been focused on the relationship between temporomandibular dysfunction (TMD) and orthodontic treatment. Whilst TMD is common in the general population irrespective of orthodontic treatment, there is no evidence to support the theory that orthodontic treatment causes TMD or cures it. Moreover, orthodontic patients do not have a higher chance of developing TMD than the general population. Accordingly, it is believed that there is no direct relation between the two. However, pre-existing TMD should be recorded, and the patient advised that treatment will not predictably improve their condition and that some may suffer increased symptoms. Whenever patients experience symptoms during treatment, the standard approach to assessing TMD should be taken. Conservative treatment should be directed at eliminating discomfort, occlusal disharmony and joint noises and reassuring the patient. Other forms of standard treatment (e.g. soft diet, jaw exercises) may also be indicated.

**Profile changes**

Unsatisfactory profile changes (dishing in of the face or increase in facial fullness) have been common complaints after orthodontic treatment. Some have even blamed extraction of premolars without proper torque control of the anterior segments. Likewise, excessive expansion of the dental arch in the anterior-posterior direction will result in increased fullness of the lip and sticking of incisors. Careful planning and adequate communication with patients helps to reduce the chance of the complaints.

A review concluded that orthodontics does not affect facial profile adversely, whilst also highlighting areas where planning is crucial. Soft tissue changes also occur naturally with age, regardless of orthodontic intervention.

**Stability or relapse**

There is extensive research on post-treatment stability or relapse. Orthodontic treatment results are potentially unstable and retention is necessary for three major reasons:

1. Gingival, periodontal and supporting bone tissues change during such treatment and require a period of time for re-organization when the appliances are removed.
2. Teeth are inherently in an unstable position after the treatment, so they are easily affected by unbalanced soft tissue pressure.
3. Continual growth of the jaws and alveolar processes affects the orthodontic result.

The initial 6-month post-treatment is important, as it may take 4 to 6 months for the periodontal ligament and supporting bone to complete re-organization. That is why teeth have a stronger tendency to move immediately after orthodontic treatment and the effect diminishes gradually after the alveolar bone and the periodontium return to their normal pattern. Proper use of retainers can help to reduce post-treatment relapse.
Most relapses (Figures 6 and 7) are due to inadequate wearing of retainers and inadequate monitoring. It has been observed that teeth move throughout life. According to extensive studies in the University of Washington 54, teeth move irrespective of whether or not they are orthodontically treated. Long-term retention and monitoring are widely advocated 53.

Throughout life the bite can change adversely due to various causes. These include: eruption of wisdom teeth, genetic influences controlling the size of the tongue, the teeth and the jaws, growth and/or maturational changes, mouth breathing, playing of musical instruments, and other oral habits. All of the latter may be beyond the control of the orthodontist. Following treatment, tooth and/or jaw position may change adversely to a degree that warrants additional treatment. The extent of any further interventions depends on the nature of the problem and might involve a variety of modalities including surgery.

**Swallowing/inhalation of small parts**

Orthodontic appliances are composed of very small parts connected together. They can be accidentally swallowed, aspirated, and they can irritate or damage oral tissues.

**Systemic diseases**

General medical problems, such as cardiac diseases 49, blood 69, neurological 58, cancer 56, or endocrine disorders 57, can affect orthodontic treatment. Any changes in the patient's health should be checked for on a regular basis.

**Conclusions**

There are several sources of potential iatrogenic damage due to orthodontic treatment. When properly performed, severe damage is very rare. More benefit is likely to accrue from treatment of severe malocclusions. Individuals should be assessed for risk factors. Rarely, attempts to correct malocclusion can leave the patient worse off than before treatment. Good clinical practice 58,59 (Table 2), careful patient selection, and good cooperation and understanding between all parties are prerequisites to minimizing tissue damage.

**References**

8. Meister RE. Comparison of enamel detachments after debonding...