Research Article

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In Vitro Release of Metal Ions from Orthodontic Brackets Under the Influence of Mouth Washes

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ABSTRACT

Background: Metal ions are released from metallic orthodontic appliances due to corrosion in the oral cavity; in addition, prophylactic fluoridated mouthwashes often prescribed to orthodontic patients to reduce the risk of white spot lesions, may have an effect on ion release from these appliances. The purpose of this study was to evaluate and compare the release of various metal ions release from the brackets in respective mouth washes.

Materials and Method: One hundred twenty stainless steel brackets were divided randomly into 4 equal groups and immersed in Chlorhexidine, Listerine, and Artificial saliva. A glass beaker was taken for placing solutions and then in each group around 40 brackets were dipped and were kept in incubator at 37ºC for around 45 days. Then the amount of ion release from each solution was checked by using atomic absorption spectrophotometer. For statistical analysis, 1-way analysis of variance (ANOVA) and the nonparametric test (Kruskal-Wallis and Mann-Whitney test) were used to study difference between the groups.

Results: The results showed that ion release was significantly (P≤0.05) higher than in the 2 mouthwashes as compared to that in artificial saliva. Higher ion release was found with chlorhexidine compared with Listerine mouthwash. The level of nickel, chromium, iron, manganese and copper ion release was significantly different in all 3 groups.

Conclusions: Within the limits of this *in vitro* study, it can be concluded that the presence of fixed orthodontic appliances leads to an increased concentration of metal ions in salivary secretions in presence of mouth washes. Hence there should be used judiciously.

Keywords: Mouthwash, Saliva, Ion release.

INTRODUCTION

Orthodontic appliances release metal ions through emission of electro-galvanic currents, with saliva acting as the medium for continuous erosion over time is a proven fact.[1,2] Stainless Steel has been the main stay material in orthodontics, since its introduction in 1932, with a wide range of applications in both fixed and removable appliances. The austenitic stainless steel commonly used for orthodontic brackets, bands and wires contain approximately 18 percent chromium and 8 percent nickel.[3] Intra-oral fixed orthodontic appliances include brackets, bands, ligatures, springs and arch wires that are made of alloys containing nickel, cobalt and chromium in different percentages. Saliva is a hypotonic solution containing bioactonate, chloride, potassium, sodium, nitrogenous compounds and proteins.[4]

The pH of saliva varies from 5.2 to 7.8. Metal is released into the oral cavity with saliva as a medium, and this could be influenced by a high chloride mixture in the saliva or the intake of

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various foods and drinks with a low pH. Release of elements can produce discoloration of adjacent soft tissues and allergic reactions in susceptible patient. Factors such as temperature, quantity and quality of saliva, plaque, pH, proteins, physical/chemical properties of solids/liquids food and oral conditions may influence corrosion processes.[5]

Nickel can lead to DNA alterations mainly through base damage and DNA strand scission even at very low concentrations.[6,7] Nickel and chromium and their compounds have been scrutinized for more than 100 years, and it was established that these metals could cause hypersensitivity, dermatitis, and asthma. Long-term exposure to copper can cause irritation of the mouth and eyes and it causes headaches, stomachaches, dizziness, vomiting and diarrhea. Intentionally high uptakes of copper may cause liver and kidney damage. Iron may cause conjunctivitis, choroiditis, and retinitis if it contacts and remains in the tissues. Manganese has symptoms such as schizophrenia, dullness, weak muscles, headaches and insomnia. The central nervous system is the chief site of damage from the disease, which may result in permanent disability.

The purpose of this study was to evaluate and compare the amounts of nickel, chromium, iron, manganese and copper ion released from orthodontic brackets in two different kinds of milieu created in oral cavity by various mouthwashes.

MATERIALS AND METHOD

The study included 120 premolar orthodontic brackets which were dipped in the individual solution of the three groups. There were three groups i.e,. Chlorhexidine, Listerine and artificial saliva.

Group1= Chlorhexidine mouthwash (40)
Group2= Listerine mouthwash (40)
Group3= Artificial saliva (40)

The artificial saliva, used as an immersion test electrolyte, is a modified Tani-Zucchi[8] with the following chemical composition: 5.3×10^{-3} mol/L KSCN, 1.5×10^{-2} mol/L $NaHCO_3$, 2×10^{-2} mol/L KC1, 1.4×10^{-3} mol/L NaH_2PO_4, 0.1 g/L CH_4N_2O (urea), and 0.1 mg/L α-amylase from human saliva. The pH was measured potentiometrically and adjusted with a small amount of acid or base. Solutions were kept in a glass container and then in each of them 40 brackets were dipped and they are kept in incubator at 37°C for around 45 days. Then the amount of ion release from each solution was checked by using atomic absorption spectrophotometer at the biotechnology laboratory.

RESULTS

One-way analysis of variance (ANOVA) was used to analyze the differences among mean ion concentrations in the 3 groups. The mean metal ion concentration for all the ions was calculated**. (Table 1)** A nonparametric test (Kruskal-Wallis) showed that the release of chromium, copper and manganese in the 2 mouthwashes and artificial saliva was significantly different ($P<0.05$) and Iron and Nickel was found no significant difference between the groups. **(Table 2)**

Table 1: Metal ion concentrations (mg/L) in the solutions at 37ºC after 45 days.

Solutions	Nickel	Chromium	Copper	Iron	Manganese	P value
Chlorhexidine	0.98±0.07	4.02±0.08	0.96±0.08	0.96±0.08	2.23±0.12	< 0.05
Listerine	0.97±0.07	0.92±0.08	5.14±0.11	0.92±0.08	1.08±0.08	
Artificial saliva	0.98±0.05	4.98±0.08	0.91±0.08	0.90±0.08	0.91±0.08	

Table 2: Comparison of Metal ion concentrations (mg/L) in three different solutions:

Ion	Group	Mean rank	Kruskal Wallis	P value
Nickel	Chlorhexidine	10.22	0.00	1.00
	Listerine	11.32		
	Artificial saliva	10.54		
Chromium	Chlorhexidine	12.88	16.55	0.04
	Listerine	4.67		
	Artificial saliva	17.66		
Copper	Chlorhexidine	4.77	15.354	0.025
	Listerine	17.44		
	Artificial saliva	5.89		
Iron	Chlorhexidine	9.09	0.00	1.00
	Listerine	9.88		
	Artificial saliva	9.99		
Manganese	Chlorhexidine	12.67	17.889	0.03
	Listerine	6.88		
	Artificial saliva	4.98		

DISCUSSION

A mouthwash must be used twice a week for about 1 minute. We assumed that each time the mouthwash was present for 6 hours in a patient's mouth (24 months, twice a week 5 about 69,000 minutes), so for this study the brackets were immersed in mouthwashes and incubated at 37ºC for 45 days (45 days 5 about 64,000 minutes).[9] We used mouthwashes in a static condition, but more metal release could occur in real life because of the fluidity of saliva in the mouth and also because oxide layers are removed by tooth brushing.[10] Kerosuo et al[11] found a great amount of release after using an oral functioning simulator apparatus to replicate the dynamic conditions of the mouth.

The general mechanism for the corrosion and subsequent release of metal ions from stainless steel involves the loss of the passive layer consisting of chromium oxide and chromium hydroxide that forms on contact with oxygen on the surface of stainless steel. Crevice corrosion, which is an intense local attack in shielded areas on a metallic surface, is the mechanism involved in the corrosion of orthodontic brackets.[12]

Chlorhexidine has affinity for bacteria because of interaction between positively charged chlorhexidine molecule and negatively charged groups on bacterial cell wall and permits the agent to penetrate in cytoplasm and cause the death of microorganism. Phenolic compounds Listerine was tried as an antimicrobial agent. Listerine is an essential oil mouth rinse which contains thymol 0.06%, menthol 0.04%, eucalyptol 0.09%, benzoic acid 0.15%, methyl salicylate 0.06%. The mechanism of action of phenol against bacterial cell is extensively complex and probably involves protein denaturation against damaging cell membrane which result in leakage of intracellular component.

Artificial saliva contains sodium chloride, potassium chloride, sodium sulphate, urea, calcium chloride, distilled water. In the microenvironment of the mouth, the presence of a chloride gradient could contribute to the increased metal degradation observed as one progresses deeper into the crevice between the teeth.[4]

In our study, the total amounts of nickel and chromium released during 45 days in artificial saliva were greater, but according to Barrett et al [13], this is in accordance with the release of nickel and chromium from deionised water were also similar. The concentration of ions such as iron, manganese and chromium were markedly higher in chlorhexidine group as compared to Listerine and artificial saliva. The amount of nickel and chromium

release in chlorhexidine and artificial saliva during 45 days were more and is not in accordance with the study conducted by Kersuo et al. [11]they studied the ion release from different appliances in sodium chloride under dynamic conditions. Since they used different appliances, comparisons between studies must be done with due consideration of the problem in measuring surface areas with attribution to differences in study design, measuring methods, solutions, and timing.

CONCLUSION

The orthodontic brackets released the most ions in the presence of chlorhexidine mouthwash. Chlorhexidine when reacted with stainless steel brackets showed release of more chromium content due to the presence of Chlorhexidine gluconate. It should be reduced because it may cause allergic reactions and carcinogenic effects shows cytotoxicity. Listerine when reacted withstainless steel brackets showed release of more amount of copper content due to the presence of phenolic compounds and the amount should be decreased because it may cause little hypersensitivity reactions such as skin rashes and irritation to eyes. It might be recommended to avoid prolonged application of chlorhexidine in patients who have allergies.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

REFERENCES

1. Gjerdet NR, ErichsenES, RemloHE, Evjen G. Nickel and iron in saliva of patients with fixed orthodontic appliances, Acta Odontologica Scandinavica .1999;49:73-78.

2. Singh DP, Seghal V, Pradhan KL, Chandna A, Gupta R. Estimation of nickel and chromium in saliva of patients with fixed orthodontic appliances, World Journal of Orthodontics .2008; 9:196-202.

3. Matasa CG. Biomaterials in orthodontics, Current Principles and Techniques.2002;4: 345-384.

4. Gajapurada J, Ashtekar S, Shetty P, Biradar A. Ion Release from Orthodontic Brackets in Three Different Mouthwashes And Artificial Saliva: An In Vitro Study. IOSR Journal of Dental and Medical Sciences. DOI: 10.9790/0853-1504017685.

5. Grimsdottir MR, Gjerdet NR, Petterson AH. Composition and in vitro corrosion of orthodontic appliances. Am JOrthod.1992;101:525-32.

6. Lee YW, et al. Carcinogenic nickel silences gene expression by chromatin condensation and DNA methylation: a new model for epigenetic carcinogens, Molecular Cell Biology.1995;15:2547-2557.

7. Faccioni F, FranceschettiP, CerpelloniM, Fracasso ME. *In-vivo* study on metal release from fixed orthodontic appliances and DNA damage in oral mucosal cells, American Journal of Orthodontics and Dentofacial Orthopedics .2003;124:687-693.

8. Tani, G. and F. Zucchi . Electrochemical measurement of the resistance to corrosion of some commonly used metals for dental prosthesis. Minerva Stomatol 1967. 16:710–713.

9. Danaei SM, Safavi A, Roeinpeikar SM, Oshagh M, Iranpour S, Omidkhoda M.Ion release from orthodontic brackets in 3 mouthwashes: An in-vitro study. Am J Orthod Dentofacial Orthop. 2011 Jun;139(6):730-4.

10. Hwang CJ, Shin JS, Cha JY. Metal release from simulated fixed orthodontic appliances. Am J Orthod Dentofacial Orthop 2001;120:383-91.

11. Kerosuo H, Moe G, Kelven E. In vitro release of nickel and chromium from different types of simulated orthodontic appliances. Angle Orthod 1995;65:111-6.

12. Maijer R, Smith DC. Corrosion of orthodontic bracket bases. Am J Orthod 1982;81:43-8.

13. Barret RD et al. Biodegradation of orthodontic appliances and Biodegradation of nickel and

chromium in vitro. Am J Orthod Dentofacial Orthop.1993; 103(1): 8-14.