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Original Research

EFFECT OF FIXED ORTHODONTIC TREATMENT ON SALIVARY NICKEL LEVELS

Dr. Rahul Mittal

Assistant Professor, Department of Orthodontics, Dasmesh institute of research and dental sciences, Faridkot, Punjab

Abstract

Background: Orthodontic devices exhibit a high degree of biocompatibility; however, there are reports of side effects linked to the release of nickel ions. Hence; the present study was conducted for assessing the effect of fixed orthodontic treatment on salivary Nickel levels. **Materials & methods:** Twenty patients receiving fixed orthodontic treatment were enrolled in the study. The orthodontic wires utilized in a sequential fashion were composed of nickel-titanium. Sample collection involved rinsing the mouth with 15 mL of distilled and deionized water for 30 seconds. Approximately 5 mL of saliva was obtained from each participant by expectoration into a beaker, which was then transferred to a designated polypropylene container. An auto-analyzer was employed to measure the ion concentration in the saliva samples, with nickel ion concentrations recorded in parts per billion (ppb). Statistical analysis was subsequently conducted. **Results:** A total of 20 patients were enrolled. Mean age of the patients was 18.6 years. Majority proportion of patients were males. Mean salivary nickel levels at pre-treatment, post-alignment and 6 months post-treatment was 42.3 ppb, 60.9 ppb and 49.8 ppb respectively. Significant results were obtained while comparing the mean salivary nickel levels at different time intervals. **Conclusion:** The concentration of nickel ions in saliva, despite being below the recommended daily allowance, warrants attention due to emerging insights into their molecular effects and potential for inducing allergic reactions.

Key words: Nickel, Orthodontic, Fixed

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Corresponding author: Dr. Rahul Mittal, Assistant Professor, Department of Orthodontics, Dasmesh institute of research and dental sciences, Faridkot, Punjab

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INTRODUCTION

Orthodontic devices exhibit a high degree of biocompatibility; however, there are reports of side effects linked to the release of nickel ions. Fixed orthodontic devices, such as brackets and archwires, are typically constructed from stainless steel and nickel-titanium (NiTi) alloys, which can lead to corrosion in the oral environment. The nickel content, a primary component of modern orthodontic devices, can range from 8% in stainless steel to over 50% in NiTi alloys.[1, 2] Stainless steel alloys generally contain between 17% and 22% chromium. The implementation of fixed orthodontic treatment significantly alters the composition of saliva.[3, 4]

Saliva acts as an electrolyte for electron and ion conduction, and the fluctuation of pH and temperature, the enzymatic and microbial activity, and the various chemicals introduced into the oral cavity through food and drink are all corrosion conductors. The inherent heterogeneity of each metal alloy and its use with other alloys, the microsurface discontinuity, the forces acting on the appliances and the friction between wires and brackets also add to the corrosion process. Nickel-titanium (NiTi) archwires contain 47-50% nickel and are the richest source of nickel in the intraoral environment of the average orthodontic patient. Recent evidence has attributed carcinogenic, mutagenic, cytotoxic, and allergenic actions to nickel in various forms and compounds.[5- 7] Hence; the present study was conducted for assessing the effect of fixed orthodontic treatment on salivary Nickel levels.

MATERIALS & METHODS

The present study was conducted for assessing the effect of fixed orthodontic treatment on salivary

Nickel levels. Twenty patients receiving fixed orthodontic treatment were enrolled in the study. The orthodontic wires utilized in a sequential fashion were composed of nickel-titanium. Selection criteria for the patients included the absence of piercings or metal restorations, overall good health, no history of prolonged medication use, no systemic diseases, and the lack of intraoral or extraoral auxiliary appliances that were soldered or welded to bands. Sampling occurred prior to the initiation of fixed mechanotherapy, following the completion of alignment and leveling with nickel-titanium wires, and six months into the treatment. Sample collection involved rinsing the mouth with 15 mL of distilled and deionized water for 30 seconds. Approximately 5 mL of saliva was obtained from each participant by expectoration into a beaker, which was then transferred to a designated polypropylene container. An auto-analyzer was employed to measure the ion concentration in the saliva samples, with nickel ion concentrations recorded in parts per billion (ppb). Statistical analysis was subsequently conducted.

RESULTS

A total of 20 patients were enrolled. Mean age of the patients was 18.6 years. Majority proportion of patients were males. Mean salivary nickel levels at pre-treatment, post-alignment and 6 months post-treatment was 42.3 ppb, 60.9 ppb and 49.8 ppb respectively. Significant results were obtained while comparing the mean salivary nickel levels at different time intervals.

Table 1: Comparison of salivary nickel levels

Time interval	Mean	SD	p-value
Pre-treatment	42.3	5.3	0.001 (Significant)
Post-alignment	60.9	6.8	
6 months post-treatment	49.8	6.1	

DISCUSSION

Biocompatibility of orthodontic appliances has been the subject of several studies, mainly due to the concern related to the possible discharge of potentially toxic and carcinogen ions during orthodontic treatment. Assessment of trace elements in human might exhibit the risk associated with orthodontic appliances, which are made of alloys containing several metals, among which of the major concern are chromium and nickel. Both of these genotoxic, mutagenic, and cytotoxic metals might induce contact allergy, asthma, hypersensitivity, birth defects, and reproductive harms. Corrosion of orthodontic alloys might lead to release of sizeable amounts of nickel and chromium ions into saliva. Chromium is added to these alloys to form an anticorrosive passive chromium oxide film.[7-9]

A total of 20 patients were enrolled. Mean age of the patients was 18.6 years. Majority proportion of patients were males. Mean salivary nickel levels at pre-treatment, post-alignment and 6 months post-treatment was 42.3 ppb, 60.9 ppb and 49.8 ppb respectively. Significant results were obtained while comparing the mean salivary nickel levels at different time intervals. Amini F et al measure salivary levels of these ions during 1 year of orthodontic treatment. Saliva samples were collected from 20 orthodontic patients, before treatment (control) and 6 and 12 months later. Nickel and chromium concentrations were determined using atomic absorption spectrophotometry. Data were analyzed using one- and two-way repeated-measures ANOVA, Bonferroni, Friedman ($\alpha = 0.05$), and Wilcoxon signed-ranks tests ($\alpha = 0.016$). Average nickel level changed from 9.75 ± 5.02 to 10.37 ± 6.94 and then to 8.32 ± 4.36 μg/L in 1 year. Average chromium concentration changed from 3.86 ± 1.34 to 4.6 ± 6.11 and then to 2.04 ± 1.66 μg/L. Alterations in nickel values were not statistically significant [$P = 0.468$ (ANOVA)], but fluctuations in chromium levels were [$P = 0.021$ (Friedman)]. The decrease in chromium concentration after 12 months was significant compared to the control [$P = 0.004$ (Wilcoxon)]. Although slightly increased after 6 months, the concentration of both ions dropped to levels slightly lower than the control groups after 12 months.[10] Kocadereli L et al determined the alterations in the chromium and nickel concentrations in the saliva of orthodontic patients treated with fixed orthodontic appliances. Forty-five orthodontic patients were included in this study. The first group consisted of 15 patients (7 female, 8 male) with fixed appliances placed in their upper and lower arches. The second group consisted of 15 patients (8 female, 7 male) with a fixed appliance placed only in the upper arch. The control group consisted of 15 patients (7 female, 8 male) who were not undergoing orthodontic treatment. Four samples of stimulated saliva were collected from each patient before insertion of the fixed appliance, 1 week after insertion of the appliance, 1 month after insertion of the appliance, and 2 months after insertion of the appliance. The same 4 samples of saliva were collected from each control patient at the same time intervals as for the fixed-appliance groups. The chemical analyses were done with an electrothermal atomic absorption spectrophotometer. The Wilcoxon matched-pairs signed ranks test was used to test differences between samples before and after insertion of orthodontic appliances. A Kruskal Wallis 1-way analysis of variance was used to test differences in nickel and chromium concentration among the 3 test groups. It was observed that there was a large variation in the concentrations of both nickel and chromium in saliva. No significant differences were found between the no-appliance group and the samples obtained after insertion of the appliances. The results of the study suggest that fixed orthodontic appliances do not significantly affect nickel and chromium

concentrations of saliva during the first 2 months of treatment.[11]

CONCLUSION

The concentration of nickel ions in saliva, despite being below the recommended daily allowance, warrants attention due to emerging insights into their molecular effects and potential for inducing allergic reactions.

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