Ions release from fixed orthodontic appliance in two different mouthwashes

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ABSTRACT

Background: Metal ions can be released from metallic orthodontic appliances due to corrosion in the oral cavity; prophylactic mouthwashes may have an effect on ion release from orthodontic wires.
Materials and Methods: Thirty six orthodontic sets of half maxillary fixed appliance with 2 types of arch wires SS and NiTi(Morelli) were constructed and immersed in 2 types of mouthwashes; Claradone (non-fluoridated) and Silver Care (fluoridated) for 28 days at 37°C, then the released Ni and Cr ionswere measured using atomic absorption spectrophotometer and compared statistically.
Results: Ni ion release was higher from NiTi wire group than SS wire group for both mouthwashes and also was higher for Silver Care group than for Claradone group. While for Cr ion was higher for Silver Care group than for Claradone group, with significant differences for all the groups.
Conclusion: Claradone non-fluoridated mouthwash cause less release of Ni and Cr ions release from the orthodontic appliance samples than Silver Care fluoridated mouthwash.
Keywords: corrosion, mouthwash, Ni, Cr. (J Bagh Coll Dentistry 2014; 26(4):152-155).

INTRODUCTION

Many studies have demonstrated that metal ions can be released from metallic orthodontic appliances as a result of corrosion due to exposure to the oral environment, and this can influence the mechanical properties of the appliance and may also affect the body [(1-3)]. Metallic orthodontic appliance sare commonly made from different alloys such as stainless steel (iron-chromium-nickel), titanium (Ti) and Elgiloy (cobalt-chromium) which are frequently used in the manufacture of brackets, while wires could be made from stainless steel (SS), cobalt-chromium, titanium-molybdenum (TMA) and nickel-titanium (Ni-Ti) alloy [(4,5)]. During orthodontic treatment, the regular use of fluoride containing products such as tooth pastes and mouth washes is recommended to reduce the risk of dental caries and development of decalcification spots around the brackets [(4,6)]. However, some studies have shown that in an acidic environment and in the presence of fluoride ions the corrosion resistance of some materials (especially titanium) can deteriorate due to the breach of the protective oxide layer on the surface of the titanium alloy [(7-9)]. Although fluoride ions in the prophylactic agents have been reported to cause corrosion, but little information is available regarding the effect of different mouthwashes on ion release from orthodontic wires [(10,11)].

The purpose of this study was to measure the levels of metal ions released from orthodontic appliance after immersion in 2 different mouthwashes. The result should help practitioners to decide which mouthwash to prescribe for their patients.

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MATERIALS AND METHODS

The sample includes 36 structurally identical orthodontic sets, each set simulate half average maxillary fixed orthodontic appliance (from central incisor to first molar) that consisted of five SS bondable brackets (slot 0.022") and one SS band and a piece of arch wire 3 cm long (0.016x0.022") of either SS or Ni-Ti which was tied to each bracket using SS ligature wire (0.001") and all were made by Morelli Ortodontia, Sorocaba-SP, Brazil (figure 1).

Each part of the appliance was cleaned ultrasonically with ethanol and acetone, rinsed with distilled water and then dried in air,and afterthe components of each set were held securely by the arch wire and ligated by stainless steel ligature wire, were immersed in acetone for 8 seconds and dried in air [(12, 13)].Only the closely similar weights were used for bands, brackets and arch wires by using the analytic balance device. The 36 constructed appliancesets were divided into 4 groups (containing 9 sets in each group) according to the type of arch wire used as follows:

- ***Group A:*** Brackets and a band ligated on SS archwire.
- ***Group B:*** Brackets and a band ligated on Niti archwire.
- ***Group C:*** Brackets and a band ligated on SS archwire.
- ***Group D:*** Brackets and a band ligated on NiTi archwire.

Then each appliance set in group A and B was fully immersed in 30 ml of non-fluoridated

mouthwash (Claradone mouthwash, Medpharma, United Arab Emirates) containing Povidone - iodine USP 1.0 % w/v with pH of 2.8, and each appliance set in group C and D was fully immersed in 30 ml of fluoridated mouthwash(Silver Care Mouth Wash,Italy) containing two fluoride salts; sodium fluoride 0.10% and monofluorophosphate 0.03% with total fluoride contentof 490 ppm with pH of 5.8 (figure 2) in closely packed glass test tube (figure 3)and kept in an incubator at 37°C for 28 days. The samples were analyzed with an atomic absorption spectrophotometer (Flameless Atomic Absorption Spectrophotometer-Shimadzu/AA-670, Japan) (figure 4) with sensitivity $1/10^{-4}$ in the Labs of the Ministry of Science and Technology. The concentrations of nickel & chromium ions were calculated as micrograms per ml. The pH of both mouthwashes was measured by HANNA (HI8014 -Romania) digital pH meter (figure 5).

The statistical analysis was done using SPSS program version 15, including descriptive statistics, t-test. P value of ($P \leq 0.05$) was regarded as statistically significant.

Figure 1: Constructed orthodontic set

Figure 2: Mouth washes used in the study.

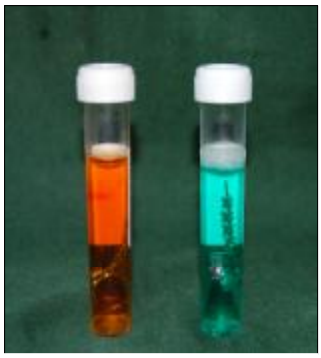

Figure 3: Samples in test tubes.

Figure 4: Flameless atomic absorption spectrophotometer.

Figure 5: HANNA digital pH meter.

RESULTS

The results of atomic absorption analysis of the nickel (Ni) and chromium (Cr) ions concentrations in the two mouthwashes showed that the release of Ni ion was higher from NiTi wire group than those of the SS wire in both mouthwashes used and also Ni ion release was higher in fluoridated mouthwash (FM) group than

those in non-fluoridated mouthwash (NFM) group for both arch wire types (Table 1) with statistically significant differences between all the groups (Table 2).

The release of Cr ion was also higher in FM group than that of NFM group (Table 1) with statistically significant difference (Table 2).

Table 1: Descriptive statistics of nickel and chromium ion concentrations in different groups

Ions	Groups	Min.	Max.	Mean	S.D.
Ni	A	.20	.41	.301	.079
	B	.31	.49	.395	.056
	C	.2900	.5000	.390	.064
	D	.3400	.5700	.4689	.077
Cr	A	.0220	.0810	.051	.018
	C	.0480	.0900	.069	.014

Table 2: Difference in the Ni and Cr ion release among different groups by t-test

Ions	Groups	Concentration differences (N=9, d.f.=8)		
		t-test	p-value	Sig.
Ni	A & B	2.082	.071	NS
	C & D	2.801	.023	S
	A & C	4.996	.001	HS
	A & D	5.023	.001	HS
Cr	A & C	-2.982	.018	S

DISCUSSION

Stainless steel orthodontic appliances can release metal ions into the saliva. Fluoridated and non-fluoridated mouthwashes are often recommended to orthodontic patients to reduce the risk of white-spot lesions around the appliances. However little information is available regarding the effect of different mouthwashes on ion release of orthodontic archwires.

In this study the appliance consisted of brackets, bands and wires, and it is likely that the brackets and bands contributed to the quantities of released ions, however, because the brackets and bands consisted of the same material and the same weight in all samples, their contribution was constant and did not influence relative comparisons of ions released from wires.

Regarding the use of mouth wash in this study, the wires were immersed in mouth washes and incubated at 37°C for 28 days.Several studies have demonstrated that the levels of metal release from fixed orthodontic appliances peak at day 7, and that all release is completed within 4 weeks [1,3,14]. In this study

A comparison of Ni ion concentration from the various solutions showed that the maximum release was in fluoridated mouthwash than in non-fluoridated mouthwash and from the NiTi wire higher than SS wire, in spite of that NFM was more acidic (pH = 2.8) than FM (pH = 5.8), and this could be attributed to the fact that povidone – iodine could reduce the corrosion of titanium alloy as the iodine does not have the ability to penetrate the oxide layer on the titanium surface [15] while in the FM the presence of fluoride ion in acid aqueous environment can lead to formation of hydrofluoric acid (which can rapidly attack titanium even in dilute concentration in pH below 7) causingbreakdown of the protective oxide layer on the surface of titanium alloy leading to decrease of corrosion resistance and this agrees with many authors [4-6,16-18]. In addition iodine is an antiseptic agent acting on bacteria, viruses, TB bacilli and Fungi with no cytotoxic or adverse reactions on the body [19].

Analysis of released Cr ions revealed adifference only in the fluoridated mouth wash group ($p<.05$), this is also agree with Kao et al. [5]. Many authors [14,16-18] have alerted practitioners to the possibility of hypersensitivity reactions to released Cr and Ni ions because they can result in symptoms of toxicity and allergic reactions.

The present study shows the risk offluoride containing mouthwashesin causingmore corrosion and higher levels of ion release from both SS and NiTi components of orthodontic appliance which may lead to impaired mechanical performance and unsatisfactory results on one hand and on the other hand Ni and Cr ions released in the organism can cause allergic reactions and this agree with many studies [4-6,16,20-24].

In conclusion, Claradone NFM caused less metallic ion release from orthodontic appliances than from Silver Care FM.

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