Damages due to Some Orthodontic Materials

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Abstract
This article describes various aspects of risks and complications, commonly encountered in orthodontic treatment as a result of its materials, and also describes ways to minimize them in the course of orthodontic treatment. Although, like many other treatments, it has fundamental risks and complications. Thus, it is important to control the risks during and after orthodontic treatment (IJO 2006;1:198-202).
Key Words: Damage, Orthodontic, material.
(Received Nov 2008; Revised and accepted Aug 2008)

Orthodontic treatment vast benefits on improvement of mastication, speech and appearance, as well as overall health, comfort, and Self-esteem, so the quality of life. Although, like many other treatments, it has fundamental risks and complications. Both intra-oral and extra-oral tissues can be damaged during orthodontic treatment.

Thus, it is important to control the risks during and after orthodontic treatment. Patient selection always plays an essential role in minimizing the complications. Furthermore, clinicians should be vigilant in evaluating every aspect of the patient's orthodontic treatment during and after treatment to achieve a successful final result. Some of the potential risks of orthodontic materials are listed below:

Allergic reaction and Cytotoxicity

Nickel

As the concentration of nickel necessary to produce a reaction in the mouth is higher than what is needed on the skin, intra-oral signs and symptoms of nickel hypersensitivity are rare. These are highly variable and difficult to diagnose, for instance, severe gingivitis which is not related to plaque may be obvious.[1] It has been shown that the level of nickel in saliva and serum increases significantly after the insertion of fixed orthodontic appliances.[2] A cytotoxic response may be induced in presence of 30 ppm nickel. Although, it has been stated that oral contacts in non-sensitized individuals may cause tolerance to nickel, rather than sensitization. It is suggested that nickel sensitization is increased by mechanical irritation, or oral mucosal injury, which may be contributed in orthodontic treatment. Duration of exposure and environmental temperatures are other factors. Extra-oral reactions are more common than intra-oral reactions.[3] These include redness, itching, eczema, dryness, pain, wrinkling and exfoliation of the skin, all of which have mainly been attributed to the metal parts of headgear orthodontic appliances. Intra-oral allergic reactions include redness, edema, itching and dryness of the lips and oral mucosa, as well as gingival inflammation. It is important to make a correct diagnosis of nickel allergy; the symptoms may occur either within or away from oral environment. The following patient history would suggest a diagnosis of nickel allergy:

I) Previous allergic response after wearing earrings;

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II) Allergic symptoms soon after the initial insertion of orthodontic components containing nickel;
III) Limited extra-oral rash adjacent to face bow.[4]
Conversely some studies have demonstrated increased nickel immuno-sensitization antibody levels in orthodontic patients .In most cases, a positive correlation between nickel hypersensitivity occurring during orthodontic treatment and any previous sensitization to the specific allergen in the patient history may be present. Allergic side-effects of metal orthodontic materials usually include extra-oral and intra-oral expressions. Extra-oral allergic reactions are observed more common than intra-oral ones. Sometimes, fever is reported as a manifestation of systemic allergic reaction.[5] The corrosion and aging of metal biomaterials that are responsible for the release of metal ions contribute to the occurrence of allergic reactions. Material degradation due to masticatory forces and friction between orthodontic appliances and materials, may enhance the corrosion, and quantity or/and rate of metal ion release. The presence of different alloys in the oral environment may cause galvanic currents which enhance corrosion rate of materials.[6] It has been shown that corrosion of nickel-containing metal orthodontic appliances (including orthodontic brackets, extra-oral face-bows, nickel-titanium orthodontic archwires, molar bands and stainless steel) was strongly correlated with the type of soldering between metal parts. When the soldering material was silver or gold, the concentration of nickel released into the oral environment was higher. It is also shown that the appearance of allergic reaction to nickel depends not only on the total nickel quantity released, but also on the condition of nickel-ion coupling. However, some clinical studies support that the use of nickel-containing dental and orthodontic materials in non-sensitized individuals may lead to decreased risk (tolerance-like) of the allergic reaction [7]. On the contrary, in individuals with prior nickel sensitization, certain allergic reactions may develop following the application of nickel-containing orthodontic appliances.[8] In cases with a history of hypersensitivity and also whenever allergic reactions to nickel-containing orthodontic materials occurred, other orthodontic materials (plastic, ceramic) or alloys without nickel must be used. In the presence of erythema or edema, orthodontic appliances should be immediately removed. Administration of cortisone medication or adrenaline in more severe cases may be indicated, although cortisone interferes with the biology of tooth movement.[9] Risk of sensitizing following long-term exposure to nickel-containing appliances may be present, as occurs in routine orthodontic therapy. On the contrary tolerance to nickel in these cases has also been reported. However, for patients who are not nickel hypersensitive, the occurrence of nickel allergic reaction is very low.

Latex

Most elastic materials used in orthodontics are latex. In the latex sensitive patient, steel ligatures or self-ligating brackets must be used, and the treatment plan modification may be necessary. The basic component of the materials such as elastic modules, elastic separators, elastic chains and intermaxillary elastics is latex. It has been suggested that the physical and mechanical properties of latex intraoral elastic orthodontic materials are superior to the non-latex elastic materials. In fact, the stability of the applied force magnitude following their application, and their strength in latex one are more better. Thus, in the lack of allergic reactions to latex materials, latex elastic materials are usually preferred[10].
The exposure of the skin or the mucosa to latex protein derivatives may induce type I hypersensitivity. The clinical signs and symptoms, including facial rash, rhinitis, edema of the face or/and the larynx, bronchospasm, dizziness, diarrhea, and, allergic shock are immediately manifested, in a few minutes or several hours after exposure to allergen[11]. Type IV hypersensitivity/ delayed type is usually restricted to / localized contact area, it is typically characterized by diffuse rash, similar to what occurs during allergic contact dermatitis with chemical substances . Although it is not life-threatening, if not treated properly, may lead to permanent skin lesions. The initial clinical signs including redness, itching, skin exfoliation

and ulceration may appear within minutes or even several hours following exposure to the allergen. In the situation of prolonged and repeated exposure to the allergen or in the people with a history of edema, urticaria or redness when there is skin contact with any type of rubber, or those with a history of allergic reaction such as asthma, hay fever or contact dermatitis are all included in the high risk group for manifestation of allergic reaction to latex. Furthermore, any prior allergic reaction of patients to certain fruits (banana, avocado, kiwi), potatoes or nuts may suggest immunosensitization, as the proteins of these foods may interact with latex proteins . In specific cases preventive administration of antihistaminic medication may be indicated. Eventually, adrenaline should always be available for the acute type I allergic reaction. [12]

Other Materials

Other orthodontic materials that may cause allergic reactions are composite and acrylic.

Toxicity is due to unpolymerized material and is greatest immediately following polymerization, although cytotoxicity is still evident 2 years after polymerization. No-mix adhesives are more toxic than two-paste adhesives.[13] Bisphenol-A-glycidyldimethacrylate (BIS-GMA) is a frequently used monomer in dental composite resins and is produced by the reaction of methyl methacrylate and diglycidylether of bisphenol A (epoxy resin).It was reported that allergic contact dermatitis from BIS-GMA occurred 24 hours after having an orthodontic fixed appliance fitted. [14]

Occupational exposure to methyl methacrylate monomer induced generalized neuropathy in a dental technician.[15] Methyl methacrylate was also present in the saliva due to monomer released of an autopolymerized base plate. Although it is not a toxic or primary irritant dose, could possibly elicit an allergic reaction. For minimization of monomer release, autopolymerized appliances should be immersed for 24 hours in water before being worn.[16]

Magnets

It was shown that static magnetic fields do not cause any changes in the human dental pulp or gingival tissues adjacent to the magnets. Moreover the fields do not produce any effect neither in the cell cultures of osteoblasts nor on the blood flow.[17] However; the cytotoxic effect related to the uncoated cobalt- samarium in a model system of mouse and human fibroblasts has been shown, this is probably related to corrosion products.

In a study, possibly due to the inhibitory effect on the osteoblasts areas of resorbtion increased progressively after stimulation with static magnetic fields [18].

CORROSION

There are several different forms of corrosion that may affect orthodontic alloys. Static stress corrosion is a kind of corrosion in which stress may cause demineralization occuring around orthodontic appliances in the presence of a corrodent. [19]

The surfaces between stainless steel and NiTi wire specimens manifest crevices and pores (the susceptible sites to corrosion). It represents another kind of corrosion as referred to as pitting corrosion.[20] The application of nonmetallic parts on a metal (elastomeric ligatures on a bracket) as a result of differences in metal ion or oxygen concentration between the crevice and its vicinity causes crevice corrosion.[21]

When different metals (or even the same alloy) are joined, galvanic corrosion takes place. The nobler metal becomes cathodic and more corrosion resistant in regard to the less noble metal. Stainless steel is characterized by a passive-active behavior depending on the environmental conditions in which the protective chromium oxide layer may be eliminated (active form) or regenerated (passive form). Thus, galvanic corrosion may take place depending on the status of the stainless steel (contact with metals arising from brazing).[22]

In a study, when the NiTi alloy was coupled with Ti , Ti initially was the anode and corroded. However, the polarity reversed in 1 hour, resulting in corrosion of the NiTi. It is suggested that coupling Ti-NiTi may remarkably enhance the corrosion of NiTi alloy, which acts as the anode.[23] In addition, mouthwashes, containing stannous fluoride, was the solution in which the NiTi wires coupled with the different brackets

showed the highest corrosion risk, while in mouthwashes, which contains sodium fluoride, the CuNiTi wires presented the highest corrosion risk.[24] Possibly as a result of friction, fretting corrosion which is the process occurring in contact areas of materials under load such as in the bracket's slot-archwire interface occurs.25 Microbiologically influenced corrosion is another kind of corrosion which results in the formation of craters in the bracket base.

Physical damages on enamel

Enamel damage is most commonly followed by occlusal contacts with orthodontic brackets; the worst one is ceramicis , metal, and composite subsequently follow. The most common site is the incisal edge of the upper anterior teeth and the buccal cusps of upper posterior teeth .When placing appliances, direct contact between the orthodontic brackets and the opposing teeth must be avoided, in the case of direct contact between orthodontic bracket and the tooth, the other teeth should properly share the occlusal loading, furthermore a night guard is sometimes required for patients who grind their teeth at night. An orthodontic band seaters or band removers which are used carelessly can result in enamel fracture, especially when large restorations are present. These can cause the fracture of unsupported cusps . Debonding can also result in enamel fracture, both with metal and ceramic brackets.[26] 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 high speed remove enamel, especially in fast air turbine hand pieces. Despite of reporting more crack due to chemical bonded ceramic brackets, In a recent study there was no statistically significant difference between the number or length of enamel cracks among the 3 groups of brackets (metal, ceramic with chemical retention, and ceramic with mechanical retention). [27]

Enamel Staining

Fortunately, a rare complication, as a result of fixed orthodontic treatment is severe enamel staining. It has been suggested that corrosion products from orthodontic bands and brackets and extrinsic stains may be contributed in tooth discoloration. Post-orthodontic extrinsic enamel staining is reported on the teeth that already have a defect, such as hypo mineralization or amelogenesis imperfecta. A green-black stain occurring at the periphery of an anterior bracket and a red-brown stain underneath anterior bands is reported as two examples of unusual staining. Both patients had generalized hypo mineralization of their enamel prior to orthodontic treatment.[28]

Conclusions

Although, if orthodontic treatment performed properly, severe damage will be very rare, individuals should be assessed for risk factors. Good clinical practice, careful patient selection, and good cooperation are essential parts to minimizing tissue damage.

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