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FEATURES SECTION

Current Products and Practice

Nickel allergy and orthodontics

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Abstract

Nickel is the most common metal to cause contact dermatitis in orthodontics. Nickel-containing metal alloys, such as nickel-titanium and stainless steel, are widely used in orthodontic appliances. Nickel-titanium alloys may have nickel content in excess of 50 per cent and can thus potentially release enough nickel in the oral environment to elicit manifestations of an allergic reaction. Stainless steel has a lower nickel content (8 per cent). However, because the nickel is bound in a crystal lattice it is not available to react. Stainless steel orthodontic components are therefore very unlikely to cause nickel hypersensitivity. This article discusses the diagnosis of nickel allergy in orthodontics and describes alternative products that are nickel free or have a very low nickel content, which would be appropriate to use in patients diagnosed with a nickel allergy.

Index words:
Delayed hypersensitivity, nickel allergy, nickel-titanium, nickel-free

Introduction

Dermatitis due to contact with nickel was first reported at the end of the nineteenth century among workers in the nickel plating industry and was recognized as an allergic response in 1925. This article discusses nickel allergy in orthodontics. After briefly discussing the biology of the reaction, we will explain the signs, symptoms and diagnosis of the condition. We will then discuss orthodontic appliance treatment options for patients with nickel allergy.

Biology of the reaction

An allergic response is one in which certain components of the immune system react excessively to a foreign substance. Nickel elicits contact dermatitis, which is a Type IV delayed hypersensitivity immune response.[1] This process has two interrelated, distinct phases. A sensitization phase occurs from the moment the allergen enters the body, is recognized and a response occurs. The elicitation phase occurs after re-exposure to the allergen to the appearance of the full clinical reaction. There may have been no symptoms at the initial exposure, but subsequent exposure leads to a more visible reaction.

Occurrence of nickel allergy

Within orthodontics, nickel is one of the most commonly used metals, as it is a component of the super elastic and shape memory wires, and is included in stainless steel and other alloys. It has been shown that the level of nickel in saliva and serum increases significantly after the insertion of fixed orthodontic appliances.[2] Nickel is the most common metal to cause contact dermatitis in orthodontics, with more cases of allergic reactions than all the other metals combined.[3] Kerosuo *et al.* found the prevalence of nickel allergy in Finnish adolescents to be 30 per cent in girls and 3 per cent in boys. This is thought to be due to ear piercing being a major cause of sensitization to nickel, as the prevalence in subjects with pierced ears was 31 per cent and those without pierced ears 2 per cent.[4] Once hypersensitivity has been established, all oral mucosal surfaces can be involved. Sensitizing patients to nickel through routine orthodontic treatment with fixed appliances has been a concern.[5] It has been suggested that a threshold concentration of approximately 30 ppm of nickel may be sufficient to elicit a cytotoxic response.[6] However, it has been stated that oral antigenic contacts in non-sensitized individuals may induce tolerance to nickel, rather than sensitization.[7] Nickel sensitization is believed to be

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increased by mechanical irritation, skin maceration, or oral mucosal injury, all of which may occur in orthodontic treatment. Environmental temperatures and duration of exposure may also be factors. The lesions of contact stomatitis may be variable and may be barely visible. Itching is not a common feature of contact stomatitis (see Table 1)[8] and extra-oral reactions are more common than intra-oral reactions.

Diagnosis of nickel allergy

It is important to make a correct diagnosis of nickel allergy, symptoms of which may occur either within or remote to the oral environment. The following patient history would suggest a diagnosis of nickel allergy:

- previous allergic response after wearing earrings or a metal watchstrap;
- appearance of allergy symptoms shortly after the initial insertion of orthodontic components containing nickel;
- confined extra-oral rash adjacent to headgear studs.

A dermatologist should confirm the diagnosis by patch testing using 5 per cent nickel sulphate in petroleum jelly.

Lesions due to other causes should be eliminated:

- candidiasis;
- herpetic stomatitis;
- ulcers due to mechanical irritation;
- allergies to other materials such as acrylic.

All adverse reactions to any orthodontic material should be reported on an 'Adverse Reaction to Dental Materials' reporting form obtainable from Adverse Reaction Reporting Project, Centre for Biomaterials and Tissue Engineering, Department of Restorative Dentistry, University of Sheffield, Sheffield S10 2TA, UK.

Table 1 Signs and symptoms of nickel allergy

Intra-oral	Extra-oral
Stomatitis from mild to severe erythema	Generalized urticaria
Papula peri-oral rash	Widespread eczema
Loss of taste or metallic taste	Flare-up of allergic dermatitis
Numbness	Exacerbation of pre-existing eczema
Burning sensation	
Soreness at side of the tongue	
Angular cheilitis	
Severe gingivitis in the absence of plaque	

Alternative materials for nickel allergy patients

The potential for orthodontic metals to cause allergic reactions is related to the pattern and mode of corrosion, with subsequent release of metal ions, such as nickel, into the oral cavity. This is dependent not only on the composition of the metal, but also the temperature, pH of the environment, and wear of the wire due to friction from sliding mechanics, abrasion, presence of solder, and strain of the wire.[9] Stainless steel contains 8 per cent nickel, whilst nickel-titanium wires may contain in excess of 50 per cent.

Archwires

Stainless steel. The majority of investigations have found that nickel sensitive patients are able to tolerate stainless steel without any noticeable reaction and this is thought to be due to the crystal lattice of the alloys binding the nickel, which is then not free to react.[10] The only publications to report an allergic response to stainless steel wire are those where the stainless steel was used for intermaxillary or internal fixation, had increased nickel content and were not tested for corrosion.[11,12] Most research concludes that stainless steel is a safe material to use for all intra-oral orthodontic components for nickel sensitive patients. Reduced nickel content stainless steel is also available, but appears to be unnecessary.

Nickel-titanium. Flexible nickel-titanium wires release increased amounts of nickel and are thought to induce nickel sensitivity: there may be up to 20 per cent conversion rate.[9] These high nickel content wires should be avoided in nickel sensitive patients. Alternatives include twistflex stainless steel, fibre-reinforced composite archwires. Wires such as TMA, pure titanium, and gold-plated wires may also be used without risk. Altered nickel-titanium archwires also exist and include plastic/resin-coated nickel-titanium archwires.[13] Ion-implanted nickel-titanium archwires have their surface bombarded with nitrogen ions, which forms an amorphous surface layer, conferring corrosion resistance and displacing nickel atoms. 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 (see Table 2).

Table 2 Nickel-free and nickel-'lite' wires and brackets

Company	Nickel-free products	
	Wires	Brackets
RMO Europe *www.rmortho.com*	Bendalloy TMA wire	Ceramic: Signature 3, Luxi 2 with gold slot
The Orthodontic Company *www.tocdental.com*	Resolve TMA wire Bioforce wire with ionguard Epoxy coated wires	Ion-implanted stanless steel: Platina Ceramic with glass slot: Mystique Plastic: Oyster ligature free
3M Unitek *www.3M.com/Unitek*	Beta III Titanium	Ceramic: Transcend, Clarity with stainless steel slot 24 carat gold-plated brackets
Forestadent *www.forestadent.com*	TMA wire Flat Line acrylic coated wire Titanium coated archwire	Ceramic with gold slot: Aspire Plastic: Brilliant
American Orthodontics *www.americanortho.com*	Beta Titanium wire	White gold + 60% paladium: Virage Polycarbonate 20/40 Reinforced polycarbonate: Silkon Urethane: Classic
TP Orthodontics *www.tportho.com*	Timmolium (TMA)	Nickel 'free' stainless steel: Avid Ceramic: MXI Cobalt chrome: Nu edge
Ormco/A Company *www.ormco.com*	TMA	Ceramic: Inspire Gold: Ortho 2 Titanium brackets
The Dental Directory *www.dental-directory.co.uk*	Betaforce beta titanium	Composite with metal slot: Avalon
HSR Primo *www.hsrprimo.co.uk*	Biosteel (0.2% Ni)	Siliaceous copolymer—Natura
Ortho-care *www.orthocare.co.uk*	Gold-plated wires Beta titanium wire	Polycarbonate: Polar, Polar plus with gold slot Ceramic: Desire with gold slot
Precision Orthodontics *www.orthoorganizer.co.uk*	Nickel-lite: Cobalt chromium alloy CNA beta titanium Gold-plated wires Resin coated wires	Composite with gold slot: Envision Ceramic: Illusion, Contour Nickel-lite: Cobalt chromium alloy Gold-plated brackets

Brackets

Stainless steel brackets again have low nickel content (6 per cent) and are considered safe. However, nickel-free alternative brackets to stainless steel include:

- ceramic brackets produced using polycrystalline alumina, single-crystal sapphire, and zirconia;
- polycarbonate brackets that are produced from plastic polymers;
- titanium brackets;
- gold-plated brackets.

Manufacturers are becoming more aware of the concern of nickel allergy and many are producing 'nickel-lite' stainless steel versions (see Table 2). The cost implications of treating a nickel sensitive patient with fixed appliances range from an increase of 30 per cent for 'nickel-lite' brackets and archwires, to in excess of three times the average cost of particular aesthetic brackets and archwires. Extra-oral metal components, including metal studs in headgear, are of greatest concern due to greater sensitivity of the skin. Plastic-coated headgear studs are available and may be a better alternative to simply wrapping a bandage around the metal component (see Table 3).

Conclusion

The craze for body piercing in younger age groups may mean that an increased number of our patients may have been sensitized to nickel by the time they reach our door.

Table 3 Other nickel-free and nickel-'lite' products

Company	Other products
TP Orthodontics www.tporto.com	Plastic-coated headgear
Masel www.maselortho.com	TMA expansion screw
Sheffield Orthodontic www.orthounlimited.com	Nickel-'free' ss wire for removeable appliances
The Orthodontic Company www.tocdental.com	Glass fibre buccal tubes Epoxy-coated quick-tie ligs
Ormco/A Company www.ormco.com	Titanium buccal tubes

Severe intra-oral manifestations of nickel allergy are thankfully rare, although extra-oral reactions are more common. Stainless steel orthodontic wires, brackets, and auxilliaries appear to be safe. However, high content nickel-titanium wires should be avoided in nickel sensitive patients, as nickel-free alternatives are available and should be considered for these patients.

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