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Nickel & Chromium Ions Release from Fixed Orthodontic Appliances in Iraqi patients

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Abstract

Nickel and chromium can cause hypersensitivity in some people , this study was conducted to investigate the alteration in the nickel and chromium concentrations in saliva of patients with fixed orthodontic appliance.

The investigation is comprised of 45 orthodontic patients .The selected sample divided into 3 groups. The first group consisted of 15 patients with fixed appliances in their upper & lower arches. The second group consisted of 15 patients with a fixed appliance placed only in the upper arch. The control group consisted of 15 patients who were not undergoing orthodontic treatment.

Nickel and chromium release was quantified with the use of an atomic absorption spectrophotometr. The analysis of variance was used to determine if differences existed between the nickel and chromium release according to time interval. Four samples of stimulated saliva were collected from each patient before insertion of fixed appliance, 1 week , 1month , and 2month after insertion of the appliance.

A considerable variation in the concentrations of both nickel and chromium was observed. Significant differences were found between the no-appliance samples and the samples obtained after insertion of the appliance.

Nickel and chromium concentrations of saliva are significantly affected by fixed orthodontic appliances during the first 2 month of treatment.

Key words: Nickel, chromium, fixed orthodontic appliances.

Introduction

Metallic orthodontic appliances are usually made of (18/8) stainless steel (18%chromium and 8% nickel).Some arch wires with elastic properties (shape memory alloys)can contain more than 50% nickel. Release of nickel from metallic orthodontic appliances has been observed in several in vitro studies.[1-3] Nickel release in vivo in the oral cavity has been more difficult to demonstrate, although corrosion has clearly been evident in the orthodontic appliances after treatment.[4-6]

The salivary nickel concentration has shown no consistent increase in patients with fixed orthodontic appliances, but rather an overall large variation .[5-6]Nickel release from dental alloys have been reported as 4.2 µg/cm2 per day.[7]

It has also been reported that the in vitro release rate for full mouth orthodontic appliances to be 40 µg/day for nickel and 36 µg/day for chromium.[1] For heat-treated stainless steel orthodontic arch wires the release rate for nickel was found to be 0.26 µg/cm2 per day.[8]

The amount of nickel & chromium released from fixed orthodontic appliances in vitro varies depending on the manipulation of the appliances and on different physical and chemical test condition. Nickel is the most common cause of metal induced allergic contact dermatitis in man and produces more allergic reactions than all other metals combined.[9]

Second in frequency is chromium .In astudy in which cultured human cells were used, nickel was recently reported to be moderately cytotoxic while chromium was considered to have little cytotoxicity.[10]

The aim of this study was to investigate the nickel and chromium concentrations in the saliva of patients treated with fixed orthodontic appliances.

Materials & Methods

The sample comprised 45 patients of both sexes from Department of Orthodontic, Collage of Dentistry, University of Baghdad. The sample was divided into 3 groups: Group A had 15 patients ,7males and 8females with the mean age of 18 years and with fixed appliances in their upper and lower arch these patients were evaluated and there was no history of previous orthodontic treatment. Group B had 15 patients, 8males and 7females with a mean age of 17years with fixed appliance placed only in their upper arch also in this group there was no history of previous orthodontic treatment. The remaining 15 patients ,7males and 8females with a mean age of 15years, served as controls with no orthodontic appliances in place and these patients represent Group C.

In the Group A the patients had maxillary molar bands with triple buccal tubes, and second and first premolar, canine, lateral and central incisor direct bonded brackets (Roth 0.22, Murreli, Brazil). In the mandible, these patients had mandibular first molar bands with double buccal tubes, and first and second premolar, canine, lateral and central incisor direct bonded brackets (Roth 0.22, Murreli, Brazil).

In the Group B the patients had the same maxillary attachments mentioned above. In both of the groups, there were no buttons either on the molar bands or on the other teeth. The arch wire was 0.16 nickel titanium (Rematitan, maxillary, mandibular; Murreli), which was applied to the brackets with elastomeric units.

Sampling of saliva

Four samples of stimulated saliva were collected from each patient :(1) before insertion of the fixed appliance, (2)1week after insertion of the appliance, (3) 1month after insertion of the appliance, and(4) 2months after insertion of the appliance. The same 4samples of saliva were collected from each control patient at the same time intervals as for the fixed appliance groups.

The patients initially rinsed their mouths thoroughly with a mouthful of distilled water. After mouth rinsing, the patient used quashi Arabia chewing gum for stimulation of the salivary secretion. The patient collected approximately 10ml of saliva into test tube.

Analaysis of nickel and chromium

The samples were analyzed with an atomic absorption spectrophotometer (Shimaduzo 750-flame/Japan) with sensitivity $1/10^{-4}$ in Ministry Of Science And Tecnology . The presence of nickel & chromium concentrations were calculated as micrograms per milliter. The use of standard samples controlled the accuracy of the equipment.

Analysis of data & statistics

The student-t- test was used to test the significant differences between the mean of salivary nickel and chromium concentrations in the samples before and after insertion of orthodontic appliances. (ANOVA) 1 way analysis of variance test was used to detect statistically significant difference in nickel and chromium concentrations among the 3 test groups.

Results

The descriptive statistics of the salivary nickel and chromium concentrations including mean and standard deviation values for upper and lower fixed appliance group, upper fixed appliance group, control group after period of 1week, 1month, and 2month are shown in (Table1).

(Table2) shows the analysis of variance comparing the nickel and chromium concentration among the 3 test groups. The results show that there is statistically significant difference in nickel concentration for upper and lower fixed appliance group and upper fixed appliance group, highly significant difference for the control group. The chromium concentration show a highly significant difference among the 3groups. (Table 3, 4) show the statistical difference of nickel and chromium concentration in different appliance group at different time interval using Student t. test.

Discussion

The method of sampling shows the momentary ,total concentration of soluble nickel and chromium in saliva but differentiation between nickel and chromium released from the appliances cannot be made from this study .The saliva concentrations for nickel and chromium in this study showed a large variation. However, despite the scatter of the values, the metal concentrations detected were all together very low. Large variations have also been constantly found in previous reports concerning analysis of metal concentrations in saliva.[6,11]

Kerosuo et al[(12)]; (1997) in their study showed that no significant differences were found between the no appliance samples and the samples obtained after insertion of different types of fixed appliances (headgear, quad helix, fixed appliance), in 47 orthodontic patients ages 8 to 30 years. This conclusion is in contrast to the result of the present study ,the difference between these two studies may be related to time factor and difference in appliances used. The present study is also in contrast with the study by Kocadereli et al[(13)];(2000) who did not find any significant differences between the no appliance group and the samples obtained after insertion of the appliance during the first 2 months of treatment.The differences of results between these two studies may be related to the diference in the materials used. The continuous flow of saliva in the mouth and short sampling period may not give time enough for detectable dissolution of metals from the appliances. deSouza and deMenezes[(14)];(2008) reavealed an increase in nickel and chromium levels in saliva of individuals after placement of metallic brackets in the oral cavity, the highest concentrations of nickel and chromium were reached 10 minutes after placement of the appliance significantly higher than those observed without the appliance.

In general, the most significant human exposure to nickel, chromium occurs through the diet,[15,16] atmosphere,[17]drinking water,[18] and the major dietary sources for these three metals are vegetables, grains, and cereals[17,19,20]. The average dietary intake for these two metals has been estimated to be 200 to 300 µg/day for nickel[17,21], 280 µg/day for chromium[19].

We cannot compare this study to the in vitro studies, because in the oral cavity the nickel and chromium concentration may be affected by many factors as temperature, quantity and quality of saliva, plaque, protein, physical and chemical properties of food and liquids, and general oral health conditions.

Corrosion of alloys in the oral environment may decrease the strength of metallic appliances. There has also been concern about adverse biologic effects of the corrosion products on the patient, such as sensitizing patients to nickel. On the other hand, the prevalence of nickel sensitivity has been reported to be lower in subjects who have received orthodontic treatment at a young age, possibly because of the induction of immunological tolerance[22,23] . These studies do not, however, include analysis of actual amounts or concentrations of nickel involved.

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Table(1) Mean salivary Nickel and Chromium and standard deviation (µg/ml)

Groups		Nickel				Chromium			
		Before	1 w	1m	2m	Before	1 w	1m	2m
A	Mean	0,528	0,793	0,899	1,043	1,438	1,49	1,648	2,203
	SD	0,019	0,02	0,019	0,022	0,0174	0,027	0,0211	0,026
B	Mean	0,518	0,597	0,64	0,6947	1,411	1,437	1,566	1,911
	SD	0,0308	0,034	0,025	0,0242	0,019	0,021	0,039	0,06
C	Mean	0,503	0,507	0,517	0,656	1,321	1,359	1,431	1,433
	SD	0,034	0,025	0,039	0,0155	0,025	0,024	0,027	0,032

Group A: Upper and lower fixed appliance group
Group B: Upper fixed appliance group
Group C: Control group

Table(2) One way ANOVA between groups

	Nickel		Chromium	
	P-value	Sig	P-value	Sig
A	0.007	S	0.000	HS
B	0.003	S	0.000	HS
C	0.000	HS	0.000	HS

*P<0.05 Significant **P>0.05 Non significant *df=59 ***P<0.01 High significant

Table(3) The statistical differences of Nickel

	A		B		C	
	P-value	Sig	P-value	Sig	P-value	Sig
Before&1w	0.03	S	0.004	S	0.000	HS
Before&1m	0.002	S	0.01	S	0.000	HS
Before&2m	0.000	HS	0.000	HS	0.000	HS
1w&1m	0.003	S	0.005	S	0.000	HS
1w&2m	0.009	S	0.009	S	0.000	HS
1m&2m	0.007	S	0.01	S	0.000	HS

*P<0.05 Significant **P<0.01 High significant *df=14

Table(4) The statistical differences of Chromium

	A		B		C	
	P-value	Sig	P-value	Sig	P-value	Sig
Before&1w	0.002	S	0.003	S	0.005	S
Before&1m	0.007	S	0.000	HS	0.000	HS
Before&2m	0.02	S	0.006	S	0.000	HS
1w&1m	0.000	HS	0.000	HS	0.02	S
1w&2m	0.000	HS	0.008	S	0.007	S
1m&2m	0.000	HS	0.000	HS	0.000	HS

*P<0.05 Significant **P<0.01 High significant *df=14