

Nickel allergies in orthodontics

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ABSTRACT

Nickel (Ni) is a common component in many orthodontic materials. An allergy to Ni is commonly seen in the population, more frequently in women. Possible allergy to Ni should be a question in the initial patient health history questionnaire. The orthodontic practitioner should be mindful of this allergy during the course of treatment and know how to diagnose a Ni allergy if it appears and subsequent action in treatment and referral if it is suspected. This paper provides a summary of Ni allergy, its epidemiology, diagnosis and recommendations and alternatives to treatment.

Key words: Allergies, metal ions, nickel ions

Introduction

Almost all fixed metallic orthodontic appliance comprises metals such as nickel (Ni), chromium (cr) and cobalt.^[1] Appliances and additional devices used during treatment are exposed to different factors, such as temperatures, pH, mechanical stress, and micro flora.^[2] All these factors may lead to release of toxic metal ions from alloy. Various studies have been conducted to show release of metal ions and its toxic effects.^[3] These leached out components of orthodontic treatment are well known allergenic, cytotoxic and mutagenic.^[3]

Prevalence

Nickel is the most common causes of allergenic contact dermatitis and produces more allergic reactions than all other metals combined.^[4] Both Ni and cr can cause hypersensitivity in some people, especially in women. Hypersensitivity to Ni in females is thought to be related to environmental exposure, as a result of contact with detergents, jewelry, earrings, and other metallic objects. In males, the hypersensitivity is usually related to occupational exposure.^[5,6]

Dietary intakes of Ni have been estimated to be 200-300 µg/day, Ni concentrations in drinking water are generally below 20 µg. Ni content in excess of 50% elicit manifestations of an allergic reaction.^[7]

Nickel ion release from orthodontic appliances and its toxic reaction has been a concern to the orthodontist as well as the patients. This article will focus on the release of Ni ions, their action on the tissues, its prevention and care to be taken.

Studies on Release of Nickel Ions

According to Agaoglu *et al.*,^[7] level of Ni in saliva and serum increases significantly after insertion of fixed orthodontic appliances. According to Bengleil *et al.*^[8] there was an increase in ion concentrations after 2 weeks of conventional archwires placement. Barrett *et al.*^[6] and Amini *et al.*^[1] have shown an increase in metal ion concentration in the oral fluid of patients with orthodontic appliances as long as 16 months from start of treatment.

Menezes *et al.*^[9] performed studies at different intervals and concluded, individuals vary with different salivary compositions also vary with release of ion concentrations.

Biologic Reactions

An allergic response is one in which certain components of the immune system react excessively to a foreign substance. Ni elicits contact dermatitis, which is a type IV delayed hyper sensitivity immune response.^[10,11] This process has two interrelated, distinct phases:

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1. Sensitization phase — first exposure and,
2. Elicitation — re-exposure to allergen.

Occurrence of Nickel Allergy

Nickel is the most commonly used metals, as it is a component of the super elastic and shape memory wires.^[12] Ni is the most common metal to cause contact dermatitis. Kerosuo *et al.*^[13] found prevalence of Ni allergy adolescents to be 30% in girls and 3% boys. Sensitizing patients to Ni through routine orthodontic treatment has been a concern.^[13] It has been suggested that a threshold concentration of approximately 30 ppm of Ni may elicit a cytotoxic response.^[14] It is believed to be increased by mechanical irritation, skin macerations or oral mucosal injury, all which may occur in orthodontic treatment.^[15]

Diagnosis

The diagnosis of Ni allergy has usually been based on patient history, clinical findings, genetic factors, and the results of patch testing's.^[16] In the patch test, 5% Ni sulfate in petroleum jelly is used. Lesions due to mechanical irritation; allergies to other materials such as acrylic should be ruled out.^[17]

Signs and Symptoms

Extra Oral

1. Generalized urticaria.
2. Wide spread eczema.
3. Flare up of allergic dermatitis.
4. Exacerbation of preexisting eczema.

Intra Oral

1. Stomatitis from mild to severe erythema.
2. Papulaperi oral rash.
3. Loss of metallic taste.
4. Numbness.
5. Burning sensation.
6. Soreness at side of the tongue.
7. Angular chelitis severe gingivitis in the absence of plaque.^[12]

Possible Risks Associated With Nickel Toxicity

The literature has shown many *in vivo* and *in vitro* studies documenting the corrosion of orthodontic appliances and the release of metal ions are indisputable. It has been reported that metal ions are taken up by the adjacent oral tissues.^[18,19]

Risk of Nephrotoxicity

Sunderman^[17] reported a patient with documented IgA nephropathy.

Risk of Cytotoxicity

Grimsdottir *et al.*^[5] used the agar overlay cytotoxicity test with mouse fibroblast cells and reported that none of the arch wires tested caused by cytotoxic effect whereas the multicomponent devices. The study carried out by Hafez *et al.*^[18] proved the cytotoxicity and genotoxicity of orthodontic appliances remained in the mouth for 6 months.

Risk of Carcinogenicity

Sunderman^[17] and Mastromatteo^[19] reported that Ni subsulphide, Ni oxide, and metallic Ni dust have been suspected to be the principal respiratory carcinogens.

Risk of DNA Damage

Several studies conducted by Faccioni *et al.*,^[20] Hafez *et al.*^[18] and Fernández-Miñano *et al.*^[21] suggesting the DNA damage in buccal mucosal cells^[22] and Heravi *et al.*^[23] suggested that DNA damage induced by orthodontic appliance would repair in healthy individuals, but decrease in repair capacity or alterations in the immune system may allow the DNA damage to remain and expressed as genome alteration and DNA mutations. Older age, presence of systemic diseases and risk factors such as tobacco smoke may also aggravate the harmful effects of fixed appliances.^[23]

Study by Das *et al.*^[24] shown Ni ion leaching from appliances can also generate free radicals resulting in oxidative stress in cell and tissue level.

Risk of Immune Changes and Alveolar Bone Loss

Lamster *et al.*^[25] reviewed two cases of women who demonstrated significant alveolar bone loss around Ni-rich nonprecious alloy and porcelain crown. A type IV hypersensitivity reaction was observed which may have caused the loss of the alveolar bone.

Risk of Sensitivity

Nickel dermatitis could be seen of two types. First type of dermatitis is described as a reaction on the skin characterized by itching or burning, popularly seen as erythemas in the web of the fingers, which would spread to the fingers, wrist, and forearms. A second type of Ni dermatitis was described as papulo-vesicular dermatitis with a tendency for lichenification.^[11]

Table 1: Ni-free and Ni-lite wires and brackets

Company	Ni-free products	
	Wires	Brackets
RMO Europe www.rmortho.com	Bendalloy TMA wire	Ceramic: Signature 3, Luxi 2 with good slot
The Orthodontic Company www.todental.com	Resolve TMA wire BioForce wire with iron guard Epoxy coated wires	Ion-implanted stainless steel: Platina ceramic with glass slot Mystique plastic: Oyster ligature free
3M Unitek www.3M.com/Unitech	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% palladium: Virage polycarbonate: Silkon urethane: Classic
TP Orthodontics www.tportho.com	Timmolium (TMA)	Ni “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.dentaldirectory.co.uk	Beta force Beta titanium	Composite with metal slot: Avalon
HSR Primo www.hsrprimo.co.uk	Biosteel (0.2% Ni)	Siliceous copolymer – Natura
Orthocare 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	Ni-lie: Cobalt chromium alloy CAN beta titanium Gold-plated wires Resin coated wires	Composite with gold slot: Envision Ceramic: Illusion, contour Ni-lite: Cobalt chromium alloy Gold-plated brackets

TMA: Titanium molybdenum alloy, Nickel: Ni

Alternate Treatment Modalities

Nickel free appliances are available to prevent an allergic reaction and toxic effects in orthodontic treatment various [Table 1].^[12]

Conclusion

In recent decades, there has been greater importance of biocompatibility of orthodontic appliances due its harmful effects. The frequency of orthodontic treatment and common use of Ni containing orthodontic material may act to increase or decrease the burden of Ni hypersensitivity in the population. There is evidence that oral exposure to Ni may induce immunologic tolerance to Ni and thereby reduce the incidence of Ni allergies. It’s also seen that damage caused by Ni ions repair in healthy individuals over period of time. Nevertheless when clinical signs or symptoms presumed to be due to Ni hypersensitivity are distressing to patients there are many choices of materials available to the orthodontist as alternatives and should be thought about. Along with orthodontic care, general wellbeing of the patient should be prime motto and steps should be taken to achieve it whenever needed.

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