Nickel allergy and orthodontics, a review and report of two cases

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VERIFIABLE CPD PAPER

IN BRIEF

- Readers will develop an understanding of the background of nickel allergy and its epidemiology in orthodontics.
- Readers will learn the signs and symptoms of a nickel allergy in orthodontics.
- Readers will have an understanding of making a diagnosis and alternative methods to treat orthodontic patients who have developed an intra-oral nickel allergy due to orthodontic appliances.
- Two detailed real life cases are presented.

PRACTICE

Nickel is a common component in many orthodontic materials. An allergy to nickel is commonly seen in the population, more frequently in women. This allergy has increased with the more frequent use of nickel containing jewellery and intraoral piercings. As a result, this allergy can be expected to be more readily encountered in dental practice. Possible allergy to nickel should be a question in the initial patient health history questionnaire. The dental practitioner should be mindful of this allergy during the course of orthodontic treatment, and know how to diagnose a nickel allergy if it appears and subsequent action in treatment and referral if it is suspected. This paper provides a summary of nickel allergy, its epidemiology, diagnosis and recommendations and alternatives to treatment. A detailed description of two cases where it was discovered in orthodontic patients is also reported.

INTRODUCTION

Orthodontists are sometimes required to treat patients with an allergy to nickel. This is a concern for the orthodontist because it is present in a vast array of materials frequently used in orthodontics. Nickel is the most common component of the super-elastic nickel-titanium (Ni-Ti) archwires used during the initial levelling and aligning phase of orthodontic treatment with a concentration of 47-50%.[1] It is also a component in stainless steel (present in both archwires and brackets), representing approximately 8% of the alloy. Extraoral orthodontic appliances such as the outer bows of headgears contain nickel and may also elicit a response on the skin.[2,3] The sensitisation and allergy to nickel is an increasing concern in orthodontics, especially with the increased prevalence of nickel containing jewellery and oral piercings.[4]

Immune response

The response by the immune system to nickel is usually a Type IV cell mediated delayed hypersensitivity also called an allergic contact dermatitis. It is mediated by T-cells and monocytes/macrophages rather than antibodies and consists of two phases. The first phase, or sensitisation, occurs when nickel initially enters the body. There is usually no response present at this time but the immune system is primed or sensitised for an allergic response. The major sensitisation routes are nickel-containing jewellery and foods. Foods that are high in nickel include chocolate, soy beans, nuts and oatmeal. A response, or the elicitation phase, is in the form of a contact mucositis or dermatitis that occurs during re-exposure to nickel and develops over a period of days or rarely up to three weeks. If nickel is leached from orthodontic appliances, this Type IV hypersensitivity reaction can occur.[5]

Epidemiology

Nickel allergy occurs more frequently than allergy to all other metals combined.[3] It is estimated that 11% of all women and 20% of women between the ages of 16 and 35 years have a sensitivity to nickel.[6-8] The sensitivity of males is only 2%, likely due to the decreased contact of nickel from jewellery. Fortunately, most individuals who have nickel sensitivity do not report adverse clinical manifestations to orthodontic appliances containing nickel. It is estimated that the occurrence of a harmful response by patients to nickel is 0.1-0.2%.[9] It is thought that a much greater concentration of nickel in the oral mucosa than the skin is necessary to elicit an allergic reaction.[10] Furthermore, the incidence of an allergic response to stainless steel orthodontic brackets has not been reported, however, there have been some reported cases.[4,11-14]

Nickel leaching of orthodontic bands, brackets and stainless steel or Ni-Ti archwires has been shown *in vitro* to maximally occur within the first week and then decline thereafter.[15] This coincides with the approximate time frame for Type IV hypersensitivity reactions. Saliva or certain intraoral conditions such as foods, oral hygiene products and fluoride may potentially corrode the nickel in the alloy and release it onto the oral mucosa. Ni-Ti orthodontic wires in combination with fluoride media have been shown to release significantly more

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nickel ions in artificial saliva.[16] Also, Ni-Ti archwires, especially when they contain copper, have been shown to corrode in the presence of fluoride mouthwash. This has implications not only in the development of contact sensitivity reactions but also in decreased mechanical properties of the wire.[17]

The amount of corrosion from different alloys, however, has not been clinically demonstrated. Factors including intra-oral temperature, pH, salivary composition, duration of exposure, wear of the wire due to friction from sliding mechanics, abrasion, presence of solder, strain of the wire and most importantly the amount of nickel that is leached are factors determining the concentration of nickel present from a particular appliance.[18] Other factors predisposing patients to nickel allergy include genetics[19] and the presence of certain major histocompatability complex haplotypes.[20] Nickel sensitivity has also been found to be higher in asthmatic patients.[21,22]

Diagnosis

The diagnosis of a response to nickel in the oral mucosa is more difficult than on the skin. A known allergy to nickel should be determined when the patient completes the medical questionnaire or during a verbal medical history review. The patient should then be forewarned of a possible response to the nickel in orthodontic appliances, particularly to the initial archwire placed. If a nickel allergy is still in question, a diagnosis can be confirmed by a dermatologist by conducting a cutaneous sensitivity test called a patch test using 5% nickel sulphate in petroleum jelly.[23]

Oral clinical signs and symptoms of nickel allergy can include the following: a burning sensation, gingival hyperplasia,[24] labial desquamation, angular chelitis, erythema multiforme, periodontitis, stomatitis with mild to severe erythema, papular peri-oral rash, loss of taste or metallic taste, numbness, soreness at side of the tongue.[25-30] It should be noted that symptoms can occur without signs. Extraoral manifestations of nickel allergy may have an intraoral origin.[31] Before the diagnosis of nickel hypersensitivity can be made, other lesions should be eliminated including candidiasis, herpetic stomatitis, ulcers due to mechanical irritation and allergies to other materials including acrylic.[32]

The nickel leachability test consists of solutions of 1% dimethylglyoxime and 10% ammonium hydroxide solutions which are mixed just prior to use. A moistened Q-tip with the combined solution is used for swabbing the arch wires *in vitro* or samples can be immersed in the mixed solution. A positive test for nickel leachability is a colour change to red. A nickel coin is used as the positive control. While a positive result can be supportive of nickel leachability from the suspected dental material, a negative test is always overridden by the clinical response to removal of the material. It could also represent a false negative which did not take into account unique intraoral conditions that may alter leachability.

Treatment

If intra-oral signs and symptoms are present and a diagnosis of nickel hypersensitivity is established, the nickel titanium archwire should be removed and replaced with a stainless steel archwire which is low in nickel content or preferably a titanium molybdenum alloy (TMA), which does not contain nickel. Stainless steel is slightly less expensive than Ni-Ti archwires while TMA is slightly more. Resin coated Ni-Ti wires are also an option. These resin-coated wires have had their surface treated with nitrogen ions, which forms an amorphous surface layer. Manufacturers claim that this results in an increase in corrosion resistance and decreased amount of leaching of nickel, more so than both Ni-Ti and stainless steel wires.[33]

Most patients who develop a reaction to Ni-Ti archwires subsequently tolerate stainless steel without a reaction.[34] This is believed to be a result of the nickel being tightly bound to the crystal lattice of the alloy, rendering them unable to be leached into the oral cavity. Stainless steel has been shown to release low amounts of nickel in artificial saliva or sweat which could help account for its low allergenicity.[35] In the rare event that the patient continues to manifest an allergic reaction, all stainless steel archwires and brackets should be removed. If any severe allergic reaction develops, the patient should be referred to a physician to be treated with antihistamines, anaesthetics or topical corticosteroids.[36] Attempts should be made to complete orthodontic treatment with TMA, fibre-reinforced composite, pure Ti or gold-plated wires.

The most commonly used orthodontic brackets that do not contain nickel include 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. Another alternative for certain treatments is the use of plastic aligners such as Invisalign™.

CASE REPORT 1

A 31-year-old female presented requesting orthodontic treatment with a chief concern that she had a unilateral posterior crossbite. Upper ceramic and lower stainless steel brackets were bonded and 0.014" Ni-Ti archwires were inserted. After three days, the patient reported that her lips had an 'anaesthetic-like' feeling. She had also been asked by her friends if she had received collagen injections into her lip due to the swelling that was apparent. Clinical examination revealed swollen lips and the development of an interlabial gap when her upper and lower lips were at rest. General sensation was within normal limits and there were no intraoral lesions present. The patient did not report any adverse taste sensation or pain. The Ni-Ti archwires were immediately removed and a stainless steel wire was inserted. The patient reported resolution of symptoms within five hours of removal of the Ni-Ti archwire. A nickel-leaching test was undertaken with the orthodontic wires used and also with the same manufacturer's unused upper and lower 0.014" Ni-Ti archwires. The results came back negative for leachable nickel. This indicated that while contact with the nickel-containing alloy initiated the patient's symptoms, the nickel was not leached out under laboratory test conditions. However, nickel leaching tests under conditions of contact with saliva, food or oral hygiene products was not

undertaken. Clinical examination after three days of removal of the archwires demonstrated that lip competence had returned. The patient's lips no longer appeared swollen and the clinical 'anaesthetic-like' symptoms did not return. After three months of treatment using a combination of stainless steel and TMA wires, the symptoms had not returned. A re-challenge with a Ni-Ti archwire was not performed.

CASE REPORT 2

A 15-year-old female was evaluated by an oral pathologist for oro-pharyngeal 'itching, sandpaper-like roughness, bumps, burning and strong discomfort' which had persisted for six months. The symptoms occurred in daily episodes of mild to moderate intensity lasting 15-60 minutes but with occasional severe episodes, which were of sufficient intensity to reduce the patient to tears. No initial or ongoing precipitating factors could be recalled. Contact with cold foods such as ice cream and warm showers seemed to help but in a transient manner.

She was allergic to dust, pollens, cats, fish and seafood with reactions ranging from rhinitis to anaphylaxis (fish and seafood). She did not report a history of allergy to any metal. Evaluation by an oto-rhinolaryngologist was unremarkable and included CT imaging and cultures. She was taking contraceptive pills for acne.

On examination, orthodontic brackets and archwires were in place but no mucosal changes could be demonstrated. Management choices were either a symptom diary without intervention or empirical chronic neuropathic pain medications such as capsaicin or a low dose antidepressant. She declined medication and at six month follow up, her diary revealed that orthodontic treatment had been initiated just prior to the onset of her symptoms. Only at this point was a metal allergy considered. The Ni-Ti archwires were replaced with stainless steel. Her previous daily symptoms for the past year resolved within two weeks and she was symptom free at a subsequent two month follow up. She has not revisited the clinic and is presumed to be in an asymptomatic state at the time of writing one and a half years later.

DISCUSSION

In both cases the diagnosis of nickel contact hypersensitivity was supported by the onset of symptoms shortly after the placement of Ni-Ti archwires and their rapid resolution upon removal. In neither case was a re-challenge or skin testing undertaken. In Case 1 the diagnosis and management was facilitated by the labial swelling while in Case 2 the (a) absence of clinical signs (b) negative history of metal allergy and (c) no initial association with the onset of orthodontic treatment provided more of a diagnostic challenge. In Case 2 the intermittent nature of her symptoms is theorised to be due to periods of increased nickel leachability from some daily alteration of the intra-oral environment (eg fluoride exposure, food composition). The absence of mucosal change is still compatible with nickel hypersensitivity since mucosal symptoms without signs have been reported. Symptom reduction by cold foods and warm showers could be due to activation of the large diameter, low threshold fibres (Gate Control Theory of Pain). An atopic history may be significant as a predisposing factor. A potential sensitisation mechanism with regard to dietary nickel or body jewellery was not explored.

CONCLUSIONS

Though an allergic response to nickel in the oral mucosa from nickel containing orthodontic appliances is more infrequent than from nickel contact on the epidermis, it can occur, particularly in females.[37] If nickel-related intraoral clinical signs and symptoms appear, the orthodontist should be prepared to undertake or continue treatment without the use of Ni-Ti wires and even without stainless steel. These two cases illustrate that clinical signs of nickel hypersensitivity may be subtle or absent. The frequency of orthodontic treatment and the common use of nickel containing orthodontic materials raises the interesting question of whether orthodontic treatment may act to increase or decrease the burden of nickel hypersensitivity in the population. There is evidence that oral exposure to nickel may induce immunologic tolerance to nickel and thereby reduce the incidence of nickel allergies.[38-42] Nevertheless when clinical signs or symptoms presumed to be due to nickel hypersensitivity are distressing to patients there are many choices of materials available to the orthodontist as alternatives.

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Erratum

Summary of: 'A survey of the workload of dental therapists/hygienist-therapists employed in primary care settings' (*BDJ* 2008; 204: 140-141)

It has been brought to our attention that an error was printed in the 'Comment' section of the above research summary. Column 2 line 4 on page 141 should read 'their dually-qualified therapists as hygienists?' The author apologises for the transposition of these key words in the version originally published.