Original Article

Longitudinal assessment of periodontal status in patients with nickel allergy treated with conventional and nickel-free braces

Camila Alessandra Pazzini[a]; Leandro Silva Marques[b]; Maria Letícia Ramos-Jorge[c]; Gilberto Oliveira Júnior[d]; Luciano José Pereira[e]; Saul Martins Paiva[f]

ABSTRACT

Objective: To perform a longitudinal comparison of periodontal status in allergic individuals treated with conventional and nickel-free braces.

Materials and Methods: Forty-two individuals allergic to nickel were randomly divided into two groups: those receiving conventional braces (n = 21) and those receiving nickel-free braces (n = 21). Periodontal status (gingival hyperplasia, change in color and bleeding) was assessed before treatment (T0) and at 3-month intervals for 12 months (T1, T2, T3, and T4), using the Löe Index. Evaluations were performed blindly by a single, calibrated examiner, followed by prophylaxis and orientations regarding oral hygiene. Data were analyzed using the Mann-Whitney *U*-test for comparisons of the gingival index between groups and Friedman's test for successive comparisons between sessions in the same group ($P \leq .05$).

Results: Periodontal status did not differ between groups in the initial 9 months of treatment, whereas significant differences were found at T3 and T4 (.039 and .047, respectively). Individuals wearing conventional appliances had higher mean gingival index scores than those wearing nickel-free braces.

Conclusion: Individuals with an allergy to nickel exhibit better periodontal health when treated with nickel-free braces than with conventional braces. (*Angle Orthod.* 2012;82:653–657.)

KEY WORDS: Nickel allergy; Orthodontic treatment; Nickel-free braces

INTRODUCTION

Studies indicate nickel as a cause of alterations in periodontal status among allergic orthodontic patients.[1–6] At the same time, there has been a tendency on the part of the industry to produce orthodontic materials with low concentrations of nickel (0.2% to 4%). Such appliances are denominated nickel-free and are advertised as releasing low quantities of nickel ions, which may diminish the allergic response in sensitive patients.[7–10]

A critical evaluation of the literature reveals little consistent evidence regarding the actual effectiveness of nickel-free appliances in orthodontic patients allergic to nickel. In a recent systematic review, Pazzini et al.[4] found only four studies suggesting that nickel-free braces may favor orthodontic treatment in allergic patients, and the authors stress the need for clinical trials that can provide more consistent evidence with regard to this issue. Studies involving nickel-free braces may provide important information by first determining whether nickel is truly the agent responsible for triggering responses of an inflammatory and/or allergic nature. Moreover, such studies would determine

[a] Pediatric Dentistry and Orthodontics Department, Universidade Federal de Minas Gerais-UFMG, Belo Horizonte-MG, Brazil.

[b] Professor, Department of Orthodontics, Universidade Vale do Rio Verde-UNINCOR, Três Corações-MG, Brazil.

[c] Pediatric Dentistry Department, Universidade Federal do Vale de Jequitinhonha e Mucuri-UFVJM, Diamantina-MG, Brazil.

[d] Professor, Pediatric Dentistry and Orthodontics Department, Centro Universitário de Lavras – UNILAVRAS, Lavras-MG, Brazil.

[e] Professor, Department of Physiology and Pharmacology, Universidade Federal de Lavras- UFLA, Lavras-MG, Brazil.

[f] Professor, Department of Orthodontics and Pediatric Dentistry, Universidade Federal de Minas Gerais-UFMG, Belo Horizonte-MG, Brazil.

Corresponding author: Dr Leandro Silva Marques, Department of Orthodontics, Vale do Rio Verde University – UNINCOR, Rua Arraial dos Forros 222, Diamantina, Minas Gerais 39100000 Brazil
(e-mail: lsmarques.prof@gmail.com)

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whether nickel-free braces actually represent a viable alternative for patients who are allergic to nickel.

The aim of the present study was to perform a longitudinal comparison of periodontal status in allergic individuals treated with conventional and nickel-free braces.

MATERIALS AND METHODS

Eighty patients awaiting treatment at an orthodontic specialization course of the Centro Universitário de Lavras (Lavras, MG, Brazil) were randomly selected for participation in the study. All participants were white; 47 (58%) were female and 33 (42%) were male, ranging in age from 10 to 45 years.

All individuals began treatment in January 2009. Before placement of the appliances, all participants received prophylaxis with bicarbonate spray and orientations regarding oral hygiene (the oral hygiene measures consisted of brushing the teeth at least four times a day and using dental floss with the help of needle and mouthwash rinse to facilitate the removal of plaque). Morelli brackets (Dental Morelli, Sorocaba, SP, Brazil) were used. The conventional appliances contained 16% to 20% chrome, 8% to 13% nickel, and 2% to 3% molybdenum; the nickel-free appliances contained up to 18% chrome, 0.2% to 4% nickel, and 3.5% molybdenum.

After treatment was begun, a skin patch test was performed to identify patients with nickel allergy. According to the allergy evaluation standards of the Brazilian Medical Association and the Federal Medicine Council (Brazilian Study Group on Contact Dermatitis, 2000), this is the most efficient method of confirming the etiologic diagnosis of allergic contact eczema. The method requires use of a 2 $\times$ 2-cm patch (Finn Chambers, Tuusula, Finland) attached to the dorsal region of the patient at two different points placed 10 cm apart, following cleansing of the skin with cotton soaked in alcohol. Owing to the extensive area involved, an ideal amount of the gel (standardized by the manufacturer) containing a 5% nickel sulfate antigen (solid petroleum jelly) (FDA Allergenic, Rio de Janeiro, Brazil, Importer and Distributor; Epitest Ltd Oy, Tuusula, Finland) remained in place for 48 hours. Patients were instructed to remove the patches if they experienced any reaction beyond the expected, and to contact the researchers in charge, as well as the municipal medical emergency room. After 48 hours, the patches were removed, and a single reading was performed in compliance with the norms of the International Contact Dermatitis Research Group[11]: (-) negative; (+) discrete erythema with some papules; (++) erythema, papules, and vesicles; and (+++) intense erythema, papules, and vesicles. All patients considered negative presented no clinical condition visible to the naked eye, and all patients considered positive presented erythema, edema, papules, and blisters (+++). At the time, seven individuals abandoned treatment for personal reasons. Forty-two individuals (57.5%) proved allergic to nickel and were randomly distributed into two groups: those receiving conventional braces (group I; n = 21), and those receiving nickel-free braces (group II; n = 21).

Clinical gingival characteristics (color, volume, and bleeding) were assessed. A standardized probe with a millimeter ruler was used to determine the presence or absence of gingival bleeding around the upper and lower first premolars at three different points on the vestibular, palatine/lingual, mesial, and distal faces. These teeth were selected owing to their location at the halfway point of each quadrant of the oral cavity. For the evaluation, the Löe Gingival Index[12,13] was used, with qualitative changes in the gingival tissue taken into consideration. The Löe Index is based on mean scores of the first premolars, multiplied by three sites per tooth. The mean value is used to classify the patient into one of four categories, with the following scores: 0—normal gums; 1—mild inflammation, slight change in color, mild edema, no bleeding upon probing; 2—moderate inflammation, reddish appearance, mild edema, bleeding upon probing; and 3—severe inflammation, reddish appearance, evident edema, ulceration, and tendency toward spontaneous bleeding. Patients with at least two of the classifications of each previous item were classified in the more severe category.

Assessments of periodontal status were carried out by a single, blinded, duly calibrated examiner (kappa >0.90) before that start of treatment (T_0) and at regular 3-month intervals for 12 months (total of five evaluations: T_0, T_1, T_2, T_3, T_4) with braces in place. Additionally, prophylaxis with a bicarbonate spray was performed in each session (following the periodontal evaluation).

Intergroup (conventional and nickel-free) and intragroup comparisons of the gingival index in the five evaluation sessions were performed using chi-square and Friedman's tests, respectively. Nonparametric tests were applied because the Löe Index is a qualitative method. Thus, values for the 0, 1, 2, and 3 scores cannot be used as ordinary variables, and they were dichotomized as presence (1, 2, or 3) and absence (0) of gingival inflammation for statistical purposes. Differences were considered significant with $P \leq .05$. This study received approval from the Human Research Ethics Committee of the Centro Universitário de Lavras (Brazil) under process number 0015.0189.000-10.

RESULTS

A 57.5% prevalence of nickel allergy (42 individuals) was noted, 67% (28) of which occurred in female

patients and 33% (14) in male patients. The study started with 21 patients in each group. However, only 20 from the conventional group and 17 from the nickel-free groups completed all treatment sessions. Table 1 and Figure 1 display median Löe Index values and percentiles (25th, 75th) for the groups with regard to periodontal status. Because the data did not present a normal distribution, median values were presented instead of means, and interquartile distribution was presented (25% and 75%) instead of standard deviation. Significant differences between groups were detected at T_3 and T_4 ($P \leq .05$). Table 2 displays intragroup findings, revealing significant differences among different evaluation times ($P \leq .05$).

DISCUSSION

Patients treated with conventional braces exhibited greater periodontal alterations than those treated with nickel-free braces. Scores between the two groups did not differ at T_0, T_1, and T_2, which suggests that both groups had the same periodontal status at baseline and over the first 9 months of treatment. Differences occurred only on the T_3 and T_4 evaluations (9 and 12 months after beginning treatment, respectively), suggesting a cumulative effect of nickel throughout orthodontic treatment. This finding is in agreement with previous studies.[2,3,14,15] However, other authors[16,17] have reported different results, which may be explained by the limited follow-up period (1 to 5 months), as well as the considerable variety in diagnostic method, study design, sample size, and research approach.

The prevalence of nickel allergy in the present study was 57.5%, and most allergic individuals were female (2:1 ratio). This is consistent with findings described by other authors.[17,18] Greater sensitivity to nickel on the part of women is related to environmental exposure, such as contact with detergents, jewelry, and other metallic objects, whereas such sensitivity in men is related to professional exposure, especially among those who handle nickel.

Table 1. Gingival Index at Five Evaluation Times (T_0, T_1, T_2, T_3, T_4) (Chi-Square Test)

Time	Group	Median	25th, 75th Interquartiles	*P* Value
T_0	Conventional	0	0.00, 1.00	.286
	Nickel-free	0	0.00, 1.00	
T_1	Conventional	0	0.00, 1.00	.457
	Nickel-free	0	0.00, 1.00	
T_2	Conventional	0.5	0.00, 1.00	.368
	Nickel-free	0	0.00, 1.00	
T_3	Conventional	1	0.00, 1.00	**.026**
	Nickel-free	0.23	0.00, 0.50	
T_4	Conventional	1	0.00, 1.00	**.031**
	Nickel-free	0	0.00, 1.00	

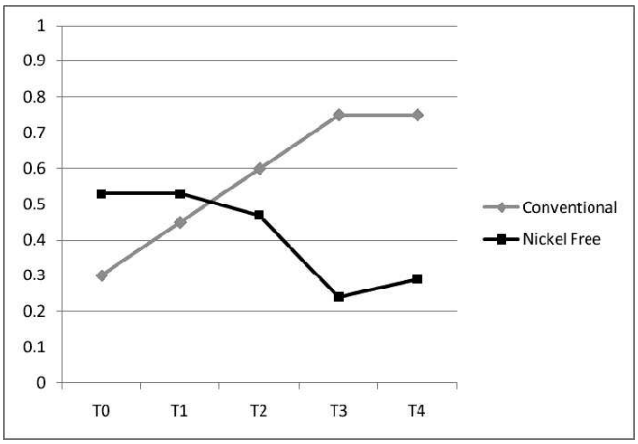

Figure 1. Mean gingival index scores at five evaluation times (T_0, T_1, T_2, T_3, T_4).

Nickel is widely used in the manufacture of orthodontic appliances.[19] However, few studies have addressed the influence of this metal on periodontal health, especially in a longitudinal fashion. Despite the fact that gingival inflammation is considered an allergic reaction to metals in orthodontic appliances,[20] the onset of periodontal disease depends mainly on the accumulation of biofilm. Placement of orthodontic braces influences the accumulation of biofilm and the colonization of bacteria, thereby leading to a greater proneness to inflammation and bleeding.[21] This indicates that inflammatory conditions of the disease may be transitory, stemming from variations in the degree of oral hygiene. In the present study, biofilm may have contributed to camouflaging the periodontal status of individuals. However, this is not believed to have been a source of bias, because all individuals received the same instructions with regard to oral hygiene before and throughout orthodontic treatment.

Nickel is more than a direct sensitizing agent of skin and mucosa; it appears to alter periodontal status, acting as a modifying factor of periodontal disease in sensitive patients. The increase in the Löe Index over time (T_3 and T_4) in the conventional group and the decrease in the nickel-free group suggest nickel adhesion to endogenous macromolecules, stimulating the proliferation of monocytes, macrophages, and cytotoxic cells, which may affect the periodontal inflammatory response.[22,23]

Table 2. Comparison of Mean Gingival Index Scores Over Time in Conventional and Nickel-Free Groups (Friedman's Test)

	Conventional (n = 20)	Nickel-Free (n = 17)
T_0	0.30^a	0.53^a
T_1	0.45^a	0.53^a
T_2	$0.60^{a,b}$	0.47^a
T_3	0.75^b	0.23^a
T_4	0.75^b	0.29^a

[a,b] Different superscript letters indicate significant differences between lines within the same column.

Furthermore, nickel induces T lymphocytes to produce cytokines, including interferon (IF)-γ, as well as interleukins (IL)-2, -5, and -10, thereby stimulating tissue proliferation, which may favor gingival hyperplasia.[24] Therefore, it would be plausible to presuppose that the continuous release of small amounts of nickel to the epithelium could be an initiating factor of gingival overgrowth induced by orthodontic therapy.[25]

The type and duration of oral exposure to nickel alloys capable of initiating an adverse reaction remain controversial issues. Metal ions in the saliva can be swallowed before they cause a reaction or may be absorbed in the mouth, and the amount of nickel released from dental alloys is significantly lower than that consumed as part of food ingestion.[26,27] In the present study, periodontal abnormalities differed between groups only after 9 months, demonstrating that the reaction is dependent on exposure time.[2,3] Release of nickel from orthodontic appliances has been demonstrated in a number of in vitro studies.[28] The release of 40 mg of nickel per day occurs with appliances spanning the entire mouth. However, daily consumption of nickel in the diet ranges from 300 mg to 600 mg, which suggests a predominantly local rather than systemic effect of nickel. In some patients with a positive patch test to nickel sulfate, perpetuation of recurrent aphthous stomatitis may be related to hypersensitivity to ingested nickel salts, independently of local contact with nickel.[29]

Nickel-free braces have been evaluated with regard to chemical composition and behavioral characteristics.[30,31] Nickel-free stainless steel braces produced by Morelli (Monobloc) do not have a significant amount of nickel in their composition and may be a viable alternative for allergic patients, in agreement with previous studies.[4,9] However, this composition decreases their mechanical properties, because nickel considerably enhances resistance to oxidation and corrosion.[32] Thus, the presented results are relative specifically to the Morelli brackets.

Although the present study carried out a longitudinal evaluation of periodontal status in individuals allergic to nickel, the immunologic aspects involved were not considered. Thus, additional studies are needed, to address humoral aspects and favor a better understanding of the mechanisms involved.

CONCLUSIONS

Based on findings of the present study:

- Individuals with an allergy to nickel exhibit better periodontal health when treated with nickel-free braces than with conventional braces.

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