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Evaluation of nickel and chromium levels in the saliva of patients undergoing fixed orthodontic treatment: A comparative 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 subjects were enrolled who were scheduled to undergo fixed orthodontic treatment. Two samples of stimulated saliva were collected from each orthodontic patient: before insertion of the fixed appliance (which served as a baseline level for salivary nickel and chromium content) and 10 days after insertion of the appliance. These samples were analyzed for nickel and chromium content using autoanalyzer and their values recorded in micro g/L. **Results:** A total of 100 subjects were enrolled. Amount of salivary nickel and chromium at the baseline was 5.8 and 3.1 respectively. There was slight increase in both the measurements after 10 days of orthodontic treatment and the levels of nickel were 6.9 and chromium were 4.1 micro gram/ L.

Conclusion: The salivary nickel and chromium concentrations significantly increased after insertion of fixed orthodontic appliances as compared to baseline levels.

Keywords: orthodontic treatment, saliva, nickel levels.

Introduction

Release of metallic ions, especially nickel and chromium, present in orthodontic fixed appliance attachments like brackets and archwires has been a reason of concern in recent years. Although metals used in the mouth have decent biocompatibility and corrosion resistance, they occasionally lose their stable surface oxide layer, leading to leaching of metallic ions when exposed to the intraoral environment causing allergies, hypersensitivity, and alterations in cellular morphology and characteristics.[1- 3] Fluorides prescribed for use during orthodontic treatment have a harmful effect of promoting leaching of ions by creating

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an acidic environment. Studies comparing in vitro and in vivo orthodontic appliance metal ion leaching have shown variable results. Substantial increase in metallic ions released in vitro has been observed. Fixed orthodontic appliances including brackets and arches are generally made of stainless steel and nickel–titanium (NiTi) alloys and therefore, have corrosion potential in the oral environment.[4- 6] The amount of nickel as the main component of contemporary orthodontic appliances may vary from 8% in stainless steel to more than 50% in NiTi alloys. Stainless steel alloys include 17%–22% of chromium.[7- 9] 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 subjects were enrolled who were scheduled to undergo fixed orthodontic treatment. Two samples of stimulated saliva were collected from each orthodontic patient: before insertion of the fixed appliance (which served as a baseline level for salivary nickel and chromium content) and 10 days after insertion of the appliance. Result was analyzed using SPSS software. These samples were analyzed for nickel and chromium content using autoanalyzer and their values recorded in micro g/L. Data was collected. Result was analyzed using SPSS software.

Results

A total of 100 subjects were enrolled. Amount of salivary nickel and chromium at the baseline was 5.8 and 3.1 respectively. There was slight increase in both the measurements after 10 days of orthodontic treatment and the levels of nickel were 6.9 and chromium were 4.1 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 10 days of orthodontic treatment	P - value
Mean Nickel	5.2	6.60	0.00 (Significant)
Mean Chromium	2.7	3.8	0.04 (Significant)

Discussion

Nickel (Ni) and chromium (Cr) containing alloys are present in great numbers in a wide variety of appliances, auxiliaries, and utilities used in orthodontics and thus become an integral part of almost every routine orthodontic intervention. The use of various combinations of metal alloys for prolonged durations in orthodontic patients warrants special consideration regarding their biocompatibility. The oral cavity is a complete corrosion cell, with many factors that enhance the biodegradation of orthodontic appliances. 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

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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.[11] Hence; the present study was conducted to assess the nickel and chromium levels in the saliva undergoing fixed orthodontic treatment.

A total of 100 subjects were enrolled. Amount of salivary nickel and chromium at the baseline was 5.8 and 3.1 respectively. There was slight increase in both the measurements after 10 days of orthodontic treatment and the levels of nickel were 6.9 and chromium were 4.1 micro gram/ L. Significant results were obtained while comparing the nickel and chromium levels at different time intervals. Imani MM et al 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 (MD = -11.5 μg/L, 95% CI = -16.92 to -6.07; P < 0.0001) and one day (MD = -1.38 μg/L, 95% CI = -1.97 to -0.80; P < 0.00001) after initiation of treatment compared to baseline (before the insertion of appliance). Salivary chromium level was higher in periods of one day (MD = -6.25 μg/L, 95% CI = -12.00 to -0.49; P = 0.03) and one week (MD = -2.07 μg/L, 95% CI = -3.88 to -0.26; P = 0.03) after the initiation of treatment compared to baseline. Corrosion of fixed orthodontic appliances leads to elevated salivary nickel and chromium concentrations early after initiation of orthodontic treatment.[10]

Pritam A et al assessed nickel and chromium level in gingival crevicular fluid in patients undergoing orthodontic treatment. Forty patients undergoing fixed orthodontic treatment were divided into 2 groups of 20 each. Group I was fixed orthodontic treatment group and was given nonfluoridated toothpaste and Group II was fixed orthodontic treatment group and was given fluoridated toothpaste. The assessment of salivary nickel and chromium levels was done using inductively coupled plasma mass spectrometry. In group I, there were 6 male and 14 female and in group II 7 males and 13 females. The mean nickel level (ng/ml) before treatment in group I was 0.49 and in group II was 0.52, on 7th day was 0.52 and 0.54, on 30th day was 13.4 and 100.2, and on 6th month was 0.54 and 0.52 in Group I and II, respectively. The mean chromium level (ng/ml) before treatment in Group I was 0.48 and in Group II was 0.52, on 7th day was 0.52 and 0.53, on 30th day was 40.6 and 62.4 and on 6th month was 4.9 and 0.52 in Group I and II, respectively. The difference was significant (P < 0.05). The release of metal ions such as nickel and chromium was more with fluoridated toothpaste as compared to nonfluoridated toothpaste in patients undergoing fixed orthodontics.[11]

Conclusion

The salivary nickel and chromium concentrations significantly increased after insertion of fixed orthodontic appliances as compared to baseline levels.

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