Comparative evaluation of ion release from orthodontic mini-implants in 2 mouthwashes: An in-vitro study

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ABSTRACT:

Introduction: *Orthodontic mini-implants can release metal ions into the saliva. NiTi orthodontic mini-implants from different manufacturers would have different corrosion resistance. Fluoridated mouthwashes are often recommended to orthodontic patients to reduce the risk of white-spot lesions around their mini-implants. We assayed the corrosion resistance, in terms of ion release, of different NiTi orthodontic mini-implants in different mouthwashes. The purpose of this study is to measure the levels of metal ions released from orthodontic mini-implants after immersion in different mouthwashes.*

Methods: *30 orthodontic mini-implants from two different companies each, divided randomly into 3 equal groups were immersed in HEXIDINE (ICPA health products, India), LISTERINE mouthwash (Johnson & Johnson ltd. Bangalore, India), and distilled deionized water incubated at 37°C for 30 days. Nickel, chromium, iron, copper, and manganese released from the orthodontic mini-implants were measured with an inductively coupled plasma spectrometer.*

Results: *The results showed that ion release in Listerine mouthwash was significantly ($P>0.05$) higher than in the hexidine mouthwash and distilled water group.*

Conclusion: *CHX-containing (HEXIDINE) mouthwash can be offered to patients who have orthodontic appliances rather than Na + alcohol–containing mouthwash (LISTERINE).*

Keywords: *Ion Release, Mini-Implants, Mouthwash.*

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INTRODUCTION

Anchorage control is an important factor in the success of orthodontic treatment. There have been many attempts to devise suitable anchorage methods, including intraoral and extraoral appliances. Mini-implants (MI) are anchorage devices that were introduced in orthodontics in the past two decades and whose use quickly spread in clinical practice.

The small size of mini-screw implants allows them to be placed into bone between the teeth, thus expanding their clinical applications(1). With more patients treated with screw implants as anchorage, their stability is gathering attention(2). In recent years, it has been reported that mini-implants corrosion can occur in the oral environment. In an acidic environment and in the presence of fluoride ions, the corrosion resistance of certain materials, particularly titanium and titanium alloys, can deteriorate(3).

The harmful effects of nickel, its carcinogenicity, allergenicity, and mutating substances have been systematically investigated at the cell, tissue, organ, and organism levels. Approximately 10% of the general population has a hypersensitive reaction to nickel (4-6).

During orthodontic treatment, practitioners recommend their patients to use mouthwashes, especially since most are adolescents who do not always follow a satisfactory oral-hygiene regimen and have a high risk of dental caries. Although fluoride ions in the prophylactic agents have been reported to cause corrosion and discoloration, little information is available regarding the effect of different mouthwashes in ion release of orthodontic mini-implants (7).

The purpose of this study was to measure the levels of metal ions released from orthodontic mini-implants after immersion in two mouthwashes.

MATERIAL AND METHODS

Thirty orthodontic mini-implants from two different companies Dentos India Pvt. Ltd. and S.K Surgicals each were used for this study. All mini-implants were used in as-received condition. The mini-implants were divided randomly into 4 equal groups and immersed in HEXIDINE (ICPA health products, India), LISTERINE mouthwash (Johnson & Johnson ltd. Bangalore, India), and distilled deionized water. These mouthwashes were chosen because of their commercial availability and identical methods of application. Each bracket was incubated in an oven set at a constant temperature of 37°C in individual 20-mL plastic-capped vials containing 15 mL of 1 mouthwash solution or distilled deionized water for 45 days.

At the end of incubation for 45 days, the immersion solution was tested with an inductively coupled plasma (ICP) spectrometer. ICP was used in this study as it has the advantage of extracting each ion simultaneously and detecting the metals without the interference of other ions. Standard stock solutions (100 mg mL_1) of chromium, copper, iron, manganese, and nickel were prepared by dissolving their appropriate salts in distilled deionized water. Each solution was analyzed for chromium, copper, iron, manganese, and nickel ions.

STATISTICAL ANALYSIS

One-way analysis of variance (ANOVA) was used to analyze the differences among mean ion concentrations in the 6 groups. The Post-Hoc Tukey's test was used for multiple group comparisons. P-value<0.05 is considered to be statistically significant.

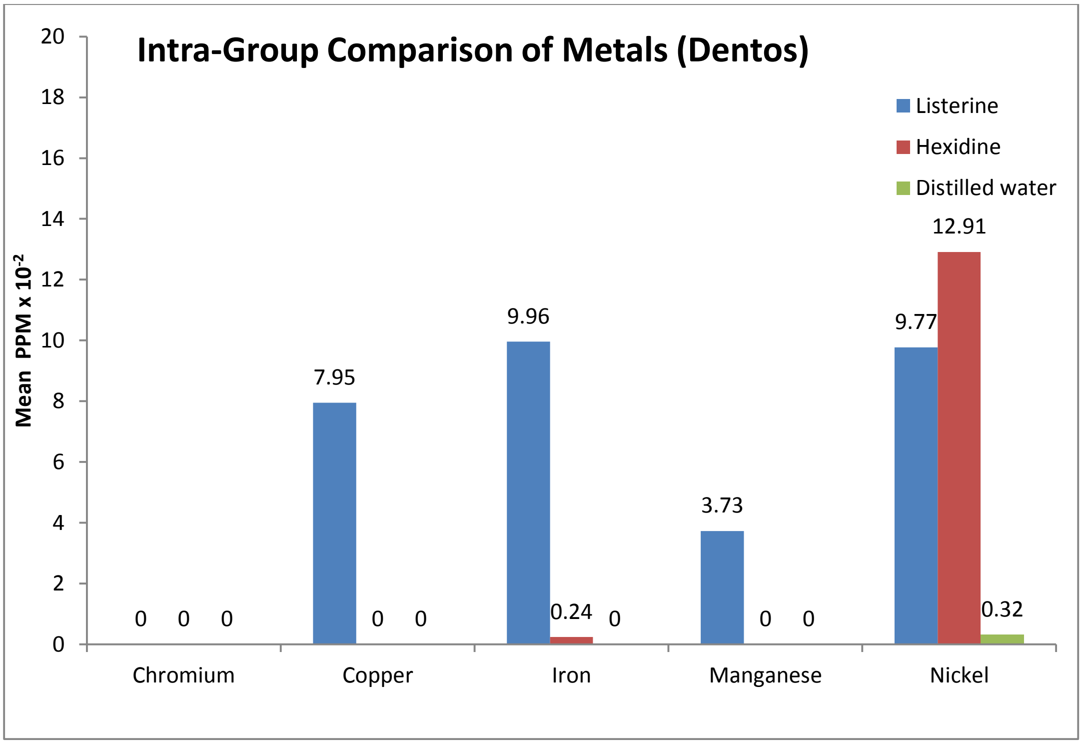
RESULTS

Intra group comparison of metals for Dentos India Pvt. Ltd. mini-implants showed that (Table1) the average level of Chromium did not differ significantly across three sub-groups (P-value>0.05 for all). The average level of Copper is significantly higher in Listerine compared to Hexidine and distilled water sub-groups (P-value <0.001 for both). The average level of Iron is significantly higher in Listerine compared to Hexidine and distilled water sub-groups (P-value<0.001 for both). The average level of Manganese is significantly higher in Listerine compared to Hexidine and distilled water sub-groups (P-value<0.001 for both). The average level of Nickel is significantly higher in Listerine and Hexidine compared to distilled water sub-groups (P-value<0.001 for both). The average level of Nickel is significantly higher in Hexidine compared to Listerine sub-group (P-value<0.001).

Table 1: Intra-group comparison of metals (Dentos Group, n = 30).

	Sub Group (Mouth wash)			P-values (Intra-Group Comparisons)		
Metal ($PPM x 10^{-2}$)	**Listerine (n=10)**	**Hexidine (n=10)**	**Distilled water (n=10)**	**Listerine v Hexidine**	**Listerine v Distilled water**	**Hexidine v Distilled water**
Chromium	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.999^{NS}	0.999^{NS}	0.999^{NS}
Copper	7.95 ± 0.45	0.0 ± 0.0	0.0 ± 0.0	0.001^{***}	0.001^{***}	0.999^{NS}
Iron	9.96 ± 1.91	0.24 ± 0.12	0.0 ± 0.0	0.001^{***}	0.001^{***}	0.987^{NS}
Manganese	3.73 ± 0.29	0.0 ± 0.0	0.0 ± 0.0	0.001^{***}	0.001^{***}	0.999^{NS}
Nickel	9.77 ± 1.09	12.91 ± 0.26	0.32 ± 0.03	0.006^{**}	0.001^{***}	0.001^{***}

Values are Mean ± Standard error of mean (SEM). P-values by one-way analysis of variance (ANOVA) with Post-Hoc Tukey's test for multiple group comparisons. P-value<0.05 is considered to be statistically significant. *P-value<0.05, **P-value<0.01, ***P-value<0.001.

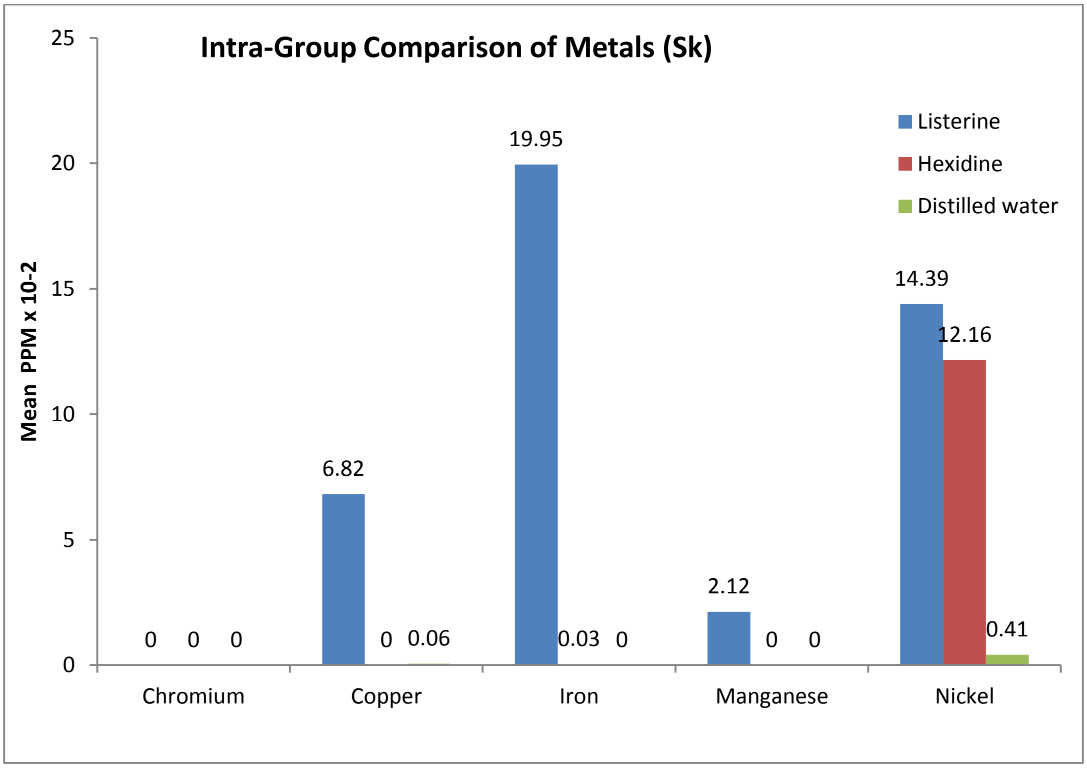


Intra group comparison of metals for S.K.Surgical mini-implants showed that (Table2) The average level of Chromium did not differ significantly across three sub-groups (P-value>0.05 for all).The average level of Copper is significantly higher in Listerine compared to Hexidine and distilled water sub-groups (P-value<0.001 for both). The average level of Iron is significantly higher in Listerine compared to Hexidine and distilled water sub-groups (P-value<0.001 for both). The average level of Manganese is significantly higher in Listerine compared to Hexidine and distilled water sub-groups (P-value<0.05 for both). The average level of Nickel is significantly higher in Listerine and Hexidine compared to distilled water sub-groups (P-value<0.001 for both). The average level of Nickel is significantly higher in Hexidine compared to Listerine sub-group (P-value<0.001).

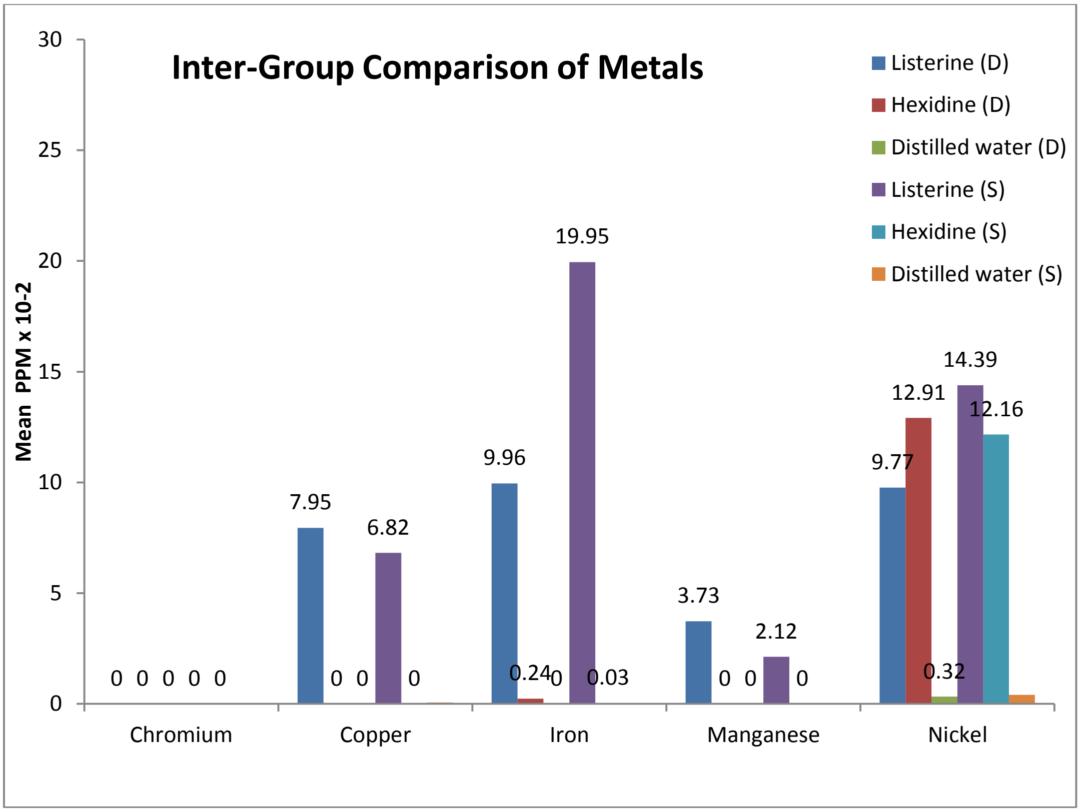
Table 2: Intra-group comparison of metals (Sk Group, n = 30).

	Sub Group (Mouth wash)			P-values (Intra-Group Comparisons)		
Metal ($PPMx10^{-2}$)	**Listerine (n=10)**	**Hexidine (n=10)**	**Distilled water (n=10)**	**Listerine v Hexidine**	**Listerine v Distilled water**	**Hexidine v Distilled water**
Chromium	0.0 ± 0.0	0.08 ± 0.04	0.0 ± 0.0	0.999^{NS}	0.999^{NS}	0.999^{NS}
Copper	6.82 ± 1.64	0.0 ± 0.0	0.06 ± 0.02	0.001^{***}	0.001^{***}	0.999^{NS}
Iron	19.95 ± 9.79	0.03 ± 0.02	0.0 ± 0.0	0.049^{*}	0.048^{*}	0.999^{NS}
Manganese	2.12 ± 0.21	0.0 ± 0.0	0.0 ± 0.0	0.001^{***}	0.001^{***}	0.999^{NS}
Nickel	14.39 ± 1.03	12.16 ± 0.12	0.41 ± 0.03	0.113^{NS}	0.001^{***}	0.001^{***}

Values are Mean ± Standard error of mean (SEM). P-values by one-way analysis of variance (ANOVA) with Post-Hoc Tukey's test for multiple group comparisons. P-value<0.05 is considered to be statistically significant. *P-value<0.05, **P-value<0.01, ***P-value<0.001.



Inter-group distribution and statistical comparison of metals showed that The average level of Chromium is significantly higher in Hexidine (Sk) group compared to Listerine (D), Hexidine (D) and Distilled water (D) sub-groups (P-value<0.05 for all).The average level of Copper is significantly higher in Listerine (D) group compared to Hexidine (S), Distilled water (S) sub groups (P-value<0.001 for all). The average level of Copper is significantly higher in Listerine (S) group compared to Hexidine (D), Distilled water (D) sub groups (P-v1alue<0.001 for all). The average level of Iron is significantly higher in Listerine (S) compared to Hexidine (D) and distilled water (D) sub-groups (P-value<0.05 for both). The average level of Manganese is significantly higher in Listerine (S) compared to Listerine (D), Hexidine (D) and Distilled water (D) sub-groups (P-value<0.001 for all). The average level of Manganese is significantly higher in Listerine (D) compared to Hexidine (S) and Distilled water (S) sub-groups (P-value<0.001 for all). The average level of Nickel is significantly higher in Listerine (S) compared to Listerine (D) and Distilled water (D) sub-group (P-value<0.001 for both). The average level of Nickel is significantly higher in Hexidine (S) compared to Distilled water (D) sub-group (P-value<0.001).



DISCUSSION

The incubation period of 45 days was decided assuming that that each time the mouthwash was present for 6 hours in a patient's mouth (24 months, twice a week = about 69,000 minutes), so for this study the mini-implants were immersed in mouthwashes and incubated at 37ºC for 45 days (45 days about 64,000 minutes) [8].

Also, 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. Although there are several studies that have investigated corrosion on orthodontic appliances caused by mouthwashes, there are not many studies that have investigated the effects of mouthwashes on different mini-implants [9-11].

Since for comparison of ion release in different mouthwashes, we needed a basic solution without influencing ions, we used deionized water to prevent the effects of saliva composition on the basic results. However, from our results, it can be concluded that the corrosiveness of the mouthwash, which in turn depends on its chemical structure, is the main factor responsible for the release of metal ions from dental mini-implants [9].

Our finding is that the greatest amount of metal ion release occurs in Na + alcohol containing mouthwashes and may contribute to both the literature and to clinical practice. Schiff et al. evaluated the corrosion effect of NaF containing mouthwashes with three different concentrations and concluded that 125 ppm NaF-containing mouthwashes should not be preferred for orthodontic appliances containing titanium, iron, chromium, and nickel [12]. The results of our study indicated that CHX-containing mouthwash caused lower amounts of metal release compared to other mouthwashes due to a greenish discoloration occurring on the CHX samples after 24 hours of immersion which constituted a type of passive surface. The pigments may be the reason for the lower metal ion release than expected [13].

From a clinical viewpoint, the corrosion of mini-implants might affect their biocompatibilty, and the final result of orthodontic treatment could be compromised [14]. Certain ions such as nickel and chromium can result in symptoms of toxicity and allergic reactions [15]. Although the reasons a miniscrew may induce inflammation are multifactorial and include patient hygiene level, type of surrounding tissue, and miniscrew head design [16], it should be noted that corrosion has been implicated as one of several triggering factors associated with peri-implantitis of dental implants [17]. These symptoms can be short-lived and intense or longer lasting and moderate, and some might be resolved, whereas others can become a chronic problem [18]. 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 mini-implants[19,20]. We also need to determine whether these ion releases have clinical significance in sensitizing patients with a history of hypersensitivity.

Metal is released into the oral cavity with saliva as the medium, and this could be influenced by a high chloride mixture in the saliva or the intake of various foods and drinks with a low PH. Also, the characteristics of saliva change according to the patient's health and the time of day. 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[21].

CONCLUSION

1. Corrosion resistance of Dentos implants was higher compared to S.K surgical implants.
2. High amount of nickel ions were released in Listerine mouthwash as compared to Hexidine mouthwash
3. CHX-containing (HEXIDINE) mouthwash can be offered to patients who have orthodontic appliances rather than Na + alcohol–containing mouthwash (LISTERINE).

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