

Evaluation of Salivary Nickel Levels in Individuals Receiving Fixed Orthodontic Treatment: An observational study

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Abstract

Background: This study aimed to evaluate the concentration of nickel in the oral cavity of individuals undergoing fixed orthodontic treatment.

Materials & methods: The study enrolled two hundred participants below the age of 35, all slated for extended orthodontic treatment. To assess nickel levels pre and post the insertion of the permanent orthodontic device, we obtained two samples of stimulated saliva from each participant. Data analysis was performed using SPSS. Nickel concentrations in the saliva samples were quantified using an autoanalyzer and reported in micrograms per liter ($\mu\text{g/L}$).

Results: The study cohort had an average age of 22.5 years. Initially, participants exhibited an average saliva nickel level of 6.2 micrograms per liter. Following 15 days of orthodontic treatment, a modest elevation was observed, with nickel concentrations reaching 14.7 micrograms per liter. These fluctuations over time were found to be statistically significant.

Conclusion: The utilization of fixed orthodontic appliances has been associated with elevated levels of nickel and chromium in saliva.

Keywords: Orthodontic, Nickel, Saliva

Introduction

Over the past two decades, orthodontic professionals have shown increased interest in exploring the potential side effects associated with the use of biomaterials, particularly metallic ones like gold, stainless steel, cobalt-chromium, nickel-titanium, and beta-titanium.¹ The introduction of nickel-titanium alloys as orthodontic wires in the 1970s, containing 48% to 51% nickel, marked a significant development in orthodontic materials. Notably, these alloys represent the highest nickel content among all orthodontic materials.^{2,3} Concerns arise from the release of nickel and chromium ions from fixed orthodontic appliances, which can act as allergens and may pose serious biological risks.⁴ Even in small quantities within the nanogram range, these ions are known to be cytotoxic, mutagenic, and potentially carcinogenic. Given these considerations, evaluating trace element levels in patients using orthodontic appliances becomes a priority.⁵ Both nickel and chromium ions have been linked to hypersensitivity reactions in some individuals, with additional potential to cause dermatitis and asthma.^{6,7}

Recognizing these health implications, our study aimed to assess the levels of nickel in the saliva of subjects undergoing fixed orthodontic treatment.

Materials & methods

The study enrolled two hundred participants below the age of 35, all slated for extended orthodontic treatment. To assess nickel levels pre and post the insertion of the permanent orthodontic device, we obtained two samples of stimulated saliva from each participant. Nickel concentrations in the saliva samples were quantified using an autoanalyzer and reported in micrograms per liter ($\mu\text{g/L}$).

Results

The study cohort had an average age of 22.5 years. Initially, participants exhibited an average saliva nickel level of 6.2 micrograms per liter. Following 15 days of orthodontic treatment, a modest elevation was observed, with nickel concentrations reaching 14.7 micrograms per liter. These fluctuations over time were found to be statistically significant.

Table 1: Salivary nickel and chromium (micro gram/ L) at different time intervals.

Metal	Baseline (before treatment)	After 15 days of orthodontic treatment	P – value
Mean Nickel	6.2	14.7	0.005 (Significant)

Discussion

A diverse array of orthodontic appliances and auxiliaries incorporate alloys containing nickel and chromium, making them integral components in nearly all standard orthodontic procedures. The potential health implications of prolonged exposure to these compounds have been under scrutiny for over a century, with a particular focus on the concern of sensitizing patients to these metal elements.^{8,9} In the oral environment of a typical orthodontic patient, nickel-titanium (NiTi) archwires stand out as the primary source of nickel, containing 48–51% nickel. Recent studies have associated nickel, in various compounds and forms, with carcinogenic, mutagenic, cytotoxic, and allergic effects.¹⁰ Several factors, including the time of day, diet, overall health, mental state, as well as the adhesion of nickel to epithelial cells, bacteria, and macromolecules in saliva, along with the sampling method, may collectively contribute to the wide range of reported nickel concentrations in studies.¹¹ Therefore, the primary objective of this study was to evaluate the levels of nickel and chromium in the saliva of individuals undergoing fixed orthodontic treatment. The study cohort had an average age of 22.5 years. Initially, participants exhibited an average saliva nickel level of 6.2 micrograms per liter. Following 15 days of orthodontic treatment, there was a modest elevation, with nickel concentrations reaching 14.7 micrograms per liter. Notably, significant variations in nickel concentrations were observed over the course of the study period. Natarajan conducted an in vivo study to assess the genotoxic effects of fixed orthodontic appliances on oral mucosal cells and their correlation with nickel and chromium concentrations. The findings revealed that the alloys of nickel and chromium in orthodontic appliances release metal ions in quantities significant enough to cause localized genotoxic effects. However, these changes were observed to revert upon the removal of the appliances.¹² Hafez conducted a longitudinal in vivo study investigating cytotoxicity, genotoxicity, and metal release in individuals with fixed orthodontic appliances. The study findings indicated that the presence of fixed orthodontic appliances led to a decline in cellular viability, induced DNA damage, and elevated nickel and chromium levels in buccal mucosa cells. Notably, these alterations were not discernible at the 6-month mark when compared to the control group. This lack of observable changes

suggests a potential development of cellular tolerance or repair mechanisms for both the cells and DNA over time.¹³

Conclusion

The utilization of fixed orthodontic appliances has been associated with elevated levels of nickel and chromium in saliva.

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