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Original Research

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

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ABSTRACT:
Background; Dental materials used for permanent restorations are intended to replace lost and defective dental tissues, be chemically stable and inert in the oral environment. **Aims and Objectives:** To compare and evaluate the physical properties of Zirconia reinforced Glassionomer with two conventional restoratives. To analyze the mechanical properties of the cements being tested. **Materials & methods;** For the compressive strength 120 cylinders of 8 mm height and diameter 4 mm were prepared using split teflon moulds for each group. Group 1 (Zirconomer), Group 11 (Hidence) Group iii (Posterior Extra) which were subjected to 1 day (24 h) and 7 day interval storage and CS values were obtained. For the Shearbond strength testing 60 specimens was bounded to flat dentinal surface by positioning polyvinyl moulds. Then mounted samples were stored in distilled water for 24 h and then subjected to Shearbond strength test using Universal testing machine. **Results;** Results shows that all the three group's shows that high Compressive strength but there was significant decrease in the mean CS in Hidence and Posterior extra groups at 7 day interval. Zirconomer reinforced GIC group showed highest Shearbond strength followed by Posterior extra group and least was seen in Hidence group and there was significant difference between Group 1 and Group 2. **Conclusion;** It can be concluded that Zirconomer reinforced Glassionomer at 7 days had no significant difference in the CS and at 24 hrs and good bond strength and sealing ability compared to other restoratives.
Key words; Compressive strength, Shear bond strength, Zirconomer.

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INTRODUCTION

In orthodontics, the various components of fixed appliances are fabricated by the use of varying materials which have their own physical and mechanical properties. [1,2] Stainless steel is most commonly used for the construction of these components such as wires, brackets, bands, buccal tubes, and other auxiliaries due to its low cost, high strength, resistance to corrosion, and biocompatibility. [2] According to the clinical needs, besides stainless steel wires, other wires such as Ni-Ti, beta titanium, cobalt chromium, and teflon polyethylene coated wires are also used.

Nickel-titanium alloys are commonly used in orthodontics, in manufacturing various components of fixed orthodontic appliances. [3] Metal ions such as nickel, chromium, and zinc can be released from the orthodontic appliances as part of the dissolution and the biomechanical process of alloys. [4] Nickel is a common allergen and powerful sensitizer. With amounts as low as 2.5 ng/mL, nickel has been found to impair the chemotaxis of leukocytes and stimulate neutrophils to become aspherical and move slowly. [5] Ion release can also cause discoloration of the adjacent soft tissues, allergic reactions, or pain. [6] The patients undergoing orthodontic treatment are exposed to metal alloys in the mouth that can corrode over a period during orthodontic treatment, resulting in the release of ions into oral mucosa and biologic fluids. [7] Corroded orthodontic appliances have shown to cause biologic health hazards including contact dermatitis, hypersensitivity, and cytotoxicity in the past studies. [8,9] In higher doses, both Ni and Cr have been found to be harmful. Nickel has been systematically studied for detrimental effects at cell, tissue, organ, and organism levels. In higher doses, Ni can be an allergen or carcinogenic and act mutating substance by causing alteration in DNA. Higher doses of chromium are also capable of inducing side effects which may include insomnia or irregular sleeping, headaches, vomiting, diarrhea, and irritability. [10,11] Hence, this study was conducted to evaluate the nickel concentrations in the saliva of patients undergoing fixed orthodontic treatment.

Materials & Methods:

A group of 50 individuals under the age of thirty, all scheduled for permanent orthodontic treatment, were part of this study. To assess the initial nickel levels in the patients' saliva, we collected two samples of stimulated saliva before and after the placement of the fixed orthodontic device. The data obtained was then analyzed using SPSS, and we determined the nickel concentration in these samples, measured in micrograms per liter (µg/L), using an autoanalyzer.

Results:

The patients had an average age of 21.5 years. Initially, the average concentration of nickel in the participants' saliva was 4.4 micrograms per liter. After 12 days of orthodontic treatment, the nickel levels showed a slight increase to 11.6 micrograms per liter. A comparison of nickel levels over time revealed significant differences.

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

Metal	Baseline (before treatment)	After 12 days of orthodontic treatment	P – value
Mean Nickel	4.4	11.6	0.001 (Significant)

Discussion:

The release of metal ions can cause DNA damage in human cells due to oxidative DNA damage (direct interaction) or interference with DNA replication (indirect interaction). [12] The mutative action of nickel may derive from its action on inhibiting several enzymes known to restore DNA breaks, promoting mutations, thereby contributing to genetic instability. [13] It seems that multidisciplinary approach toward the problem of the assessment of exposure of the human organism to trace elements may reveal different aspects associated with the application of metals in dentistry. [14] Although some studies in the past have shown that the level of metals released from orthodontic appliances in saliva or serum was significantly below the average dietary intake and did not reach toxic concentrations, [12] those were short-term studies conducted over few weeks to months. Hence, this study was conducted to evaluate the nickel concentrations in the saliva of patients undergoing fixed orthodontic treatment.

In the present study, the patients had an average age of 21.5 years. Initially, the average concentration of nickel in the participants' saliva was 4.4 micrograms per liter. A study by Dwivedi A et al, determine and compare the level of nickel and chromium in the saliva of patients undergoing fixed orthodontic treatment at different time periods. The sample of saliva of 13 patients was taken at different time periods that is: Group 1 (before appliance placement), Group II, III, and IV (after 1-week, 1-month, and 3 months of appliance placement respectively). The fixed appliance comprised of brackets, bands, buccal tubes, lingual sheath, transpalatal arch and wires composed of Ni-Ti and stainless steel. Level of nickel and chromium in saliva was highest in Group II and lowest in Groups I for both the ions. On comparison among different Groups, it was statistically significant for all the groups (<0.001) except between Group III and Group IV. The release of nickel and chromium was maximum at 1-week and then the level gradually declined. These values were well below the toxic dose of these ions. The results should be viewed with caution in subjects with Ni hypersensitivity. [15]

In the present study, after 12 days of orthodontic treatment, the nickel levels showed a slight increase to 11.6 micrograms per liter. A comparison of nickel levels over time revealed significant differences. Another study by Quadras DD et al, fixed orthodontic appliances can release metal ions such as nickel, chromium, and zinc into saliva and blood, which can cause contact dermatitis, hypersensitivity, and cytotoxicity. This study was undertaken to assess the release of nickel, chromium, and zinc in saliva and serum of patients undergoing fixed orthodontic treatment. This in vivo study was conducted on 80 participants with an age range of 15–40 years. Thirty were included as controls and 50 participants were treated with fixed orthodontic appliances. Saliva and blood samples were collected at five different periods, before insertion of fixed orthodontic appliance and at 1 week, 3 months, 1 year, and 1.5 years after insertion of appliance, respectively. The metal ion content in the samples were analyzed by atomic absorption spectrophotometry. Mean levels of nickel, chromium, and zinc in saliva and serum were compared between groups using independent sample t-test and before and after results using paired t-test. $P < 0.05$ was considered as statistically significant. At the end of 1.5 years, the mean salivary levels of nickel, chromium, and zinc in controls were 5.02 ppb, 1.27 ppb, and 10.24 ppb, respectively, as compared to 67 ppb, 30.8 ppb, and 164.7 ppb at the end of 1.5 years. This was statistically significant with $P < 0.001$. A significant increase in the metal ion levels were seen in participants with before and after insertion of appliance ($P < 0.001$). Orthodontic appliances do release considerable amounts of metal ions such as nickel, chromium, and zinc in saliva and serum. However, it was within permissible levels and did not reach toxic levels. [16] Yassaei S et al investigated the salivary concentration of nickel and chromium of patients undergoing orthodontic treatment.In this study 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.There was no significant difference in the average amount of salivary nickel and chromium of patients at various stages of orthodontic appliance placement. [17] Imani, M. M., 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 and one day after initiation of treatment compared to baseline (before the insertion of appliance). [18]

Conclusion:

The placement of fixed orthodontic appliances led to an increase in salivary nickel levels compared to the levels observed before the treatment commenced.

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