Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies ***NLM ID:*** *101716117*

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr Index Copernicus value = 85.10

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Original Research

Analysis of nickel and chromium concentration in the GCF of patients undergoing fixed orthodontic treatment

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ABSTRACT:
Background: Fixed orthodontic appliances usually include brackets, bands, arch wires, and springs. They are made of stainless steel, nickel–titanium, or nickel-cobalt alloys. 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; the present study was undertaken for analysing nickel and chromium concentration in the GCF of patients undergoing fixed orthodontics treatment. **Materials & methods:** A total of 20 patients scheduled to undergo fixed orthodontic treatment were enrolled in the present study. Complete demographic and clinical details of all the patients were obtained. Pre-treatment clinical examination of all the patients was carried out. GCF samples were obtained during the pre-treatment phase using micropipettes. Study casts were made and treatment planning was done. Fixed orthodontic treatment was started. Patients were recalled on follow-up at every 30 day interval. GCF samples were again taken at 30 days after starting of the treatment and at 150 days after starting of the treatment. Auto-analyser was used for assessment of GCF nickel and chromium levels. **Results:** Mean Nickel concentration at baseline, at 30 day follow-up and at 150 day follow-up was found to be 3.1 µg/gm of GCF, 4.8 µg/gm of GCF and 12.1 µg/gm of GCF respectively. Mean chromium concentration at baseline, at 30 day follow-up and at 150 day follow-up was found to be 3.9 µg/gm of GCF, 4.7 µg/gm of GCF and 16.3 µg/gm of GCF respectively. A significant increase in GCF concentrations of nickel and chromium were seen at different successive follow-ups in patients undergoing fixed orthodontic treatment. **Conclusion:** In patients undergoing fixed orthodontic treatment, there is considerable increase in GCF concentrations of nickel and chromium.
Key words: Nickel, Chromium

Received: 12/01/2020 **Accepted:** 23/02/2020

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This article may be cited as: Chandel N, Mandhotra P. Analysis of nickel and chromium concentration in the GCF of patients undergoing fixed orthodontic treatment. J Adv Med Dent Scie Res 2020;8(3):135-137.

INTRODUCTION

Fixed orthodontic appliances usually include brackets, bands, arch wires, and springs. They are made of stainless steel, nickel–titanium, or nickel-cobalt alloys. The stainless steel currently used in orthodontic clinics is of type 302 or 304, both of which contain 8–10% nickel.[1] Orthodontic alloys contain chromium and nickel, which might induce contact allergy, asthma, or hypersensitivity. Corrosion of orthodontic alloys might release nickel and chromium ions into saliva. Chromium oxide forms an anticorrosive passive film over orthodontic appliances. Nevertheless, in clinical situations, this protective layer is disrupted because of mastication, brushing, thermal stresses, saliva flow, biofilm microorganisms and their by-products and enzymatic activities, recycling of appliances, friction between brackets and wires, occlusal loadings, and acidic drinks, mouthwashes, or toothpastes. The influence of orthodontic treatment on systemic levels is controversial, showing increases and lack of changes.[2-4]

The average dietary intake of chromium is estimated to be 50–200 µg/day. 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. 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.[5- 7] Hence; the present study was undertaken for analysing nickel and chromium concentration in the GCF of patients undergoing fixed orthodontics treatment.

MATERIALS & METHODS

The present study was conducted with the aim of analysing the nickel and chromium concentration in the GCF of patients with fixed orthodontic treatment. Written consent was obtained from all the patients before the starting of the study. A total of 20 patients scheduled to undergo fixed orthodontic treatment were enrolled in the present study. Complete demographic and clinical details of all the patients were obtained. Pre-treatment clinical examination of all the patients was carried out. GCF samples were obtained during the pre-treatment phase using micropipettes. Study casts were made and treatment planning was done. Fixed orthodontic treatment was started. Patients were recalled on follow-up at every 30 day interval. GCF samples were again taken at 30 days after starting of the treatment and at 150 days after starting of the treatment. Auto-analyser was used for assessment of GCF nickel and chromium levels. All the results were recorded in Microsoft excel sheet and were analysed by SPSS software. Chi-square test and student t test were used for evaluation of level of significance.

RESULTS

In the present study, a total of 20 patients scheduled to undergo fixed orthodontic treatment were analysed. Mean age of the patients was found to be 15.4 years. There were 13 males and 7 females. Mean Nickel concentration at baseline, at 30 day follow-up and at 150 day follow-up was found to be 3.1 µg/gm of GCF, 4.8 µg/gm of GCF and 12.1 µg/gm of GCF respectively. Mean chromium concentration at baseline, at 30 day follow-up and at 150 day follow-up was found to be 3.9 µg/gm of GCF, 4.7 µg/gm of GCF and 16.3 µg/gm of GCF respectively. In the present study, a significant increase in GCF concentrations of nickel and chromium were seen at different successive follow-ups in patients undergoing fixed orthodontic treatment.

Table 1: Demographic data

Parameter		Number of patients	Percentage of patients
Age group (years)	Less than 20	12	60
	More than 20	8	40
Gender	Males	13	65
	Females	7	35

Table 2: Mean Nickel and chromium concentration in GCF at different time intervals

Concentration	Baseline	30 day follow-up	150 day follow-up
Mean Nickel (µg/gm of GCF) concentration	3.1	4.8	12.1
Mean Chromium (µg/gm of GCF) concentration	3.9	4.7	16.3

Table 3: Comparison of mean nickel and chromium concentration in GCF at different time intervals

Time interval comparison		p-value
Nickel concentration	Baseline Vs 30 day follow-up	0.00*
	Baseline Vs 150 day follow-up	0.01*
	30 day follow-up Vs 150 day follow-up	0.04*
Chromium concentration	Baseline Vs 30 day follow-up	0.02*
	Baseline Vs 150 day follow-up	0.01*
	30 day follow-up Vs 150 day follow-up	0.03*

*: Significant

DISCUSSION

Oral tissues are subjected to chemical and physical stimuli, as well as the metabolism of various bacterial species. The salivary pH ranges from 5.2-7.8. Factors that influence the occurrence of metal corrosion processes in the mouth such as quantity and quality of saliva, temperature, plaque, pH, protein, physical/chemical properties of food and drink, and oral conditions. In orthodontic treatment, hypersensitivity reactions often occur due to the content of nickel and chromium in brackets, bands, and stainless steel wire. Alloys in orthodontic metals contain about 6-12% nickel and 15-22% chromium. Nickel elements function to provide good properties in the bracket for formability, hardness, and heat resistance.[8-10] Hence; the present study was undertaken for analysing nickel and chromium concentration in the GCF of patients undergoing fixed orthodontics treatment.

In the present study, a total of 20 patients scheduled to undergo fixed orthodontic treatment were analysed. Mean age of the patients was found to be 15.4 years. There were 13 males and 7 females. Mean Nickel concentration at baseline, at 30 day follow-up and at 150 day follow-up was found to be 3.1 µg/gm of GCF, 4.8 µg/gm of GCF and 12.1 µg/gm of GCF respectively. Mean chromium concentration at baseline, at 30 day follow-up and at 150 day follow-up was found to be 3.9 µg/gm of GCF, 4.7 µg/gm of GCF and 16.3 µg/gm of GCF respectively. Amini F et al assessed the levels of nickel and chromium in GCF. The gingival index worsened over time (chi-square test, P <0.001). The mean nickel levels were 3.894 ±

1.442, 5.913 ± 2.735, and 19.810 ± 8.452 µg per gram, respectively, at baseline, month 1, and month 6. Chromium concentrations were 1.978 ± 0.721, 4.135 ± 1.591, and 13.760 ± 3.555 µg per gram, respectively. Compared with the baseline, nickel increased by 150% and 510%, respectively, in the first and sixth months (Friedman, P <0.0001), and chromium increased by 200% and 700%, respectively. Six months of fixed orthodontic treatment might intensify the levels of nickel and chromium in the GCF as well as gingival inflammation.[11]

In the present study, a significant increase in GCF concentrations of nickel and chromium were seen at different successive follow-ups in patients undergoing fixed orthodontic treatment. Mudjari S et al assessed the levels of nickel and chromium ions in hair and Gingival Crevicular Fluid (GCF) of orthodontic patients and to evaluate the corrosion of orthodontic bracket surfaces. Nickel and chromium ion concentrations were measured in hair and GCF of 15 patients (9 females and 6 males, aged 16-28 years old) who had fixed orthodontic treatment using atomic absorption spectroscopy. After 16 months, compared with the baseline, average hair nickel level changed from 0.125 µg/g to 0.956 µg/g with statistically significant difference (p=0.00); average chromium level changed from 0.090 µg/g to 0.295 µg/g but no significant difference (p>0.05); average GCF nickel level changed from 3.335 µg/g to 10.410 µg/g; average chromium level changed from 1.859 µg/g to 9.818 µg/g. Both of these increases were significant (p=0.000). SEM examinations showed that the corrosion on brackets was seen in the fourth month, and more severely visible after 8 and 16 months of uses. After 16 months of treatment, compared with the baseline, the hair nickel level was increased by 7.7 times; while for chromium was by 3.3 times. Gingival crevicular fluid nickel level was increased by 3.1 times and chromium level was by 5.3 times.[12] Stainless steel and nickel-titanium alloys might contain about 8 wt% and about 55 wt% of nickel, respectively, while containing about 20 wt% and less than 0.2 wt% of chromium, respectively.38 Biocompatibility of nickel or chromium alloys does not rely solely on their systemic concentrations. Even low doses might bind to certain organs. There are also dosageindependent effects that change the DNA or inhibit DNA-restoring enzymes. Furthermore, chronic releases of these elements might be associated with cellular or DNA alterations, or activation of inflammatory components such as monocytes. On the other hand, most corrosion products are unlikely to be toxic or carcinogenic. Furthermore, after removal of the orthodontic appliances, the DNA damage might be reversed. Hypersensitivity and allergic stomatitis are the main concerns with these ions in orthodontics, since nickel and chromium are the first and second most common sources of type-IV sensitivity. Moreover, nickel might predispose sensitive patients to periodontitis.[9- 12]

CONCLUSION

From the above results, the authors concluded that in patients undergoing fixed orthodontic treatment, there is considerable increase in GCF concentrations of nickel and chromium.

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