

Evaluation of the Effect of Pudhina Mouthwash on Surface Characterisation of Nickel Titanium Archwires Used in Orthodontics – An Invitro Study

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ABSTRACT

Objective: Mouthwashes are prescribed for maintaining and improving patient's oral hygiene during orthodontic treatment. Commercially available mouthwashes e.g. Chlorhexidine, Listerine, fluoride containing mouthwashes alters the surface characteristics of orthodontic wires. Hence the purpose of the study was to evaluate the effect of a herbal mouthwash containing Pudhina, on surface quality and compositional changes of Nickel Titanium orthodontic wires.

Materials and Methods: In this in-vitro study, pre-formed 0.016 * 0.022 inch NiTi arch wire was used. The study comprised of two 25mm length Niti wires, one control and one test sample. Control sample was stored at room temperature without any manipulation, while the test sample was immersed in Pudhina mouthwash solution for 1.5 hours, after which the test specimen was removed and rinsed with distilled water. Both control and test samples were sent for scanning electron microscopy analysis, to qualitatively characterize the topography of the wire surface. Electron dispersion spectrum analysis was done to evaluate the various components of both the wires.

Results: No significant difference in the average surface roughness for both wire samples was observed. There was no significant difference seen in the composition of wire after immersion in Pudhina mouthwash.

Conclusion: Pudhina mouthwash did not have significant influence on the surface roughness of the wire, also there was no alterations in the composition of the Ni-Ti wire. Hence Pudhina mouthwash may be prescribed as a natural, non-destructive prophylactic agent for orthodontic patients.

Keywords:

Mentha arvensis (Pudhina), Surface changes, Nickel Titanium Orthodontic wires, Scanning electron microscopy, Electron dispersion spectrum analysis

1.Introduction

The principle of orthodontic therapy is to utilize the stored elastic energy in the orthodontic wires to carry out desired tooth movement.^[1] Efficient orthodontic treatments rely on the perfect design and condition of the wires. Wires exposed to the oral environment are subjected to acidic environment of the oral cavity and various supplements such as prophylactic agents and mouthwash solutions which results in corrosion of the wire. This gradual corrosion of the wire resulting from chemical reactions can have several adverse effects such as the release of elements from metallic wires and roughening of the wire surface.^[2] Orthodontic treatment requires the use of bands, brackets, wires, and ligatures resulting in a change in oral environment which makes the dental plaque elimination challenging. Dental plaque accumulation accentuates around the bands and brackets during orthodontic treatment leading to gingivitis and dental caries.^{[3],[4],[5]} Studies have shown progression of hyperplastic gingivitis during 1–2 months after bonding of the fixed appliances.^[4] Alterations in oral microflora and limited access to teeth surfaces result in gingivitis and decalcifications around fixed appliances, therefore, to prevent these side effects, oral irrigation with different mouthwashes have been suggested.^{[6],[7]} Chlorhexidine is one of the most commonly prescribed

mouthwashes which is used effectively in periodontal and orthodontic patients. This mouthwash inhibits plaque formation and acidogenic bacteria and indirectly can reduce dental caries.^[8] However, chlorhexidine mouth rinses are usually prescribed for a short term only due to its metallic taste and adverse effects on tooth colour and normal oral flora.

Fluoride ions in fluoride mouthwashes, are prescribed by orthodontist for prevention of white spot lesions, have been reported to cause corrosion, discoloration, and alteration of the mechanical properties of metallic wires.^[9,10] Prescribing oral mouthwashes is usually necessary in orthodontic patients, but the main concern is their side effects on orthodontic attachments and wires. These mouthwashes can affect superficial surface characteristics and mechanical properties of metallic parts of orthodontic appliances. To overcome the side effects of inorganic mouthwashes, more natural and herbal products can be used as mouthwashes. One such natural alternative is *Mentha arvensis* (Pudhina). Pudhina / Mint is a commonly available herb and is found to have a broad range of therapeutic effects such as antiviral, antibacterial, antifungal, analgesic, anti-inflammatory, immune enhancing effect, which can be used to prevent plaque accumulation, gingival inflammation, and demineralization around orthodontic brackets. Hence, the objective of this article is to evaluate the effect of Pudhina as a mouthwash on the surface properties of the NiTi orthodontic wire.

2. Materials and Methods

In our study two preformed 0.016 * 0.022 inch NiTi wires of length 25 mm each were use

1. Control group – A single 0.016 * 0.022 inch NiTi wire stored at room temperature without manipulation
2. Test group – A single 0.016 * 0.022 inch NiTi wire immersed in Pudhina mouthwash.

Preparation of Pudhina mouthwash – Pudina leaves were obtained from market and were dried in sunlight. The dried leaves were then powdered finely. 100 gram of finely powdered Pudina was then macerated with 500 ml of 100% methanol and later subjected to filtration with Whatman filter paper to obtain a clear filtrate. The filtrate so obtained was reduced at a temperature less than 60° C to obtain a solid residue of Pudina extract.^[11] Test sample was immersed in Pudhina mouthwash solution for 1.5 h. This exposure time is equivalent to 3 months of 1-min daily mouthwash application.^[12] The test specimen was removed from the mouthwash solution and rinsed with distilled water and sent for scanning electron microscopy analysis, to qualitatively characterize the topography of the wire surface. The samples were also sent for electron dispersion spectrum analysis to determine change in the constitution of the wire after immersion in Pudhina mouthwash, if any.

3. Results

Both the control and test wire samples were evaluated using scanning electron microscope under a magnification of 800X. Both the wire surfaces appeared to have numerous linear zones, which might be the result of the manufacturing process of the wire. The test wire surface did not show any dark smudge areas, elongated, mottled, globular or pitted surface characteristics, after exposure to Pudhina mouthwash, indicating no severe changes in the wire surface topography as compared with the control wire as shown in [\[Figure 1\]](#) and [\[Figure 2\]](#).

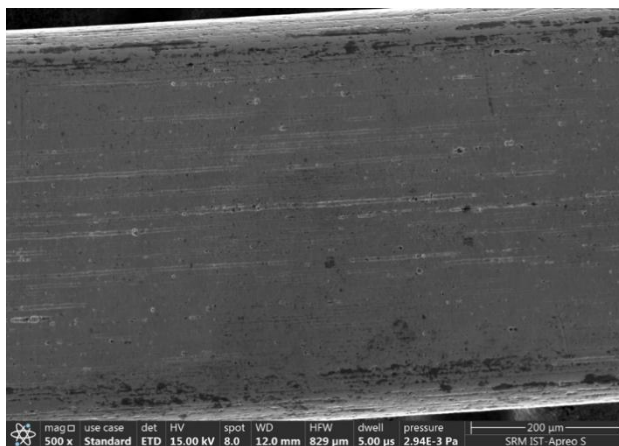


Fig.1: SEM – Control sample

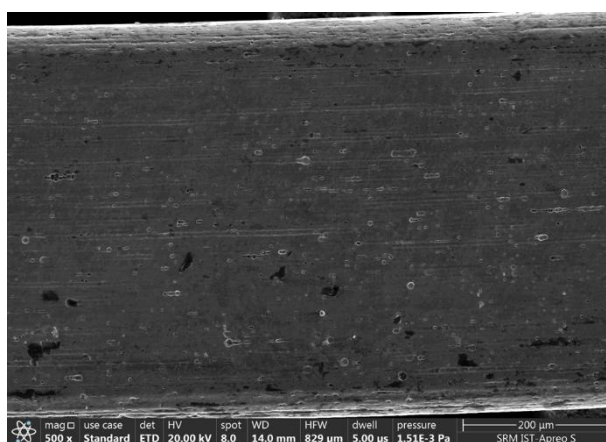


Fig.2: SEM – Test Sample

Electron dispersion spectrum analysis of control [Figure 3] and test wire samples [Figure 4] did not show any change in the constituents of the wire after immersion in Pudhina mouthwash as shown in [Table 1] and [Table 2].

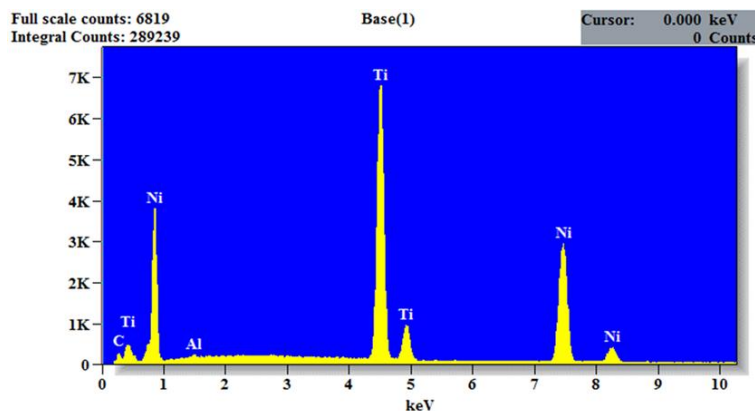


Fig.3 : Electron dispersion spectroscopy – Control sample

<i>Element</i>	<i>Net Counts</i>	<i>Int. Cps/nA</i>	<i>Weight %</i>	<i>Atom %</i>
<i>C</i>	1459	---	2.08	8.60
<i>Al</i>	518	---	0.27	0.50
<i>Ti</i>	92736	---	43.47	45.07
<i>Ti</i>	5654	---	---	---
<i>Ni</i>	49666	---	54.17	45.83
<i>Ni</i>	35238	---	---	---
<i>Total</i>			100.00	100.00

Table 1: Electron dispersion spectroscopy – Control sample

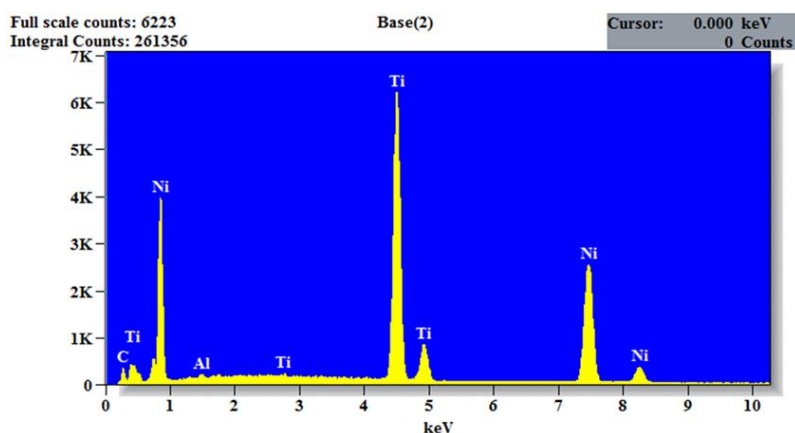


Fig.4 : Electron dispersion spectroscopy – Test sample

<i>Element</i>	<i>Net Counts</i>	<i>Int. Cps/nA</i>	<i>Weight %</i>	<i>Atom %</i>
<i>C</i>	1822	---	2.85	11.48
<i>Al</i>	453	---	0.26	0.47
<i>Ti</i>	82149	---	43.54	44.03
<i>Ti</i>	4936	---	---	---
<i>Ni</i>	43190	---	53.35	44.01
<i>Ni</i>	33798	---	---	---
<i>Total</i>			100.00	100.00

Table 2 : Electron dispersion spectroscopy – Test sample

4.Discussion

Fixed orthodontic treatment requires bonding of attachments/brackets to the teeth surface to facilitate tooth movement. These attachments provide a surface for retention of plaque and make oral hygiene maintenance difficult. Maintenance of good oral hygiene during fixed orthodontic treatment is very important to prevent the iatrogenic effects of bonding attachments to the teeth surface. Mouthwashes prescribed for these purposes (chlorhexidine (most commonly used) and fluoride containing) might have negative effects on the properties of orthodontic archwires, which are the mainstay of orthodontic treatment. Nowadays, many patients are attracted toward the herbal or natural products because they are considered to be harmless and have minimal side

effects, if any. *Mentha arvensis* (Pudhina) is a traditional folk medicinal plant which has various nutrients that provide this plant with a wide range of therapeutic effects and nutritional value with many health benefits. More than 160 phytochemicals are present in the Pudhina / Mint plant which includes phenolic compounds, organic acids, and alkaloids which are proven to have antimicrobial, antifungal, anti-inflammatory, and anti-carcinogenic properties.^[13] Analysis has shown that there are no toxic or prohibited substances in *Mentha arvensis* and it is a potential source of phytochemical constituents and antimicrobial agents which may be useful for pharmaceutical industries.^{[14],[15]}

Studies have not been conducted to evaluate the effect of Pudhina mouthwash on the corrosion of orthodontic wires, so this study was undertaken to evaluate the surface changes and compositional changes in orthodontic wire by Pudhina mouthwash. Soni *et al.*^[16] studied the effect of fluoride mouthwash on the surface quality of orthodontic wires and found that fluoride mouthwash produced qualitative surface topography changes on wires and following fluoride exposure wires exhibited an increase in overall surface roughness. Study done by Brar *et al.*^[17] also found that fluoride-containing Listerine mouthwash produced high corrosion rate of the wire, followed by chlorhexidine, and least corrosion rate was found in organic (neem) mouthwash. Pudhina / Mint has been used as a mouthrinse in gingivitis patients and as a mouth freshener. Hence, to make use of anti-caries and anti candidal property of Pudhina in orthodontic treatment, we conducted a study to evaluate the effects of Pudhina mouth wash in orthodontic archwire.

The archwire used in orthodontic treatment for aligning (0.016*0.022 inch NiTi wire) was chosen for the study. The control group was not immersed in any solution whereas the test group was immersed in the prepared Pudhina mouth rinse for 1.5 h which is equivalent of 3 months of 1 min daily mouth rinsing with Pudhina mouthwash.^[18] The passivation effect for nickel-titanium wires is provided by the titanium oxide layer formed at the surface of the wire. This surface passivation prevents further oxygen diffusion, resulting in corrosion resistance, however, if the passivation layer is disrupted, the wires become susceptible to corrosion.^[19] In our study, there was no significant change in the wire surface topography indicating that the passivating layer was not disrupted and the corrosion resistance of the wire was maintained. Studies have found that chlorhexidine mouthwash increases corrosion of orthodontic wires and causes release of Ni and Cr ions from the wires.^{[17],[20]} This provides metallic taste sensation and discoloration of teeth. Pudhina mouthwash did not cause significant corrosion of the archwire thus decreasing the possibility of metallic ion release. This can be confirmed by electron dispersion spectrum analysis which showed the same levels of different constituents of the wire even after immersion in Pudhina mouthwash. Hence, proving that Pudhina mouthwash is reliable in maintaining the surface properties and corrosion resistance of the wire. Oral cavity conditions are more complex due to factors such as pH changes, oxygen level concentration, temperature, food debris which leads to increased corrosion of orthodontic wires and further study is needed to evaluate the changes intraorally.

5. Conclusion

Pudhina mouthwash did not cause any change in the surface property or the constitution of the orthodontic wire. Further research can be carried on this subject to confirm the *in vivo* use of Pudhina mouthwash.

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Nil.

Conflicts of interest

There are no conflicts of interest

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