Journal of Positive School Psychology http://journalppw.com
2022, Vol. 6, No. 2, 265 – 271

# To assess the surface changes and the release of nickel ions from Nickel-titanium(NiTi) and chromium ions from stainless steel (SS) orthodontic wires on exposure to Betadine Mouthwash

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## Abstract

Introduction: Resistance to degradation and corrosion is a necessity for orthodontic arch wires. Nickel ions and chromium ions can be released from Nickel-titanium and Stainless steel orthodontics arch wires and it can cause various reactions in the body such as allergy and cytotoxicity. This is an in-vitro studywhich has been done to assess the surface changes and the release of nickel ions from Nickel-titaniumand chromium ions from stainless steel (SS) orthodontic wires on exposure to Betadine Mouthwash.

Methods: The study was done on Stainless steel and Nickel-titanium orthodontic arch wires. The samples were immersed in Betadine mouthwash for 1,6,12,24, and 168 hours. SEM analysis was used to study the surface characterisation and EDS was used to quantify the elemental percentage of Nickel in NiTi and Chromium in Stainless steel wire.

Results: changes in Nickel ion concentration was seen in Niti wires, stainless steel wires were relatively stable and no change in Chromium ion concentration was seen.

Conclusions: Nickel ions are released from orthodontic archwires when immersed in betadine gargle.SS wires are relatively stable in betadine solution compared to NiTi wires.

**Aim:** To assess the surface changes and the release of nickel ions from Nickel-titanium and chromium ions from stainless steel (SS) orthodontic wires on exposure to Betadine Mouthwash

## Introduction

Fixed orthodontics involves the use of different types of wires and a range of bracket systems which are made of alloys.These alloysconsists of chromium, cobalt, nickel, and titanium[1,2] and can undergo corrosion in the oral environment due to various changes in the oral cavity leading to release of ions[3].

These ions, especially Nickel, can cause allergic reactions[2]. Aside from the allergic reactions,

release of ions may even cause cytotoxic effects, mutagenesis, and carcinogenesis[4,5].

An increase in pH in the oral cavity can also lead to release of ions from the appliances[6]. Previous studies have found that ions release from Nickel-titanium wires is more than that of stainless steel wires[7].This in-vitro study has beendone to assess the changes in surface characteristics as well as release of nickel and chromium ions from orthodontic archwires on exposure to Betadine mouthwash.

## Materials and methods

2 groups of archwires were used. NiTiand SS wires of 0.016x0.022 dimensions were used in the as received condition from the dealer.

These were then immersed in 100 ml of betadine gargle solution which were kept in a petri dish. The time frames used were 1 hour, 6 hour, 12 hour, 24 hour and 1 week. The wire not immersed in the solution was taken as control wire.

Conentrationof the betadine mouthwash was 1% w/v which was then diluted with bottled water at 1:1 ratio

The samples were then tested using SEM analysis for the wires and AAS analysis for the solution at various intervals of 1,6,12,24 hours and 1 week respectively

SEM analysis :Targeted analysis of sample surfaces can be done using Scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS) (Figure 1,2). These techniques are widely used for material surface analysis. SEM shows a magnified image of the material surface whereas EDS shows the elemental composition of the material.

Figure 1.

Figure 2.

## Results

SEM analysis :

1.Stainless steel wire in Betadine mouthwash

Image A Image B Image C

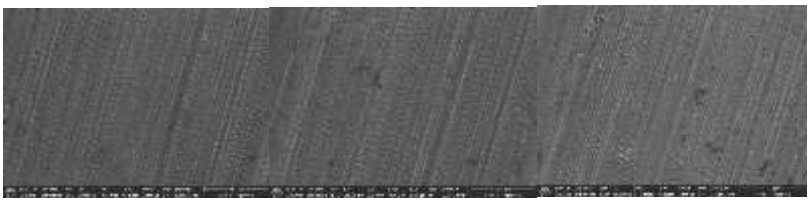

Image D Image E Image F

| | |
|---|---|
| Image A | Stainless steel wire Control |
| Image B | Stainless steel wire, 1 hour |
| Image C | Stainless steel wire, 6 hour |
| Image D | Stainless steel wire, 12 hour |

| | |
|---|---|
| Image E | Stainless steel wire, 24 hour |
| Image F | Stainless steel wire, 1 week |

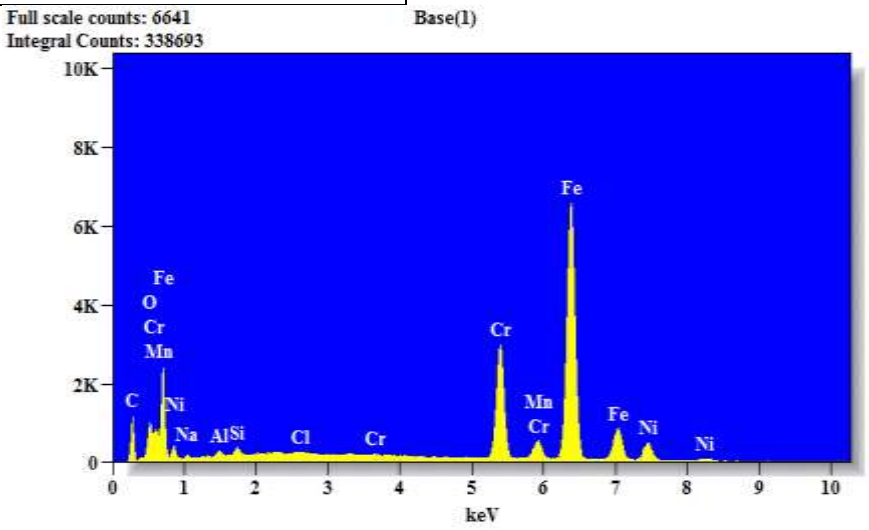


Table 1: EDS of stainless steel wire control

| Element | Net Counts | Weight % | Atom % |
|---|---|---|---|
| C | 6476 | 6.97 | 23.60 |
| O | 5296 | 3.66 | 9.29 |
| Na | 533 | 0.51 | 0.91 |
| Al | 1089 | 0.44 | 0.66 |
| Si | 1747 | 0.55 | 0.79 |
| Si | 0 | --- | --- |
| Cl | 450 | 0.11 | 0.12 |
| Cl | 33 | --- | --- |
| Cr | 43207 | 16.87 | 13.20 |
| Cr | 2215 | --- | --- |
| Mn | 1827 | 1.01 | 0.75 |
| Mn | 0 | --- | --- |
| Fe | 104953 | 63.19 | 46.03 |

| | | | |
|---|---|---|---|
| Fe | 22462 | --- | --- |
| Ni | 7609 | 6.71 | 4.65 |
| Ni | 3126 | --- | --- |
| Total | | 100.00 | 100.00 |

Table 2 : Chromium weight percentage in SS wire exposed to Betadine mouthwash using EDS in various time frames

| Wire | Time frame | Cr weight % |
|---|---|---|
| Stainless Steel | Control | 16.87% |
| | 1 hour | 16.62% |
| | 6 hour | 16.23% |
| | 12 hour | 16.43% |
| | 24 hour | 16.83% |
| | 1 week | 16.71% |

2.Nickel Titanium wire in Betadine mouthwash

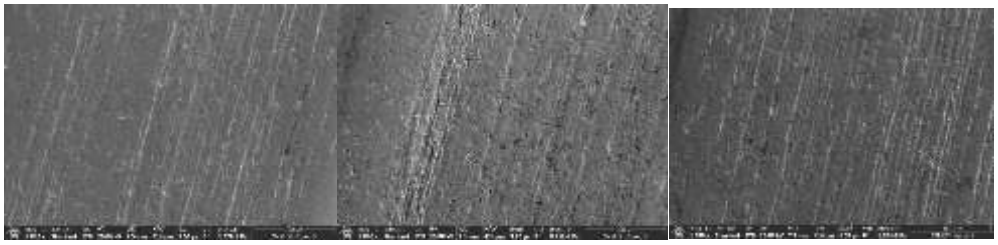

Image G Image H Image I

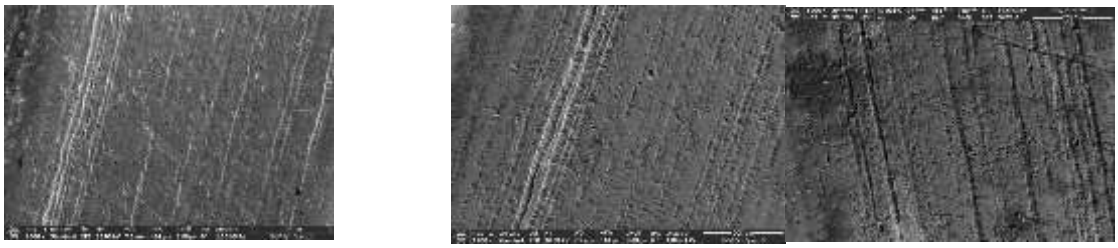

Image J Image K Image L

| | |
|---|---|
| Image G | NiTi control |
| Image H | Niti ,1 hour |
| Image I | Niti, 6 hour |
| Image J | Niti, 12 hour |
| Image K | Niti, 24 hour |

| | |
|---|---|
| Image L | Niti, 1 week |

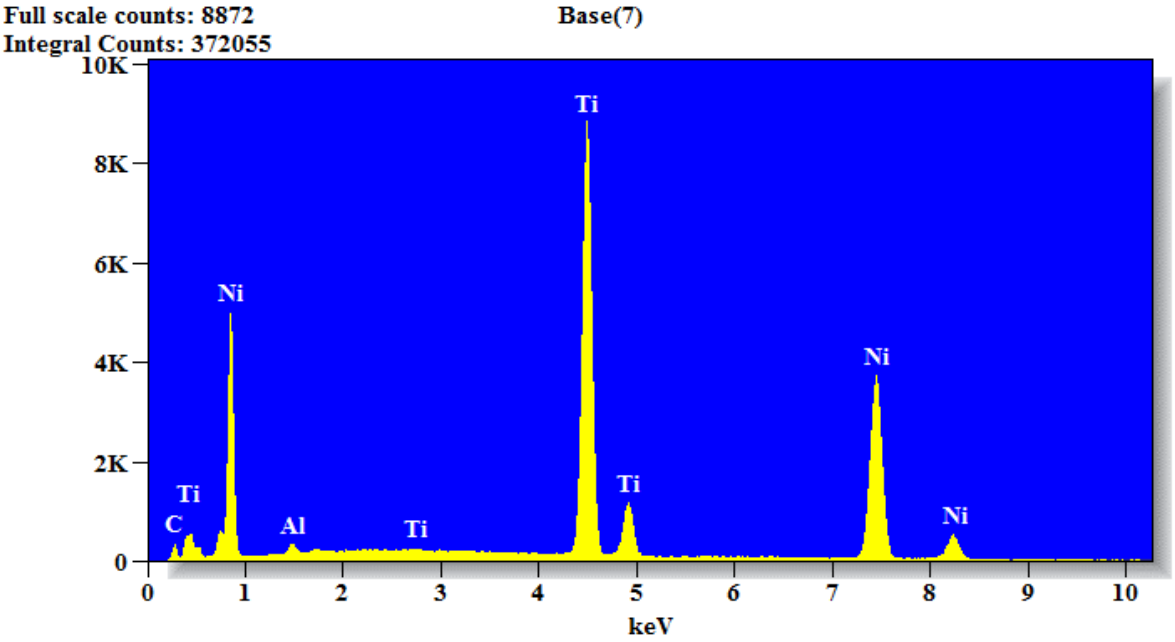


Table 3. EDS of NiTi control wire

| Element | Net Counts | Weight % | Atom % |
|---|---|---|---|
| C | 1860 | 2.20 | 9.02 |
| Al | 1380 | 0.59 | 1.08 |
| Ti | 118221 | 43.23 | 44.53 |
| Ti | 6609 | --- | --- |
| Ni | 63580 | 53.98 | 45.36 |
| Ni | 45700 | --- | --- |
| Total | | 100.00 | 100.00 |

Table 4. Nickel weight percentage in Niti wire exposed to Betadine mouthwash using EDS in various timeframes

| Wire | Time frame | Ni weight % |
|---|---|---|
| NiTi | Control | 53.98% |
| | 1 Hour | 53.83% |
| | 6 hour | 44.86% |
| | 12 hour | 45.12% |
| | 24 hour | 45.33% |

| | | |
|---|---|---|
| | 1 week | 44.18% |

## Discussion

Image A,B,C,D,E,F shows the SEM image of stainless steel wire exposed to betadine mouthwash in various time frames and it did not show any surface changes as the exposure time to betadine mouthwash increased. Table 1 shows the elemental composition of the control stainless steel wire which showed 16.87 weight percentage of Chromium. Table 2 shows the Chromium weight percentage in different time frames and it did not show any variations suggesting that stainless steel wire is relatively stable and does not have any ion release in betadine mouthwash.

Image G,H,I,J,K,L shows the SEM image of NiTi wire exposed to betadine mouthwash in various time frame. Increase in surface roughness is evident from the images, with the roughness increasing with increasing time frames. Table 3 shows the elemental composition of NiTi control wire which showed 53.98 weight percentage of Nickel. Table 4 shows the Nickel weight percentage in NiTi wires as the exposure time to betadine increased. A reduction in Nickel weight percentage was seen at 6,12,24 hours and 1 week. Ion leaching was present in Niti wires when exposed to betadine mouthwash suggesting it is less stable in betadine mouthwash.

Corrosion resistance of orthodontic wires varies among different manufacturers [8]and in this case we have assayed the corrosion resistance with respect to ion release and surface changes in betadine gargle solution.

Increase in incidence of allergic reaction to Nickel and increase in availability of orthodontic treatment have created growing interest in the composition of alloys and the release of metals during treatment.Several authors have reported corrosion of orthodontic appliances *in vitro*, but due to variation in study designs and different electrochemical factors make comparisons between the studies difficult[9].

The preparation and analytical procedures are technique sensitive and may be a source of variation also.Stainless steel wire does not exhibit much surface changes in betadine solution and there isn't much variation in chromium ion concentration in the wire[9].

NiTi wires exhibit surface changes as well variation in Nickel ion concentration in the wire which implies that betadine has a deleterious effect on NiTi wires.

In this study, even though release of Nickel and chromium ions were detected, how much ions would be absorbed by the patient still needs to be determined

## Conclusion

Nickel ions are released from orthodontic archwires when immersed in betadine gargle.

SS wires are relatively stable in betadine solution compared to NiTi wires.

Further studies are required with more extensive, more number of samples and longer duration of time period to measure the effects of betadine mouthwash on orthodontic archwires as well as to measure the amount of ions ingested by the patient.

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