the Journal of CONTEMPORARY DENTAL PRACTICE
at www.thejcdp.com
Volume 5 Number 4 November 15, 2004
Fall Issue

Nickel and Cobalt Hypersensitive Reaction Before and After Orthodontic Therapy in Children

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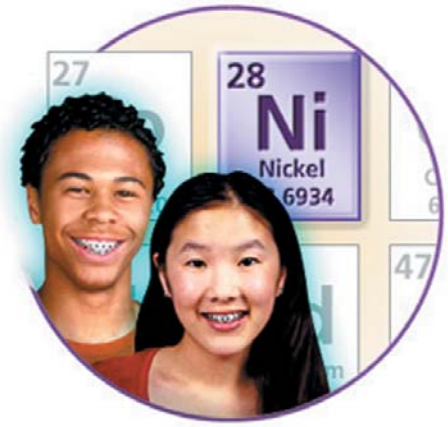


Abstract

Nickel and cobalt are major components of alloys used in orthodontics. The objectives of this cross-sectional study was to determine the prevalence of a nickel hypersensitivity reaction before and after orthodontic treatment with conventional stainless steel brackets and wires. The total sample consisted of 82 patients (55 females, and 27 males) from the Orthodontic Department at the Faculty of Dentistry, Süleyman Demirel University. A patch test and a questionnaire were used to evaluate hypersensitivity to these metals. The statistical analysis was carried out using Fisher's exact X^2 (2 x 2) test. The prevalence of nickel allergy was found to be higher in females than males (14.55% in females, 0% in males), and the prevalence of cobalt allergy was found to be 9.76% (7.27% in females, 14.81% in males). Orthodontic treatment with conventional stainless steel alloys does not appear to have an allergenic effect on the gingival and oral health of the patient. A family history of an allergy to these metals or the use of metallic objects in contact with the skin do not characterize nickel and cobalt hypersensitivity. This suggests orthodontic therapy with conventional stainless steel appliances does not initiate or aggravate a nickel hypersensitivity reaction. There was no association between the before treatment and after treatment to a nickel and cobalt hypersensitivity reaction.

Keywords: Nickel allergy, colbalt allergy, hypersensitivity, orthodontic treatment

Citation: Saglam AMS, Baysal V, Ceylan AM. Nickel and Cobalt Hypersensitive Reaction Before and After Orthodontic Therapy in Children. J Contemp Dent Pract 2004 November;(5)4:079-090.

Introduction

A hypersensitive reaction to nickel is due to a direct relationship with the presence of this metal in the environment and may be caused by indirect or direct contact with the skin and/or mucosa.[1]

The majority of metals used in orthodontics contain nickel and cobalt. The incidence of nickel hypersensitivity is significant. Jones et al.[2] reported a positive skin patch test to nickel sulphate in 20% of the female patients and 2% of the male patients in a population of 100 dental patients. However, Blanco-Dalmou et al.[3] found 31.9% of the women and 20.7% of the men in a population of 403 showed a positive reaction to a similar patch test with nickel sulphate. Hypersensitivity to nickel in females is thought to be related to environmental exposure as a result of contact with detergents, costume jewellery, earrings, metal clasps, and other metallic objects.[4, 5] In males the hypersensitivity is usually related to occupational exposure but may also result from contact with wristwatches, metal buttons, metallic frames of glasses, buckles, and other metallic objects.[1, 6]

The aim of this study was to:

1. Determine the nickel and cobalt hypersensitivcity patient profile in relationship to the following factors: gender, personal history, and family history of allergic reaction to using metallic objects.
2. Determine the prevalence of nickel and cobalt hypersensitivity in a sample of orthodontic patients treated with orthodontic fixed stainless steel appliances before and after treatment.
3. Assess gingival tissue responses to nickel - containing fixed orthodontic appliances in patients who are nickel and cobalt hypersensitive before and during orthodontic treatment.

Materials and Methods

Eighty-two randomly selected patients from the Orthodontic Department in the Faculty of Dentistry at Süleyman Demirel University participated in the study. Of the 82 subjects tested, ages ranged from 11 to 20 years with a mean age of 14.32 years. The 55 females ranged in age from 11 to 20 years with a mean of 14.16 years. The 27 males ranged in age from 11 to 18 years with a mean of 14.63 years (Table 1). These patients were evaluated before, during, and after fixed standard Edge-wise stainless steel orthodontic appliances were inserted. Fifty-five were female and 27 were male. Only patients with a negative orthodontic history were included included in this study.

All patients underwent a thorough clinical evaluation that consisted of an objective clinical examination and completion of a health questionnaire. After this first evaluation, each subject was given a nickel patch test with hypoallergenic adhesive tape, absorbent filter paper, 5% nickel sulphate, and 1% cobalt in white petrolatum. In this test, two filters were used, one with the nickel sulphate and cobalt and the other without any test agent (placebo). The inner side of the middle portion of the upper back was chosen as the test site.[7] Each subject was told not to traumatize, moisten, or remove the test unless there was an intense discomfort, such as local irritation or fever. They were also instructed to report immediately to the dermatologist if such problems arose. The patches were removed after 48 hours, and after 30 minutes the first reading was performed. If a question arose at 48 hours regarding the patch test result, the patch was replaced and the patient returned the next day. At 48-hour and 72-hour intervals, the test sites were reviewed independently by two dermatologists. Each patch test response was interpreted and a score assigned. The scores were defined as follows:

- **-** Negative reaction
- **?+** Doubtful reaction
- **+** Weak (nonvascular) positive reaction: erythema, infiltration, possible papules
- **++** Strong (vascular) positive reaction: erythema, infiltration, papules, vesicles
- **+++** Extreme positive reaction: bullous

In addition to a nickel patch test, gingival status was investigated. Presence of inflammation in the marginal portion of the gingiva is usually recorded by means of probing assessments, according to the principles of the Gingival Index outlined in the publication by Löe.[8] All patients in this study were banded and/or bracketed with fixed stainless steel

Table 1. Distribution of children by age and sex.

	Age			
Gender	Minimum	Maximum	Mean	Sd
Female	11.00	20.00	14.16	2.04
Male	11.00	18.00	14.63	1.84
Total	11.00	20.00	14.32	1.99

Table 2. Association between nickel hypersensitivity and gender.

	Gender			
Reaction	Female	Male	Total	2 x 2
Positive	8	0	8	
Negative	47	27	74	0.034*
Total	55	27	82	

Table 3. Association between cobalt hypersensitivity and gender.

	Gender			
Reaction	Female	Male	Total	2 x 2
Positive	4	4	8	
Negative	51	23	74	0.240
Total	55	27	82	

orthodontic appliances. Orthodontic wires included nickel titanium. Patients were followed using monthly intervals.

The statistical analysis that was carried out was Fisher's exact X^2 (2 x 2) test.

Eight of the 82 patients reported a positive skin patch test when tested for nickel. This represents an overall prevalence of 9.76% (Table 2 and Figure 1). The eight patients who tested positive were all females. There was sexual dimorphism for the hypersensitive reaction to nickel with a prevalence for females of 14.55% (Table 2). Also, eight of the 82 patients reported a positive skin patch test when tested for cobalt. This represents an overall prevalence of 9.76% (Table 3 and Figure 2). However, not one of the 82 patients had an allergic reaction in the gingiva according to Löe.[8]

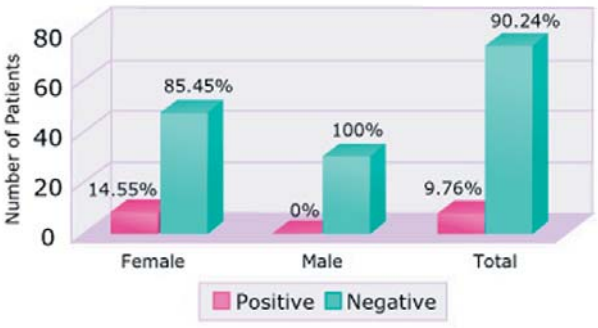


Figure 1. Association between nickel hypersensitivity and gender.

Results

No statistically significant difference was found between the association of a personal history of an allergic reaction to metals and a hypersensitivity reaction to nickel and cobalt (Tables 4 and 5).

There was no association between a hypersensitive reaction to nickel and a family history of an allergic reaction to nickel (Table 6). The same was true of cobalt (Table 7).

There was no association between a hypersensitive reaction to nickel and cobalt and the use of metallic objects such as earrings, glasses, and other clothing accessories (Tables 8 and 9).

There was no significant inflammatory reaction or discomfort as a result of the fixed orthodon-

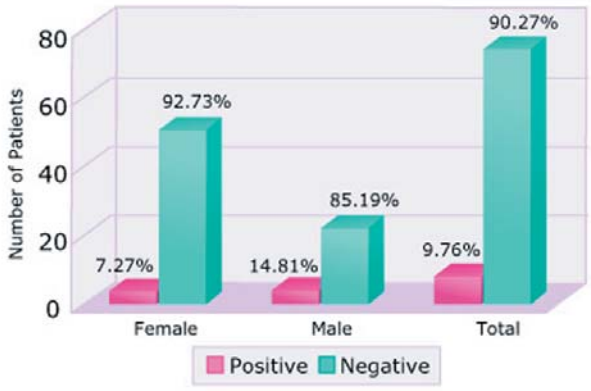


Figure 2. Association between cobalt hypersensitivity and gender.

Table 4. Association between hypersensitive reaction to nickel and personal history.

	Personal History			
Reaction	Present	Absent	Total	2 x 2
Positive	3	5	8	
Negative	22	52	74	0.806
Total	25	57	82	

Table 5. Association between hypersensitive reaction to cobalt and personal history.

	Personal History			
Reaction	Present	Absent	Total	2 x 2
Positive	3	5	8	
Negative	22	52	74	0.806
Total	25	57	82	

Table 6. Association between hypersensitive reaction to nickel and family history.

	History			
Reaction	Present	Absent	Total	2 x 2
Positive	3	5	8	
Negative	20	54	74	0.851
Total	23	59	82	

Table 7. Association between hypersensitive reaction to cobalt and family history.

	History			
Reaction	Present	Absent	Total	2 x 2
Positive	0	8	8	
Negative	23	51	74	0.062
Total	23	59	82	

Table 8. Association between hypersensitive reaction to nickel and use of metallic objects.

	Use			
Reaction	Present	Absent	Total	2 x 2
Positive	2	4	6	
Negative	6	70	76	0.989
Total	8	74	82	

Table 9. Association between hypersensitive reaction to cobalt and use of metallic objects.

	Use			
Reaction	Present	Absent	Total	2 x 2
Positive	3	5	8	
Negative	5	69	74	0.998
Total	8	74	82	

Table 10. Association between hypersensitive reaction to nickel before treatment and after treatment.

	Nickel			
Reaction	Present	Absent	Total	2 x 2
Before treatment patch test	3	5	8	
After treatment patch test	5	69	74	0.998
Total	8	74	82	

Table 11. Association between hypersensitive reaction to cobalt before treatment and after treatment.

	Cobalt			
Reaction	Present	Absent	Total	2 x 2
Before treatment patch test	4	47	51	
After treatment patch test	6	45	51	0.371
Total	10	92	102	

tic appliances used on these patients regardless of the nickel content over the 6 month follow-up period.

There was no association between the before treatment and after treatment to a nickel and cobalt hypersensitivity reaction (Tables 10 and 11).

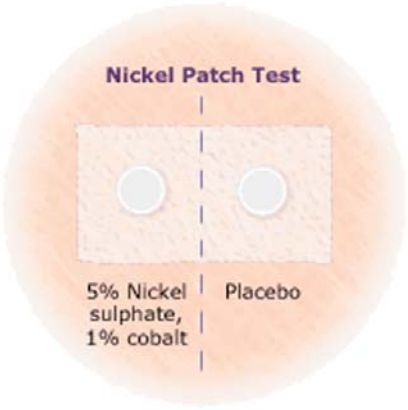
Discussion

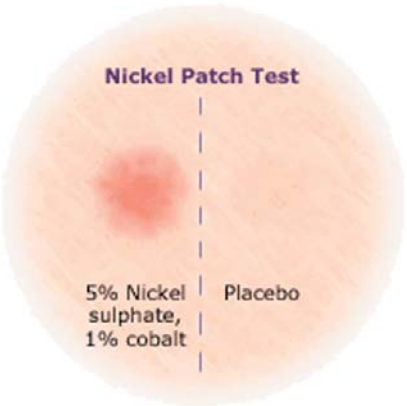
Nickel and cobalt hypersensitivity reactions were determined in this study by the patch test, which was considered to be an acceptable method for evaluating contact dermatitis.[9] However, there may be a risk of sensitization of the subject when this test is applied. When a high salt concentration is used, this may even result in false-positive reactions to tests because of its irritating effect.[10] Similarly, a low salt concentration may produce false-negative reactions to tests. A concentration of 5% nickel sulphate, as was used in this work, probably does not cause any irritating effect despite the fact that it was at a higher concentration than that necessary to cause dermatitis.[1]

The site used for application may also interfere in the final result of the test. An allergic reaction as well as an irritating reaction occurs more frequently in cases where the upper back is used.[11] In this study the upper back was also chosen to minimize the occurrence of false-positive results.

Metallic orthodontic appliances are usually made of 18/8 stainless-steel (18% chromium and 8% nickel). Some arch wires with elastic properties (shape memory alloys) can contain more than 50% nickel. Release of nickel from metallic orthodontic appliances has been observed in several in vitro studies.[5, 12, 13] It is interesting to note how little nickel was in fact released from most of the alloys used in orthodontics. Park and Shearer[5] reported a release of 40 mg nickel and 36 mg chromium per day from a simulated full-mouth orthodontic appliance. However, the oral daily intake of nickel by food is estimated to be between 300 to 600 mg (L). Nickel release in vivo in the oral cavity has been more difficult to demonstrate, although corrosion has clearly been evident in the orthodontic appliances following treatment.[14, 5] Nevertheless, some authors observed the presence of large concentrations of nickel in dental alloys does not increase the probability of an allergic reaction to this metal.[10, 16, 17]

Nickel is reported to produce more metal hypersensitivity than all other metals.[18-20] Nickel contact dermatitis is commonly observed with some investigators claiming as high as 28% positive reactions in the nickel sulphate patch test when carried out on the general population.[3] Arikan and Kulak[19] reported the allergic reaction for nickel was 11.7%, while it was 9.76% in the present





study (Table 2). The difference between these results may be due to the differences in the age range of the two test samples; however Blanco-Dalmau et al.[3] reported finding no relationship between age and nickel hypersensitivity.

A significant difference was found in the incidence of nickel and cobalt hypersensitivity between sexes. Of all the women tested, 14.55% showed a positive reaction to nickel and 7.27% to cobalt. The incidence of the same reaction in men was 0% for nickel and 14.81% for cobalt. Blanco-Dalmau et al.[3], Jones et al.[21], Moffa et al.[22], and Arikan and Kulak[19] reported the incidence of hypersensitivity to nickel is higher in women than men, and this was confirmed by our observation. Many investigators reported this is possibly due to the fact women have more contact with these metals from wearing jewellery containing these metals and so they may have been sensitized at an early age. But in this report, a difference was found in the hypersensitive reaction to nickel and use of metallic objects. The other reason may be due to the study group which did not have a history of exposure to non-precious jewellery.

Although nickel is widely used in orthodontic and prosthetic dental appliances[23-26], few epidemiological data presently exist on nickel hypersensitivity in connection with fixed orthodontic and prosthetic appliances.

No correlation was found between a previous history of allergy and nickel and cobalt hypersensitivity. Blanco-Dalmau et al.[3], Jones et al.[21], Arikan and Kulak[19], and Janson[20] reported a positive correlation between previous history of allergy and nickel hypersensitivity. These results suggest histories could be valid and useful in that they are a means of predicting contact sensitivity to metal. However, Jones et al.[21] also stated a positive history of allergy does not necessarily prevent a patient from successfully wearing a dental prosthesis containing nickel.

There was also no association between contact allergic reaction and a family history of allergy. This observation was also reported by Larsson-Stymne and Widctröm[27] and Janson et al.[28]

Conclusion

Prevalence of nickel allergy is higher in females than males (14.55% in females, 0% in males). Prevalence of cobalt allergy is 9.76% (7.27% in females, 14.81% in males). A previous family history of allergy and the use of metallic objects in contact with the skin do not characterize the nickel and cobalt hypersensitive subject. There was no association between the before treatment and after treatment to a nickel and cobalt hypersensitivity reaction. As a conclusion, conventional orthodontic treatment with nickel and cobalt containing appliances does not cause a hypersensitive reaction.

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