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ORIGINAL RESEARCH

Assessment of alterations in salivary Nickel and Chromium levels in patients undergoing fixed orthodontic treatment: A clinical study

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ABSTRACT:
Background: Austenitic stainless steel is usually used to make orthodontic bands, brackets, and wires. They contain around 8–12% nickel and 17–22% chromium. Stainless steel derives its features of ductility and corrosion resistance through these elements. Hence; the present study was undertaken for assessing the alterations in salivary nickel and chromium levels in patients undergoing fixed orthodontic treatment. **Material and methods:** This in-vivo study was conducted to detect salivary levels of Ni and Cr in 80 patients undergoing fixed orthodontic treatment. Slot buccal tubes were banded to molars, which was welded onto band material. The wires used in a sequential manner were nickel-titanium wires (0.014″, 0.016″), heat activated nickel-titanium wires (0.017″ × 0.025″, 0.019″ × 0.025″) and stainless steel wires (0.017″ × 0.025″, 0.019″ × 0.025″). The sample of saliva was collected 10 minutes after asking the patients to clean the mouth with distilled water. Approximately 5 ml of saliva was collected. The sample was refrigerated and sent to the laboratory for processing. **Results:** Mean nickel content in the first group was 2.014, with a standard deviation of 0.546. The mean and standard deviation in the other three groups was elaborated in table 3. Similarly, the mean Chromium content in the first group was 12.913 with a standard deviation of 2.594. The mean Chromium content in the second group was 67.514 with a standard deviation of 7.082. The mean and standard deviation in the other groups was elaborated in table 4. Statistically significant differences in the amount of Ni and Cr released into saliva were observed between the experimental and control groups with p values of .046 and .027 respectively. **Conclusion:** Fixed orthodontic appliances tend to significantly alter the salivary levels of Nickel and Chromium.
Key words: Saliva, Chromium, nickel, orthodontic appliances

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INTRODUCTION

Despite being highly biocompatible, orthodontic appliances release Nickel and Chromium ions which can cause unwanted side effects. Austenitic stainless steel is usually used to make orthodontic bands, brackets, and wires. Despite their advantages they are a source of metallic corrosion which may lead to hypersensitivity in patients. Nickel content may vary in orthodontic appliance from 8% to 50% in stainless steel and NiTi alloys respectively. The Chromium constitutes 17-22% of stainless steel. Gross variations in the composition of saliva can be observed with fixed orthodontic treatment due to release of Ni and Cr ions, predisposing to allergies.[1] The highest

leaching of Ni and Cr ions was seen in the initial few days to one month with a gradual decline thereafter. However their concentration in saliva never reached toxic levels.[2]

The patients receiving orthodontic treatment are vulnerable to metallic components in the oral cavity. These can show corrosion as time progresses eventually causing leaching of ions into the oral cavity. As a result of degradation and release of metal ions in the mouth, these orthodontic appliances may pose various health problems like contact dermatitis, hypersensitivity, and cytotoxicity[3]. Saliva plays the role of an electrolyte for this corrosion process. A lot of factors promote this corrosion process like friction between the orthodontic components, the forces acting on the appliance and their innate composition and heterogenicity.[4]

Both Ni and Cr can be dangerous in elevated doses. Nickel has been studied in detail for adverse effects from cellular to organism levels. Elevated doses of Ni can cause changes in the DNA by means of mutations. It can thus predispose to allergies and even cancer. Insomnia or irregular sleeping, headaches, vomiting, diarrhoea, and irritability can be caused by higher levels of Chromium[5]. The purpose of this study was to assess the variations in the chromium and nickel concentrations in the saliva of patients receiving fixed orthodontic treatment.

MATERIAL AND METHODS

The purpose of this study was to determine the alterations in the chromium and nickel concentrations in the saliva of orthodontic patients treated with fixed orthodontic appliances. This in-vivo study was conducted to detect salivary levels of Ni and Cr in 80 patients undergoing fixed orthodontic treatment. It was ascertained that these patients did not have any metallic restorations (amalgam fillings, crown and bridge). The patients were devoid of any systemic disease and were not on any prolonged medication course. The un-stimulated saliva of these 20 patients was collected at different periods during the treatment. The specified time of saliva collection was divided into four categories:

- Immediately before the start of treatment
- 10 days after the start of treatment
- One month after the start of treatment
- Two months after the start of treatment

The duration of treatment was 12-15 months. Slot buccal tubes were banded to molars, which was welded onto band material. The wires used in a sequential manner were nickel-titanium wires (0.014″, 0.016″), heat activated nickel-titanium wires (0.017″ × 0.025″, 0.019″ × 0.025″) and stainless steel wires (0.017″ × 0.025″, 0.019″ × 0.025″). The sample of saliva was collected 10 minutes after asking the patients to clean the mouth with distilled water. Approximately 5 ml of saliva was collected. The sample was refrigerated and sent to the laboratory for processing. SPSS software was used to analyse the collected data. The standard deviation and mean of the concentration of Ni and Cr was calculated. Analysis was done SPSS software. Student *t*-test was used to calculate the difference in mean levels.

RESULTS

The present study was conducted on eighty patients. Out of the 80 patients 53 were males. The percentage of male patients was 66.25%. The remaining 27 patients were females comprising of 33.75% of the patients lot. The age distribution of patients was illustrated in table 1.

Table 1: Gender distribution of patients

Gender	No of patients	Percentage
Male	53	66.25
Female	27	33.75

The patients in this study were divided into 3 age groups:

1. 15-20 yrs
2. 21-25 yrs
3. >25 yrs

On compiling the data, 47 out of 80 patients belonged to the age group of 15-20 years (58.75%). No of patients in the age group of 21-25 and more than 25 were 21(26.25%) and 12(15%) respectively. Age distributions were illustrated in table 2.

Table 2: Age groups of patients

Age	No of patients	Percentage
15-20 years	47	58.75%
21-25 years	21	26.25%
>25 years	12	15%

Based on the time of saliva collection was divided into four categories:

- Immediately before the start of treatment

- 10 days after the start of treatment
- One month after the start of treatment
- Two months after the start of treatment

After processing the results, the data was collected and analysed. It was observed that the mean Nickel content in the first group was 2.014, with a standard deviation of 0.546. The mean and standard deviation in the other three groups was elaborated in table 3.

Table 3: Level of Nickel in saliva of different groups

Groups	Mean+/- standard deviation	P value
1	2.014+/-0.546	0.046 (Significant)
2	7.164+/-1.265	
3	3.716+/-1.426	
4	2.959+/-1.421	

Similarly, the mean Chromium content in the first group was 12.913 with a standard deviation of 2.594. The mean Chromium content in the second group was 67.514 with a standard deviation of 7.082. The mean and standard deviation in the other groups was elaborated in table 4. Statistically significant differences in the amount of Ni and Cr released into saliva were observed between the experimental and control groups with p values of .046 and .027 respectively.

Table 4: Level of Chromium in saliva of different groups

Groups	Mean+/- standard deviation Chromium	P value
1	12.913+/-2.594	.027 (Significant)
2	67.514+/-7.082	
3	26.427+/-5.552	
4	19.049+/-2.568	

DISCUSSION

Composition of majority of brackets is AISI type 304L and 316 L stainless steel. These alloy comprise of 17–22% chromium and 8–12% nickel with a little amount of manganese, copper, titanium, iron and silicon. Carbon content is less than .03%. Orthodontic wires with different physical and mechanical properties are also available now. Over time there has been an increase in the popularity of arch wires which have a greater concentration of Ni and/or titanium like NiTI and TMA wires. Also, there has been an increased inclination to use recyclable brackets. All this may predispose to greater corrosion products and consequent health hazards.[6]

Nickel and chromium may trigger hypersensitivity. As a result of this they are keenly observed by orthodontists. Gingival crevicular fluid (GCF) may depict variations in systemic response as a result of inflammation induced due to the action of orthodontic forces. Difference in the concentration of metal ions can thus be observed in GCF. However the only problem lies in the lack of knowledge of baseline metal levels of GCF. As a result of this the role of orthodontic treatment on GCF metal levels is yet to be studied in elaboration.[7] The purpose of this study was to assess the variations in the chromium and nickel concentrations in the saliva of patients receiving fixed orthodontic treatment.

The present study was conducted on eighty patients. Out of the 80 patients 53 were males. The percentage of male patients was 66.25%. The remaining 27 patients were females comprising of 33.75% of the patients lot. The age distribution of patients was illustrated in table 1. Yassaei S et al investigated the salivary concentration of nickel and chromium of patients undergoing orthodontic treatment. Average quantity of nickel around 20 days after the start of treatment was found to be 0.8µg/L more than before placement. Similarly the average quantity of chromium in the saliva was measured to be n a range of 2.6 and 3.6µg/L.[8]

In the present study, 47 out of 80 patients belonged to the age group of 15-20 years (58.75%). No of patients in the age group of 21-25 and more than 25 were 21(26.25%) and 12(15%) respectively. Kocadereli L et al observed the changes in value of Ni and Cr in saliva in patients undergoing orthodontic treatment. They did not find any significant variation between control groups and between patients undergoing orthodontic treatments. They claimed that fixed

orthodontic appliances do not significantly alter nickel and chromium values of saliva in the initial couple of months of treatment.[9]

In the present study, mean Nickel content in the first group was 2.014, with a standard deviation of 0.546. The mean and standard deviation in the other three groups was elaborated in table 3. Similarly, the mean Chromium content in the first group was 12.913 with a standard deviation of 2.594. The mean Chromium content in the second group was 67.514 with a standard deviation of 7.082. The mean and standard deviation in the other groups was elaborated in table 4. Statistically significant differences in the amount of Ni and Cr released into saliva were observed between the experimental and control groups with p values of .046 and .027 respectively. Singh DP et al conducted a study to assess elevation in salivary nickel and chromium concentration owing to orthodontic treatment. They found a statistically significant difference in salivary nickel and chromium values at different times of orthodontic treatment. Maximum concentrations of nickel and chromium were observed at the end of first week and then concentrations dropped by around 3rd week. Their levels were still significantly higher than pre-treatment values.[10]

CONCLUSION

The study concluded that fixed orthodontic appliances tend to increase the salivary levels of Nickel and Chromium. The release of Ni and Cr tends to decrease with time. Further studies would be beneficial to support the claim.

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