PEDIATRIC DENTISTRY/Copyright © 1988 by
The American Academy of Pediatric Dentistry
Volume 10, Number 2

Nickel sensitivity in pediatric dental patients

W.H. Feasby, DDS, MSc, FRCD(C) E.R. Ecclestone, MD, FRCP(C)
R.M. Grainger, DDS, MSc, FRCD(C)

Abstract

A nickel sensitivity patch test was applied to 700 child dental patients, aged 5-12 years, from the Dental Clinic at the University of Western Ontario and nearby pediatric dental offices. Approximately one-half the children were known to have nickel-containing dental appliances. From a case history obtained from the parents, the history of the wearing of pierced earrings and other jewelry was ascertained.

The overall positive patch test rate was 8.1% with the females having a rate of 9.5% and males 6.8%.

Positive patch tests were more frequent for girls wearing earrings than those without earrings. Positive patch tests were more frequent for boys and girls with nickel-containing intraoral devices than those without the nickel devices. However, none of the differences were statistically significant. A study of exposure time revealed a trend toward more response over time, but this was not statistically significant. Old formulation nickel-chromium crowns were associated with a significantly higher patch test rate in children 8-12 years old. This suggests that in the development of intraoral appliances consideration should be given to the nickel content.

It has been reported that the problem of nickel contamination and associated skin contact is potentially serious, but no effort has been made to define its magnitude (Sunderman et al. 1975). Fisher (1973) has stated that nickel is one of the most common causes of allergic contact dermatitis, especially in women. Attention has been drawn to the problem of allergy and dermatitis from exposures to nickel owing to the presence of nickel in alloys used in orthopedic prostheses, cardiac pacemaker electrodes, cardiac valve replacements, sutures, and intravenous cannulae, as well as exposures due to jewelry (Sunderman 1977).

Nickel-associated problems also have been of some concern in dentistry. Park and Shearer (1983) demonstrated in vitro that nickel is released from simulated orthodontic appliances. Bergman et al. (1980) reported that nickel from nonprecious dental casting alloys accumulated in mouse tissues. Blanco-Dalmou et al. (1984), using a 5% nickel sulphate gel, found that 20.7% of men and 31.9% of women developed an allergic response to nickel. With 2.5% nickel sulphate in white petrolatum, Prystowsky et al. (1979) found that 9% of adult women and 0.9% of adult men revealed a positive response.

The purpose of the present study was to determine the level of nickel sensitivity in a child population by using a skin reaction test. The study also compared the skin test reaction of those children with nickel-containing intraoral appliances with those who did not possess those devices.

Method

The study was conducted with children attending the Undergraduate Clinic of the Faculty of Dentistry, University of Western Ontario, and neighboring pediatric dental offices. Two groups of children were developed. One group was selected because it had nickel-containing intraoral appliances such as stainless steel crowns, band-loop space maintainers, lingual arches, and appliances with stainless steel clasps and springs. Another group of children was selected without nickel-containing intraoral appliances or any history of dental appliances. Most children ranged in age from 4 to 11 years.

After obtaining parental permission, a dentist-technician placed two bandages on each child's upper arm. One of the bandages contained 2.5% nickel sulphate in white petrolatum gel. The patients returned in 48 hr for the reading of the patch test response. A questionnaire was completed that recorded the presence of earrings and how long they were worn. The patient's age and the duration of exposure to pierced earrings and dental devices was calculated.

The frequency of positive patch tests with or without various potential allergens was calculated. The significance of the difference was evaluated by using the Chi-square test. Project protocol was reviewed and approved by the Human Resources Review Committee of the University of Western Ontario.

Results

Records were completed for 700 children (352 boys, 348 girls; Table 1). The positive patch test rate by age and sex is recorded in Table 2. The overall rate was 8.1% with the boys revealing 6.8% and the girls 9.5% positive patch test. A variety of intraoral nickel devices was found, including stainless steel crowns, nickel-chromium crowns, band-loop space maintainers, lingual arches, and other intraoral devices containing stainless steel (Table 3).

TABLE 1. Age and Sex Distribution of Sample Population

Age	*Boys*	*Girls*	*Total*
5 years	79	63	142
6-7	88	94	182
8-9	101	104	205
10-11	73	76	149
12	11	11	22
	352	348	700

TABLE 2. Rate of Positive Patch Test by Age and Sex

Age	*Boys*	*Girls*	*Total*
5 years	8.9%	12.7%	10.6%
6-7	6.8	14.9	11.0
8-9	7.9	3.8	5.8
10-11	2.7	9.2	6.0
12	9.1	0.0	4.5
All ages	6.8%	9.5%	8.1%

TABLE 3. Number of Nickel Appliances in Sample

	Boys	*Girls*
S.S.C.	52	41
I Cr	34	34
B-L	38	37
L-A	14	11
Other	44	47
Total	182*	170*

* Some children had more than one type of appliance.
S.S.C.—stainless steel crown, I Cr—ion Ni-Chro crown, B-L—band-loop space retainer, L-A—lingual arch, other—banded restorations and removable appliances with stainless steel clasps.

The nickel component of the stainless steel crowns and bands ranged from 10 to 13% and in the wires used in lingual arches and band-loop space maintainers ranged from 16 to 18%. The nickel component of the nickel-chromium primary crowns was the old percentage (72%) which is now obsolete.

Since it was suggested that the females exhibit a higher positive patch test rate than males because of jewelry use (Prystowsky et al. 1979; Blanco-Dalmau et al. 1984), the patch test rate for girls with and without pierced earrings was compared (Table 4). The differences were not significant.

When the positive patch test rate for children with and without nickel intraoral appliances was compared, it was found that overall those with appliances had a higher positive patch test rate, but the differences were not significant (Table 5). A positive patch test rate by duration of exposure to a nickel-containing device was analyzed for boys and girls (Table 6). Once again, a comparison of those with no exposure and those with exposure up to five years did not reveal a statistically significant difference. Each type of device was analyzed separately and it was found that children with nickel-chromium crowns had a significantly higher positive response than those children without that type of intraoral device (Table 7). It was reported that the nickel-chromium crowns (old formation) had a 72% nickel content. The manufacturer has stated that this formulation is no longer being manufactured.

TABLE 4. Positive Patch Test Rate for Girls with Earrings

	Earrings Absent		*Earrings Present*	
Age	*N*	*Per cent*	*N*	*Per cent*
5 years	45	13.3	18	11.1
6-7	64	10.9	30	23.3
8-9	61	3.3	43	4.7
10	46	4.4	41	12.2
	216	7.9	132	12.1*

* Trend is not significant[a].

TABLE 5. Positive Patch Test Rate with All Nickel-Containing Dental Appliances

	Boys		*Girls*	
Age	*Without Appliances*	*With Appliances*	*Without Appliances*	*With Appliances*
5 years	6.0%	13.8%	12.0%	15.4%
6-7	8.2	5.1	14.6	15.2
8-9	2.1	13.2	1.8	6.1
10	2.3	4.9	8.7	7.3
All	4.7%	9.3%	9.1%	10.1%

Chi-square test[a] revealed no significant differences.

Discussion

Prystowsky et al. (1979) found in a patch test study of 1158 volunteer adults that four of 460 men (0.9%) and 63

TABLE 6. Positive Patch Test Rate by Sex and Exposure Time to Any Appliance

Years	*Boys*	*Girls*
0	4.6%	9.0%
1	11.9	10.3
2-3	6.5	8.8
4-5	0.0%	22.2%

Chi-square test[a] revealed no significant differences.

TABLE 7. Patch Test Rate Ni-Chro Crowns* Sexes Pooled

Age	*Without Crowns (% positive)*	*With Crowns (% positive)*
0-5 years	11.0%	8.3%
6-7	10.7	13.0
8-9	4.8	17.7
10-	4.8	50.0**
All, 8 and older	4.8%	23.8%**

* Old formulation with 72% nickel.
** Chi-square analysis[a] significant at $P < 0.05$.
Footnote a—all chi-square tests were applied to absolute data.

of 698 women (9%) had positive reactions to a 2.5% nickel sulphate gel. This study reports comparable levels of sensitivity for girls (9 vs. 9.5%), but the boys showed a frequency of positive reaction 7.5 times more frequently (0.9 vs. 6.8%; Table 2).

The sex difference has been attributed to women's being exposed to nickel more frequently by earrings (pierced ears), jewelry, etc., than men (Prystowsky et al. 1979; Blanco-Dalmau et al. 1984). However, the present study did not demonstrate a significant difference in patch test rate attributable to the presence of earrings in girls (Table 4). It should be noted, however, that both this study and Prystowsky's (1979) found a positive patch test rate of 12% in those females with earrings. The noted relatively high positive test rate in boys and the finding that the high test rating in girls was not attributable to earrings alone, suggests that this population has environmental exposures to nickel that differ from the San Francisco adult population tested by Prystowsky et al. (1979).

Of particular dental interest was a comparison of patch test rate in children with and without nickel-containing intraoral devices (Table 5). It is noteworthy that in six of eight groups the positive response rate was higher in those with appliances. However, in no comparison was the difference statistically significant. The data then were arrayed to enable comparison by duration of exposure to the intraoral nickel (Table 6). Once again, a trend toward more response with time was revealed, but the differences were not statistically significant. It is interesting to note that no boys exposed to nickel appliances for 4-5 years had a positive test result while 22.2% of girls did. This would suggest that other factors besides dental appliances (Table 6) and earrings (Table 4) should be investigated. These findings do not justify a conclusion that dentally applied intraoral stainless steels are sensitizing children to nickel at a rate that varies significantly from those children exposed to nickel in the general environment only.

A statistically significant correlation was found with the positive patch test readings and the presence of nickel-chromium crowns (old formulation). It was found that for the sexes pooled, ages 8 years and older, there was a significant correlation between the presence of the nickel-chromium crowns and a positive patch test. However, it should be noted that this is the old formulation according to information received from the manufacturer (3M Canada, Inc., personal communication), which reported a nickel content of 72%.

Conclusions

A study employing a 2.5% nickel sulphate gel in a skin patch test on 700 child dental patients found:

1. The total population positive patch test rate was 8.1%. Females were positive more frequently than males (9.5 vs. 6.8%).
2. Girls wearing pierced earrings tended to have a higher positive test rate.
3. Children with nickel-containing intraoral devices tended to demonstrate a higher positive test rate.
4. Positive patch test rates did not increase significantly with increasing exposure time.
5. Children eight years old and older, with old formulation nickel-chromium crowns (72% nickel), had a significantly higher positive patch test rate.

This study was supported by Physicians Services, Inc. Foundation and the Department of Paediatrics, University of Western Ontario, London, Ontario, Canada.

The authors gratefully acknowledge the assistance of Barbara Downar-Zapolski, research assistant.

Dr. Feasby is a professor, pediatric dentistry, Dr. Ecclestone is an associate professor, pediatrics, and Dr. Grainger is a professor, community dentistry, The University of Western Ontario. Reprint requests should be sent to: Dr. W.H. Feasby, Dept. of Paediatric Dentistry, Faculty of Dentistry, Dental Sciences Bldg., The University of Western Ontario, London, Ontario N6A 5C1 Canada.

Bergman M, Bergman B, Soremark R: Tissue accumulation of nickel released due to electrochemical corrosion of nonprecious dental casting alloys. J Oral Rehabil 7:325-30, 1980.

Blanco-Dalmau L, Carrasquillo-Alberty H, Silva-Parra J: A study of nickel allergy. J Prosthet Dent 52:116-19, 1984.

Fisher AA: Contact Dermatitis, 2nd ed. Philadelphia; Lea and Febiger, 1973.

Park DY, Shearer TR: In vitro release of nickel and chromium from simulated orthodontic appliances. Am J Orthod 82:156-59, 1983.

Prystowsky SD, Allen AM, Smith RW, Nonomura JH, Odom RB, Akers WA: Allergic contact hypersensitivity to nickel, neomycin, ethylenediamine and benzocaine. Arch Dermatol 115:959-62, 1979.

Sunderman FW Jr, Coulston F, Eichorn GL, Fellows JA, Mastromatteo E, Reno HT, Samitz MH: Nickel: a report of the Committee on Medical and Biologic Effects of Environmental Pollutants. Washington DC; National Academy of Sciences, 1975 p277.

Sunderman FW Jr: A review of the metabolism and toxicology of nickel. Ann Clin Lab Sci 7:377-98, 1977.