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Original Research

Analysis of nickel and chromium levels in the saliva of patients undergoing fixed orthodontic treatment: An observational study

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ABSTRACT:
Background: To assess the nickel and chromium levels in the saliva undergoing fixed orthodontic treatment. **Materials & methods:** A total of 100 patients who were under 30 years old and were slated to have fixed orthodontic treatment were enrolled. In order to establish a baseline for salivary nickel and chromium levels, each orthodontic patient had two samples of stimulated saliva taken: before the fixed device was put in place and 10 days later. The results were assessed using SPSS software. These samples' nickel and chromium concentrations were measured with an autoanalyzer and their results were given in micro g/L. **Results:** Mean age of the patients was 20.1 years. Amount of salivary nickel and chromium at the baseline was 5.9 micro gram/ L and 4.5 micro gram/ L respectively. There was slight increase in both the measurements after 12 days of orthodontic treatment and the levels of nickel were 8.2 micro gram/ L and chromium was 5.2 micro gram/ L. Significant results were obtained while comparing the nickel and chromium levels at different time intervals. **Conclusion:** When compared to baseline values, salivary nickel and chromium concentrations considerably increased after the placement of fixed orthodontic appliances.
Keywords: Orthodontic, Treatment, Saliva

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INTRODUCTION

Orthodontic appliances are highly biocompatible, although some side effects associated with the release of nickel ions have been documented.[1]Fixed orthodontic appliances including brackets and arches are commonly made of stainless steel and nickel–titanium (NiTi) alloys and, therefore, have corrosion potential in the oral environment.[2] The amount of nickel as the main constituent of contemporary orthodontic appliances[3]may vary from 8% in stainless steel[4,5]to more than 50% in NiTi alloys. Stainless-steel alloys include 17% to 22% of chromium.[6] Fixed orthodontic treatment causes major changes in the composition of the saliva.[7] Nickel and chromium ions released from fixed orthodontic appliances can serve as allergens or may have serious biological side effects. Moreover, they are cytotoxic, mutagenic, and carcinogenic in small quantities in the range of nanograms. Evaluation of the level of trace elements in patients using orthodontic appliances is a priority.[8] Both nickel and chromium ions can cause hypersensitivity reactions in some people.[9] In addition, nickel and chromium can cause dermatitis and asthma.[10] Increased prevalence of nickel hypersensitivity as well as the increased demand and availability of orthodontic treatment have attracted the attention of researchers towards the composition of alloys and their ion release potential during orthodontic treatment. Orthodontic appliances (brackets and wires) exposed to the oral environment are affected by thermal alterations in the oral cavity and pH, constant presence of saliva, exposure to foods and drinks, mechanical loads applied to them, and abrasion. They are subjected to aging as such and may undergo dissolution or oxidation.[11,12] The placement of archwires can cause an increase in salivary nickel and chromium levels and, therefore, nickel may be released from the wiresas well as bands and brackets.[13] Daily oral intake of nickel from food is estimated to be 200–300 to 600 μg/day.[14] The average dietary intake of chromium is estimated to be 50–200 μg/day.[15] In vitro nickel release from orthodontic appliances was

reported to be 22–40 μg/day, which was lower than the estimated dietary intake. The inherent heterogeneity of metal alloys and their use in combination with other alloys, microconversion, the forces acting on the appliances, and the friction between wires and brackets may further add to the corrosion process.[16] Therefore, in orthodontic practice, it is essential to know the exact amount of each ion released during the course of treatment, and inform the patient undergoing orthodontic treatment in this respect.

Hence, this study was conducted to assess the nickel and chromium levels in the saliva undergoing fixed orthodontic treatment.

MATERIALS & METHODS

A total of 100 patients who were under 30 years old and were slated to have fixed orthodontic treatment were enrolled. In order to establish a baseline for salivary nickel and chromium levels, each orthodontic patient had two samples of stimulated saliva taken: before the fixed device was put in place and 10 days later. The results were assessed using SPSS software. These samples' nickel and chromium concentrations were measured with an autoanalyzer and their results were given in micro g/L.

RESULTS

Mean age of the patients was 20.1 years. Amount of salivary nickel and chromium at the baseline was 5.9micro gram/ L and 4.5 micro gram/ L respectively. There was slight increase in both the measurements after 12 days of orthodontic treatment and the levels of nickel were 8.2micro gram/ L and chromium was5.2 micro gram/ L. Significant results were obtained while comparing the nickel and chromium levels at different time intervals.

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

Metal	Baseline (before treatment)	After 12 days of orthodontic treatment	P – value
Mean Nickel	5.9	8.2	0.000 (Significant)
Mean Chromium	4.5	5.2	0.001 (Significant)

DISCUSSION

It has been shown that nickel and chromium ions can cause hypersensitivity reactions, dermatitis, and asthma; thus, nickel and chromium ions released from stainless-steel orthodontic bands, brackets, and wires are likely to cause allergic reactions.[17] The composition of saliva may be affected by many physiological variables such as time of the day, health conditions, diet[18], and salivary flow rate.[19] The emotional state also affects the salivary flow rate; for example, anxiety and depression can cause dry mouth.[20] The large variations in nickel levels reported in studies might be explained by the differences in saliva composition and pH, which are influenced by various physiological and environmental factors such as time of the day, diet, health, and mental conditions as well as nickel adhesion to epithelial cells, bacteria, macromolecules of the saliva[21,22,23], and the method of sampling (stimulated versus unstimulated saliva collection).[24,25]Hence, this study was conducted to assess the nickel and chromium levels in the saliva undergoing fixed orthodontic treatment.

In this study, mean age of the patients was 20.1 years. Amount of salivary nickel and chromium at the baseline was 5.9 micro gram/ L and 4.5 micro gram/ L respectively. There was slight increase in both the measurements after 12 days of orthodontic treatment and the levels of nickel were 8.2 micro gram/ L and chromium was 5.2 micro gram/ L. Significant results were obtained while comparing the nickel and chromium levels at different time intervals.

In a study by Yassaei S[26], 32 patients who presented to the orthodontic clinic were selected. The salivary samples were taken from the patients in four stages: before appliance placement and 20 days, 3 months, and 6 months following appliance placement. The salivary samples were collected in a plastic tube and were stored in the freezer before analysis. The samples were then transferred to the laboratory, and the amounts of metals were determined by graphite furnace atomic absorption spectrometry with an autosampler. Each sample was analyzed three times, and the average was reported.It was found that the average amount of nickel in the saliva 20 days after appliance placement was 0.8 μg/L more than before placement. Also, the amount of salivary nickel 20 days after the appliance placement was more than at the other stages, but the differences were not significant. The average amount of chromium in the saliva was found to be between 2.6 and 3.6 μg/L. The amount of chromium at all stages after appliance placement was more than before, but the differences between the chromium levels of saliva at all stages were not significant.

Imani, M. M., et al[27]reviewed the effect of fixed orthodontic treatment on salivary levels of these ions by doing a meta-analysis on cross-sectional and cohort studies. The Web of Science, Scopus, Cochrane Library, and PubMed databases were searched for articles on salivary profile of nickel or chromium in patients under fixed orthodontic treatment published from January 1983 to October 2017. A random-effect meta-analysis was done using Review Manager 5.3 to calculate mean difference (MD) and 95% confidence interval (CI), and the quality of questionnaire was evaluated by the Newcastle–Ottawa scale. Fourteen studies were included and analyzed in this meta-analysis. Salivary nickel level was higher in periods of 10 min or less and one day after initiation of treatment compared to baseline (before the insertion of

appliance). Salivary chromium level was higher in periods of one day and one week after the initiation of treatment compared to baseline.

CONCLUSION

When compared to baseline values, salivary nickel and chromium concentrations considerably increased after the placement of fixed orthodontic appliances.

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