Metal Hypersensitivity in Orthodontic Patients

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Abstract

Orthodontic treatment of individuals with metal hypersensitivity is a matter of concern for the orthodontist. Orthodontic appliances contain metals like Nickel, Cobalt and Chromium etc. Metals may cause allergic reactions and are known as allergens. Reaction to these metals is due to biodegradation of metals in the oral cavity. This may lead to the formation of corrosion products and their exposure to the patient. Nickel is the most common metal to cause hypersensitivity reaction. Chromium ranks second among the metals, known to trigger allergic reactions. The adverse biological reactions to these metals may include hypersensitivity, dermatitis and asthma. In addition, a significant carcinogenic and mutagenic potential has been demonstrated. The orthodontist must be familiar with the best possible alternative treatment modalities to provide the safest, most effective care possible in these cases. The present article focuses on the issue of metal hypersensitivity and its management in orthodontic patients.

Key words: Nickel-Titanium alloy; biological effects; biocompatibility; tissue reaction; orthodontics; corrosion

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Introduction

Metals form an integral part of orthodontic practice. Orthodontic auxiliaries, made up of metal consist of bands, arch wires, ligature wires, hooks, tubes, brackets, and springs (1). Metals like stainless steel, cobalt chromium, nickel-titanium, and ß-titanium, may be used singly or in combination to fabricate these appliances. Orthodontic treatment of individuals with metal hypersensitivity is a matter of concern for the orthodontist. Orthodontic treatment is a dynamic process that relies on the body's ability to adapt to the appliances utilized. Orthodontic treatment exposes alloys to a moist and corrosive environment, biodegrade them, thus increasing the chance of metal sensitization (2). An allergic reaction, or hypersensitization, is defined as an excessive immune reaction that occurs when coming into contact with a known antigen. Adverse hypersensitivity reactions are manifested most often as allergic contact dermatitis of the face and neck; but mucosal and gingival reactions, as well as a potential general dermal and systemic reaction can also occur. Nickel, in particular, is the most common contact allergen in women (3). Chromium ranks second among the metals, known to trigger allergic reactions (4). When hypersensitivity reaction occurs in a patient, treatment time and efficiency, treatment satisfaction, general health and quality of life are adversely affected.

Epidemiology

The incidence of adverse reactions in orthodontic patients has been estimated at 1:100, with 85% of these being contact dermatitis (5). Allergic and tissue reactions to orthodontic wires, as well as metal release from wires, have been reported by many workers (4,7,8). The amount of metal released from fixed orthodontic appliances in vitro varies depending upon the manipulation of the appliances and on different physical and chemical test conditions (4,9-16). Park and Shearer (4) reported an average release of 40 µg nickel and 39 µg chromium per day from a simulated full-

mouth fixed appliance. Nickel allergy occurs more frequently than allergy to all other metals combined (17). It is estimated that 11% of all women and 20% of women between the ages of 16 and 35 years have sensitivity to nickel (18,19). The sensitivity of males is only 2%, likely due to the decreased contact of nickel from jewellery. Chromium allergy is estimated to be 10% in males and 3% in females (20). Fortunately, the occurrence of a harmful response to nickel is only 0.1-0.2% (21). This is due to the fact that a much greater concentration of nickel is required to elicit an allergic reaction in the oral mucosa than the skin (6).

Immune response

Metal sensitivity is usually a Type IV cell mediated delayed hypersensitivity (22). It is also called allergic contact dermatitis. It is mediated by T-cells and monocytes/macrophages. It consists of two phases. The first phase is also called as sensitization phase, occurs on initial entry of the allergic material into the body. This phase remains subclinical. The immune system prepares itself for future exposures to the same allergen. This first phase is followed by a response or the elicitation phase, which occurs during re-exposure to same allergen. Clinical manifestations of elicitation phase develop over a period of days or rarely up to three weeks.

Factors affecting the reaction of an individual can be broadly divided into two categories: physical factors and biological factors. Biological factors include: intra-oral temperature, pH, salivary composition, and duration of exposure. Physical factors include: wear of the wire due to friction from sliding mechanics, abrasion, presence of solder, strain of the wire and most importantly the amount of metal that is leached from the orthodontic appliance (23). Other factors predisposing patients to metal allergy include genetics (24) and the presence of certain major histocompatability complex haplotypes (25). Nickel sensitivity has been found to be higher in asthmatic patients (26,27).

Diagnosis

Hypersensitivity is diagnosed through the patient's history, clinical findings, biocompatibility tests patch tests) (28), including cutaneous sensitivity (patch) tests (29), and in-vitro cell-proliferation assays (30).

Patient history: Previous history of allergic response should be ruled out. Patient should be questioned for any history of allergic reactions from wearing earrings or a metal watchstrap; appearance of allergy symptoms shortly after the initial insertion of orthodontic components; confined extra-oral rash adjacent to headgear studs (31,32). Allergy to nickel is an increasing concern in orthodontics, especially with the increased prevalence of nickel containing jewelry and oral piercings (33).

Clinical Findings: Clinical Findings of allergic reaction may involve following features:

- Mucosal erythema with or without edema,
- Contact stomatitis,
- Lip swelling with a perioral rash.
- Eczematous dermatitis or hives/urticaria
- Gingival hyperplasia (34)
- labial desquamation
- Angular cheilitis (35-38)
- Multiform erythema (39)
- Periodontitis (40,41)
- Burning sensations, perioral dermatitis and, rarely, orolingual paresthesia (42).

Management/Treatment

Management of patient with allergy in orthodontic set up should start at the level of diagnosis and treatment planning. However, if an orthodontic patient presents with mild signs and symptoms of metal allergy during the course of treatment, the appliances should be removed immediately (43). Patients with more intense reactions should be treated with antihistamines, anesthetics, or topical corticoids (42,44).

Nickel titanium archwire should be removed and replaced with a stainless steel archwire or preferably a titanium molybdenum alloy (TMA), as TMA does not contain nickel. Most patients who develop a reaction to Ni-Ti archwires subsequently tolerate stainless steel without a reaction (43). Resin coated Ni-Ti wires can also be used. Surface of these resin-coated wires is treated with nitrogen ions. Nitrogen ions form an amorphous surface layer on the wire. Fibre-reinforced composite is also an option for allergic patients. Manufacturers claim that these altered nickel-titanium archwires exhibit less corrosion than stainless steel or non-coated nickel-titanium wires, which results in a reduction of the release of nickel and decreases the risk of an allergic response.

Alternatives to prevent chromium allergy in orthodontics would be the use of Teflon coated (Tooth-colored epoxy resin) wires, Optifelx archwires, Fiber reinforced composite archwires, Beta III Titanium, CNA Beta –Titanium and TMA wires. These wires also prevent allergic reactions from nickel. Ceramic brackets, polycarbonate brackets, polycrystalline brackets, single crystal sapphire and zirconia brackets, gold plated brackets and titanium brackets are also helpful to avoid allergic reactions to chromium and nickel. Plastic coated headgears may be a better alternative to simply wrapping a bandage around the metal component. Glass fibre buccal tubes are also an aid to avoid contact dermatitis (45).

Orthodontic brackets that do not contain nickel should be used e.g. ceramic brackets produced using polycrystalline alumina, single-crystal sapphire and Zirconia. Other nickel-free alternative brackets include polycarbonate brackets made from plastic polymers, titanium brackets and gold brackets.

Conclusion

As the need for orthodontic treatment is increasing, reported number of patients with allergy has been also increased. Therefore, it is imperative to take thorough history from patients. Also, clinician should be aware of the potential for hypersensitization in patients treated with modern orthodontic appliances. The unexplained occurrence of gingival or mucosal inflammation, erythema, or the report of a burning sensation in the patient's oral tissues should be investigated as a potential allergic response to their orthodontic appliances.

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