An Evaluation of Ion Released from Two Brands of Brackets in Three Types of Mouthwashes

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ABSTRACT

Background: Mouthwashes used widely as ancillary to mechanical oral hygiene methods. Little information provided about the effect of mouthwashes on ions released from orthodontic brackets. Therefore, the present study has been established to evaluate the effect of different mouthwashes on the ion release and the biocompatibility of two brands of brackets.

Materials and Methods: Eighty premolar stainless steel brackets were used (40 brackets from Dentaurum and 40 brackets OrthoTechnology Company). They were subdivided into four subgroups (n=10) according to immersion media (deionized distilled water, Corsodyl, Listerine and Silca herb mouthwashes). Each bracket was stored in a closely packed glass tube filled with 15ml of the immersion media and incubated for 45 days at 37ºC. Chromium, nickel, copper and manganese ions release were measured using Atomic absorption spectrophotometer, while iron ions release were measured by using Iron kit and spectrophotometer. For statistical analysis, t-test, analysis of variance (ANOVA) and least significant difference (LSD) were used.

Results: The results revealed that the ions released from Dentaurum brackets were significantly higher than that from OrthoTechnology brackets in all type of immersion media except for Chromium ions in Corsodyl mouthwash. The release of copper and chromium ions was significantly higher in Listerine and Corsodyl mouthwashes than in deionized distilled water being related to the pH of the immersion media. While, the release of iron, nickel and manganese ions in the three mouthwashes was comparable to that in deionized distilled water.

Conclusions: The amount of released ions were below toxic levels and did not exceed the daily dietary intake, but it may be recommended to avoid prolonged use of Listerine and Corsodyl mouthwashes in patients allergic to chromium.

Key words: Brackets, mouthwashes, ions release, corrosion. (J Bagh Coll Dentistry 2015; 27(4):155-160).

INTRODUCTION

Plaque control is the major consensus during orthodontic treatment to prevent the occurrence of cavities and periodontal inflammation [(1)]. Therefore during orthodontic treatment, practitioners recommend that their patients use mouthwashes, since most of them are adolescents who do not always follow a satisfactory oral-hygiene regimen and have a high risk of dental caries [(2)].

In the oral environment, orthodontic appliances are exposed to potentially damaging physical and chemical agents which may cause metallic corrosion [(3)]. Recent improvements in the composition and quality of orthodontic alloys have significantly increased their biocompatibility and stability inside the oral cavity. However the release of metal ions from dental alloy is a phenomenon that cannot be avoided; it's difficult to find a material that will be fully stable within an organism and will show no sign of biodegradation [(4)]. Therefore during the last decade, there has been increased interest among dental and biomedical professionals in the side effects associated with the use of biomaterials, especially the metallic materials; fixed appliances in orthodontics involve brackets and archwires that are metallic. These brackets are exposed to the oral cavity, which is a potentially hostile environment where electrochemical corrosion phenomena can occur. Thus, orthodontic brackets and other auxiliary components should be made of highly corrosion resistant metals and metal alloys [(5)].

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MATERIALS AND METHODS

The sample consists of 80 premolar stainless steel brackets, which were divided according to their manufacture (Dentaurum and OrthoTechnology) into two groups each group contained 40 brackets that each subdivided into four subgroups, one of these subgroup immersed in 15 ml of deionized distilled water (controlled group), pH 7.5, while the second one immersed in 15 ml of Corsodyl mouthwash, pH 4.49, furthermore the third one immersed in 15 ml of Listerine mouthwash, pH 3.8 and finally the forth one immersed in 15 ml of Silca herb mouthwash, pH 7.85.

After that each individual capped – glass tube which was marked with specific color that represents the brand of bracket was filled with 15 mL of each different mouthwash and deionized distilled water using measuring glass cylinder then all the capped – glass tubes were incubated in an incubator set at a constant temperature of 37°C for 45 days.

After incubation period, the samples were prepared for estimation of ions concentration included copper, manganese, nickel, chromium and iron by using atomic absorption spectrophotometer following standardized procedure.

The Concentrations of Copper, Nickel, and Chromium were determined by using flame atomic absorption spectrophotometer at wave lengths for each element, while the concentration of manganese was determined by using furnace atomic absorption spectrophotometer and finally Concentration of iron was determined by colometric method with spectrophotometer, iron kit used.

RESULTS

The amount of ions released from the stainless brackets were compared between two different brands (Dentaurum and OrthoTechnology) in each mouthwash and among different widely used mouthwashes (Corsodyl, Listerine and Silca herb) and deionized distilled water that used as a control medium.

Iron Ions Released:

Reviewing table1, the results revealed that the amount of iron ions released, in all types of mouthwashes, from the brackets of Dentaurum Company were higher than that released from OrthoTechnology Company with a highly significant difference as indicated by independent sample t-test.

The amount of iron ions released from the brackets of Dentaurum Company were higher in Listerine, followed by deionized distilled water, Silca herb and the least amount were released from Corsodyl mouthwash with a highly significant difference as indicated by ANOVA test.

Regarding OrthoTechnology Company, the amount of iron ions released were higher in deionized distilled water followed by Silca herb then Listerine and Corsodyl with a highly significant difference.

For both companies, LSD test showed a highly significant difference when comparing the iron ions released between each two mouthwashes.

Chromium Ions Released:

As can be seen in table 2, the results revealed that the amount of Chromium ions released, in all types of mouthwashes, from the brackets of Dentaurum Company were higher than that released from OrthoTechnology Company with a highly significant difference as indicated by independent sample t-test except for silca herb mouthwash which showed non-significant difference ($p>0.05$) and in Corsodyl mouthwash OrthoTechnology showed higher amount of the ions.

The amount of Chromium ions released from the brackets of Dentaurum Company were higher in Listerine followed by Corsodyl, deionized distilled water and the least amount were released from Silca herb mouthwash with a highly significant difference as indicated by ANOVA test.

Regarding OrthoTechnology Company, the amount of Chromium ions released were higher in Listerine followed by Corsodyl then deionized distilled water and Silca herb with a highly significant difference.

For both companies, LSD test showed a highly significant difference when comparing the Chromium ions released between each two mouthwashes.

Nickel Ions Released:

Reviewing table 3, the results revealed that the amount of Nickel ions released, in all types of mouthwashes, from the brackets of Dentaurum Company were higher than that released from OrthoTechnology Company with a highly significant difference as indicated by independent sample t-test.

The amount of Nickel ions released from the brackets of Dentaurum Company were higher in deionized distilled water followed by Corsodyl, Listerine and the least amount were released from Silca herb mouthwash with a highly significant difference as indicated by ANOVA test.

Regarding OrthoTechnology Company, the amount Nickel of ions released were higher in deionized distilled water followed by Corsodyl then Silca herb and Listerine with a highly significant difference.

For both companies, LSD test showed a highly significant difference when comparing the Nickel ions released between each two mouthwashes.

Copper Ions Released:

Reviewing table 4, the results revealed that the amount of Copper ions released, in all types of mouthwashes, from the brackets of Dentaurum Company were higher than that released from OrthoTechnology Company with a highly significant difference as indicated by independent sample t-test.

The amount of Copper ions released from the brackets of Dentaurum Company were higher in Listerine followed by Corsodyl, deionized distilled water and the least amount were released from Silca herb mouthwash with a highly

significant difference as indicated by ANOVA test.

Regarding OrthoTechnology Company, the amount of Copper ions released were higher in Listerine followed by deionized distilled water then Corsodyl and Silca herb with a highly significant difference.

Manganese Ions Released:

Reviewing table 5, the results revealed that the amount of Manganese ions released, in all types of mouthwashes, from the brackets of Dentaurum Company were higher than that released from OrthoTechnology Company with a highly significant difference as indicated by independent sample t-test.

The amount of Manganese ions released from the brackets of Dentaurum Company were higher in Listerine followed by deionized distilled water, Silca herb and the least amount were released from Corsodyl mouthwash with a highly significant difference as indicated by ANOVA test.

Regarding OrthoTechnology Company, the amount of Manganese ions released were higher in Listerine followed by deionized distilled water then Silca herb and Corsodyl with a highly significant difference.

For both companies, LSD test showed a highly significant difference when comparing the Manganese ions released between each two mouthwashes.

Table (1): Iron Release from Brackets of Different Companies in Different Mouthwashes.

Groups	Dentaurum				OrthoTechnology				Company difference	
	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	t-test d.f =18	p-value
D.W	797.810	10.574	780.4	814	705.320	16.381	682.9	725.6	15.001	0.000***
Corsodyl	673.873	5.852	665.6	683.28	591.830	5.411	580.06	598.18	32.549	0.000***
Listerine	816.134	9.103	803.9	829.5	676.891	5.080	667.67	683.28	42.239	0.000***
Silca herbal	739.890	9.429	728.6	756	687.160	8.122	679.8	703.7	13.399	0.000***
Group difference	F-test=518.72 d.f =39 p-value=0.000***				F-test= 260.62 d.f =39 p-value=0.000***					

Table (2): Chromium Release from Brackets of Different Companies in Different Mouthwashes

Groups	Dentaurum				OrthoTechnology				Company difference	
	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	t-test d.f =18	p-value
D.W	109.8	6.88	99	119	101.5	3.92	95	106	3.315	0.004***
Corsodyl	270.1	4.23	263	275	314.7	4.60	308	320	-22.58	0.000***
Listerine	945.2	33.19	851	959	610.2	4.26	602	616	31.656	0.000***
Silca herbal	79.1	3.14	74	83	77.4	4.60	70	83	0.965	0.347
Group difference	F-test =5571.43 d.f =39 p-value=0.000***				F-test= 32185.09 d.f =39 p-value=0.000***					

Table (3): Nickel Release from Brackets of Different Companies in Different Mouthwashes

Groups	Dentaurum				OrthoTechnology				Company difference	
	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	t-test d.f =18	p-value
D.W	199.2	3.99	193	206	166	3.02	161	170	20.970	0.000***
Corsodyl	194.4	2.72	191	199	120.3	4.99	112	128	41.245	0.000***
Listerine	144.8	2.49	141	149	101	4.27	94	109	28.040	0.000***
Silca herbal	137.2	2.15	134	140	105.4	5.04	99	113	18.360	0.000***
Group difference	F-test =1232.04 d.f =39 p-value=0.000***				F-test =455.25 d.f =39 p-value=0.000***					

Table (4): Copper Release from Brackets of Different Companies in Different Mouthwashes

Groups	Dentaurum				OrthoTechnology				Company difference	
	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	t-test d.f =18	p-value
D.W	282.2	4.54	277	291	101.3	5.29	93	110	82.030	0.000***
Corsodyl	739.9	2.56	737	745	81.1	2.42	77	85	591.090	0.000***
Listerine	901.1	8.35	891	913	150	10.54	130	160	176.660	0.000***
Silca herbal	115	4.78	109	121	54.7	3.30	51	61	32.804	0.000***
Group difference	F-test =46080.96 d.f =39 p-value=0.000***				F-test =416.45 d.f =39 p-value=0.000***					

Table (5): Manganese Release from Brackets of Different Companies in Different Mouthwashes

Groups	Dentaurum				OrthoTechnology				Company difference	
	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	t-test d.f = 18	p-value
D.W	2.746	0.051	2.68	2.83	2.316	0.049	2.21	2.37	19.128	0.000***
Corsodyl	1.435	0.028	1.39	1.47	0.996	0.043	0.92	1.06	26.945	0.000***
Listerine	3.921	0.039	3.85	3.97	3.249	0.039	3.18	3.29	38.528	0.000***
Silca herbal	2.081	0.037	2.01	2.13	1.833	0.044	1.77	1.91	13.698	0.000***
Group difference	F-test= 7159.71 d.f = 39 p-value=0.000***				F-test= 4582.27 d.f = 39 p-value=0.000***					

DISCUSSION

Brackets from two different manufactures were used, which are widely used in orthodontic department in the college of dentistry at Baghdad University.

Adhesive resins were not used on the base of brackets in this study to prevent other sources of ion release [6]. Therefore, the exposed surface for ion release was approximately twice that of clinical conditions because the bracket bases would be covered with a bonding material in clinical use [3,7].

Mouthwashes usually used twice a week for about 1 minute, it is also recommended that after mouthwash the patient must not eat, drink, and rinse, so the components of mouthwash are present for a long time, and it is difficult to determine the exact duration of contact between brackets and mouthwashes. In this study we assumed that each time the mouthwash was present for 6 hours in a patient's mouth (24 months, twice a week about 69,000 minutes), therefor the brackets were immersed in mouthwashes and incubated for 45 days (45 days about 64,000 minutes) [3,7,8].

The level of ions released from different companies

results revealed that the amount of released, in all types of mouthwashes, from the brackets of Dentaurum Company was higher than that released from OrthoTechnology Company with a highly significant difference as indicated by independent sample t-test except for chromium ion released in Silca herb mouthwash was non-significant differenceand in Corsodyl mouthwash OrthoTechnology showed higher amount of the ions, this agree with Lin et, al., [9] who found that the brand of the commercial SS brackets had a significant influence on the corrosion resistance, and the difference in corrosion resistance might be related to the different surface characterizations, such as surface residual stress and metallurgical factors, produced during the various manufacturing processes, instead of the surface roughness and preexisting defect.

For nickel ions released from brackets in the various solutions, the maximum release were in deionized water and the next highest were in chlorhexidine mouthwash, this agrees with Patel et al and Danaei et, al., [3,7]. The reason might be because deionized water has an extremely low concentration of ions, and the lack of ions makes this solvent one of the most aggressive solvents known, the corrosion of different metals and alloys as a result of immersion in deionized water has been studied [10] while the group immersed in chlorhexidine this could be attributed to the corrosiveness of chlorhexidine compared with the other two mouthwashes; this agrees with previous reports about the irritating effects of chlorhexidine [3,7,11,12].

Furthermore Listerine and Silca herb mouthwashes revealed less amount of nickel ions, this may be due to the composition of mouth wash itself this agrees with House et, al., [13], who stated that the level of corrosion of any metal depends on the chemistry of the solvent in which it is

immersed. While for OrthoTechnology Company the release of nickel ions were also the greatest in deionized distilled water followed by Chlorhexidine, but the difference was that the amount of nickel ions released in Silca herb mouthwash higher than in Listerine mouthwash this may be due to difference in the reaction between the alloys from different companies with the mouthwashes. Regarding OrthoTechnology Company the release of nickel ions were also the greatest in deionized distilled water followed by Chlorhexidine, but the difference was that the amount of nickel ions released in Silca herb mouthwash higher than in Listerine mouthwash this may be due to difference in the reaction between the alloys from different companies with the mouthwashes.

Iron ions released from the brackets of Dentaurum Company were higher in Listerine followed by deionized distilled water, Silca herb and the least amount were released from Corsodyl mouthwash with a highly significant difference, Listerine mouthwash has the lowest pH this may be the cause of higher release, this agrees with Huang et, al., [14] who reported that the metal ions release were more when the brackets were placed in acidic environment, but if we follow that report Chlorhexidine must be the second in the level of iron ions release add to that when noticing the amount of ions released from OrthoTechnology Company, which were higher in deionized distilled water followed by Silca herb, then Listerine and Corsodyl with a highly significant difference, so this means that the release of iron ions were not related to the pH of the solution.

Regarding Copper ions released from the brackets of Dentaurum Company were higher in Listerine followed by Corsodyl, deionized distilled water and the least amount was released from Silca herb mouthwash with a highly significant difference, this agrees with the studies that revealed the levels of released ions were gradually increased with decreasing solution pH. These results agree with the finding of and Kuhta et, al. [4] and Staffolani et, al. [15]. In the other hand regarding OrthoTechnology Company, the amount of Copper ions released were higher in Listerine followed by deionized distilled water then Corsodyl and Silca herb with a highly significant difference, this return us to the same point that the ions release depend on the reaction of alloy to the solution, this agrees with the result of Duffó and Farina [16] who showed that the aggressiveness of the different liquids is independent on the pH of the solution.

Now for Chromium ions released from the brackets of Dentaurum Company which were higher in Listerine followed by Corsodyl, deionized distilled water and the least amount were released from Silca herb mouthwash with a highly significant difference, and it was the same sequence for OrthoTechnology Company, these results agree with the study of Okazaki and Gotoh[17] which revealed that with decreasing pH ($pH \leq 6$), the quantity of Cr released gradually increased and bottomed out at pH 6.

Finally the amount of Manganese ions released from the brackets of Dentaurum Company were higher in Listerine followed by deionized distilled water, Silca herb and the least amount were released from Corsodyl mouth wash with a highly significant difference and it was the same findings for OrthoTechnology Company, this results do not agree with the study of Huang et, al., [18], but chlorhexidine mouthwash has lower pH value than deionized distilled water and Silca herb mouthwash this again return us to the findings of Duffó and Farina [16] who showed that the aggressiveness of the different liquids is independent on the pH of the solution..

The level of ions released from different companies, results revealed that the amount of released, in all types of mouthwashes, from the brackets of Dentaurum Company was higher than that released from Orthotechnology Company with a highly significant difference as indicated by independent sample t-test except for chromium ion released in Silca herb mouthwash was non-significant difference this agree with Lin et, al.,[9] who found that the brand of the commercial SS brackets had a significant influence on the corrosion resistance, and the difference in corrosion resistance might be related to the different surface characterizations, such as surface residual stress and metallurgical factors, produced during the various manufacturing processes, instead of the surface roughness and preexisting defect.

The WHO recommended daily doses (RDD) for the following elements are: Ni, 25-35 µg/day; Cr, 50-200 µg/day; Mn, 2.5-6 mg/day; Fe, 10-18 mg/day[10]. The amount of ions released did not exceed the recommended daily doses. However, even a small amount of release might produce sensitivity when the orthodontic appliances are in place for 2 to 3 years. Because symptoms can develop several years later, nickel hypersensitivity should be observed on a long-term basis [18]. Certain ions such as nickel and chromium can cause allergic reactions and toxicity symotoms[19]. These symptoms can stay for short time but intense or may be moderate but long lasting, furthermore these symptoms might be cured or can become chronic problem. Since the toxicity of

nickel is a concern, and the natural capacity to eliminate nickel exceeds the accumulation capacity, the risks are minimal [20]. However, clinicians should be aware that the release of metal ions might cause a local hypersensitivity reaction at oral soft-tissue sites, such as mild erythema or redness with or without edema [21]. Also, severe gingivitis can be related not only to poor oral hygiene but also to a hypersensitivity reaction to nickel or chromium ions released from stainless steel [22-23].

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