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COMPARATIVE EVALUATION OF SODIUM FLUORIDE AND AMINE FLUORIDE BASED MOUTHRINSES ON THE SURFACE ROUGHNESS OF NICKEL TITANIUM WIRES: A SCANNING ELECTRON MICROSCOPY (SEM) STUDY

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ABSTRACT

Introduction: A routine prophylactic procedure during fixed appliance therapy is the use of fluoride mouthrinses to help maintain the patients' oral hygiene and reduce the chances of development of white spot lesions and caries post fixed therapy. They are commercially available mouthrinses and easily available over the counter. These prophylactic agents affect the mechanical properties of the Ni-Ti wires. Thus, it is vital to study the effects of these fluoride agents on the Orthodontic appliance during fixed appliance therapy.**Aim and Objective**: The aim of the study was to assess the effect on the surface roughness of Ni-Ti wires when subjected to two different fluoride based mouthrinses**Materials and Method:** This was a scanning electron microscopy study wherein one hundredand twenty Ni-Ti wires of dimensions 0.019" x 0.025" (Ormco Corp, California, USA) were evaluated. The wires were cut into pieces of 10 mm each and were placed in three solutions for 4.5 hours. Two fluoride based mouthrinses and one control solution was used for the study. The solutions were divided into three groups as followsGroup I: A Control Solution – Artificial Saliva, Group II: Sodium Fluoride Based mouthrinse (Proflo Fluoride Mouth Rinse, Sandika Pharmaceuticals Ltd, India), Group III: Amine fluoride based Amflor Oral Rinse® **(**Amine fluoride, Group Pharmaceuticals Ltd, India). Surface irregularities were studied with a Scanning Electron Microscope (Quanta 200, FEI, Hillsboro,USA).Image obtained through SEM were evaluated for its roughness profile by surface analysis software "Mountains Map Premium 7.3" and degree of irregularities analysed.**Results:** Based on the SEM results, there was a statistically significant increase ($P < 0.05$) in the surface roughness (Sa) of wires exposed to Sodium fluoride as compared to those exposed to Amine fluoride. This increase in surface roughness, in turn affects the frictional resistance of the wire making its application in levelling and alignment

Keywords: Fluoride, Mouthrinse, Ni-Ti, Surface roughness, Scanning Electron Mi

Introduction

Fixed Appliance is the mainstay therapy in Orthodontics. Orthodontic tooth movement occurs in three phases starting with the initial levelling and alignment, followed by space closure and finishing and detailing.[1]

There are two methods for space closure. They are frictionless mechanics, which involves the use of loops to close the spaces and the second method is sliding mechanics which consists of sliding movement of the wires in the bracket slots and tubes.[2]

Present day Orthodontists prefer sliding mechanics as there is simplicity in this technique.

However, the frictional resistance offered by the bracket-slot and wire interface affects space closure. Thus, controlling this friction is important.

Various factors play a role in friction, one of them being surface roughness. An increase in the

surface roughness of the wire would directly increase the frictional resistance of that particular wire.[3]

With the introduction of fluoride based toothpastes and mouthrinses, an increase in the

prescription of these products were done by Orthodontist to overcome one of the major shortcomings of fixed appliance therapy, i.e., maintaining the oral hygiene.

Due to the presence of wires, brackets, elastics and other treatment modalities, it is difficult for the patient to maintain their oral hygiene thereby causing an increase in caries and white spot lesions at the end of fixed orthodontic therapy.

The fluoride based mouthrinses usually have a pH of 3.5-7 and this causes a damage to the

oxide layer present on these wires thereby causing corrosion and discolouration thereby altering the mechanical properties of orthodontic wires.[4]

The effect of fluoride on NiTi archwires have not been commonly addressed. Thus, this study

aims to assess the effect on the surface roughness of Ni-Ti wires when subjected to two different fluoride based mouthrinses.

Aims and Objectives

The aim of the study was to assess the effect on the surface roughness of Ni-Ti wires when

subjected to two different fluoride based mouthrinses

Materials and Method

This in-vitro study was carried out in the Department of Orthodontics and Dentofacial

Orthopaedics in MGM Dental College & Hospital, Kamothe, Navi Mumbai. The study was approved by the Institutional Ethical committee.

One hundred and twenty (forty each) Ni-Ti wires of dimensions 0.019" x 0.025" (Ormco Corp,

California, USA) were evaluated as a part of the study. The wires were cut into pieces of 10 mm each and were placed in three solutions for 4.5 hours. Two fluoride based mouthrinses and one control solution.

The solutions were divided into three groups as follows:

Group I: A Control Solution – Artificial Saliva.

Group II: Sodium Fluoride based mouthrinse (Proflo Fluoride Mouth Rinse, Sandika Pharmaceuticals Ltd, India)

Group III: Amine fluoride based mouthrinse (Amflor Oral Rinse® Group Pharmaceuticals Ltd, India).

Figure 1: PROFLO Mouthrinse (Group II)

Figure 2: Amflor Mouthrinse (Group III)

Surface irregularities were studied with a Scanning Electron Microscope (Quanta 200, FEI,

Hillsboro, USA). Each specimen was cleaned, dried, and mounted with the help of a double

ended tape on cylindrical mounts of 1" in diameter. The mounted specimens were magnified at 5,000x magnification and images were obtained. Images obtained through SEM were evaluated for its roughness profile by surface analysis software "MountainsMap Premium 7.3" and degree of irregularities analysed. A 2D SEM image is converted in a 3D topographic file by the aforementioned software which is later used for evaluating the surface roughness of the specimen.

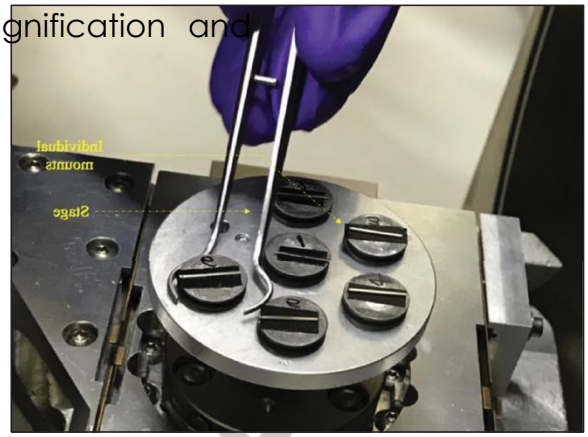


Figure 3: Individual mounts loaded on the stage of SEM

Results

The surface roughness of the NiTi wires exposed to sodium fluoride and amine fluoride based mouthrinses was assessed after immersing them in the three test solutions for a duration of 4.5 hours.

The results are tabulated as follows:

	Sa (average roughness)		Sq (root mean square roughness)	
	Mean	SD	Mean	SD
Group I(Control)	62.36	3.71	126.42	5.72
Sodium F^+ based)	66.34	3.59	112.21	8.46
Group III (Amine F^+ based)	61.56	2.30	120.6	5.28

Table 1: Mean 'Sa' and 'Sq' values

Both the average roughness (Sa) and root mean square roughness (Sq) were calculated.

Sa is the extension of Ra (arithmetical mean height of a line) to a surface. It expresses, as an absolute value, the difference in height of each point compared to the arithmetical mean of the surface. This parameter is used generally to evaluate surface roughness. Sq represents the root mean square value of ordinate values within the definition area. It is equivalent to the standard deviation of heights.

Figure 4: Scanning Electron Microscope

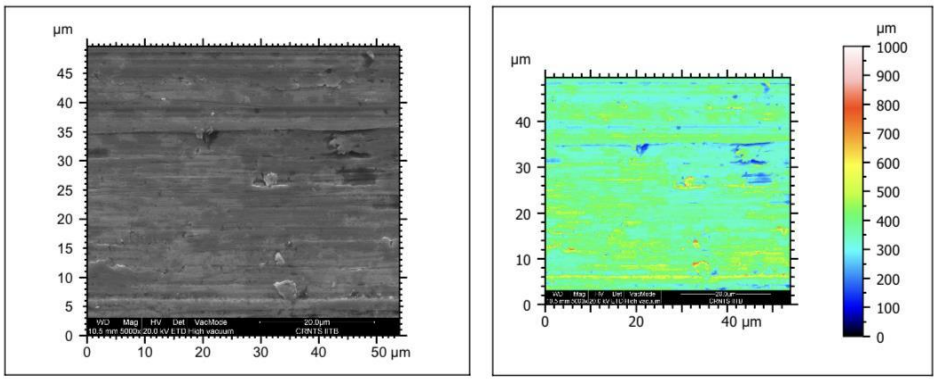


Figure 5: SEM results of Group I [Control group]

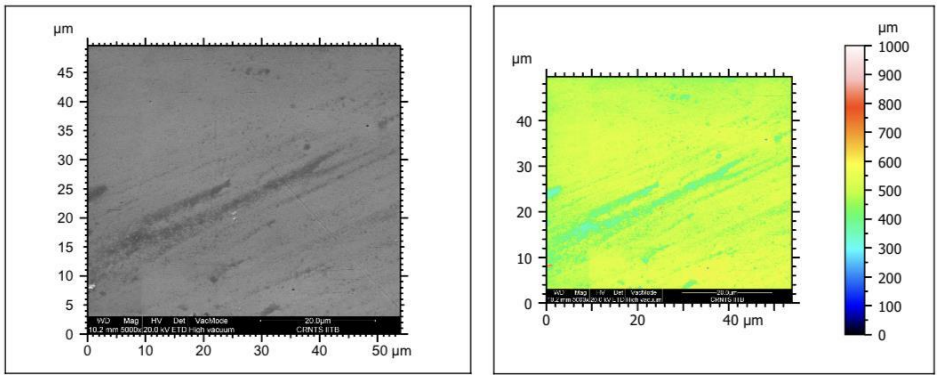


Figure 6: SEM results of Group II [Sodium fluoride based mouthrinses]

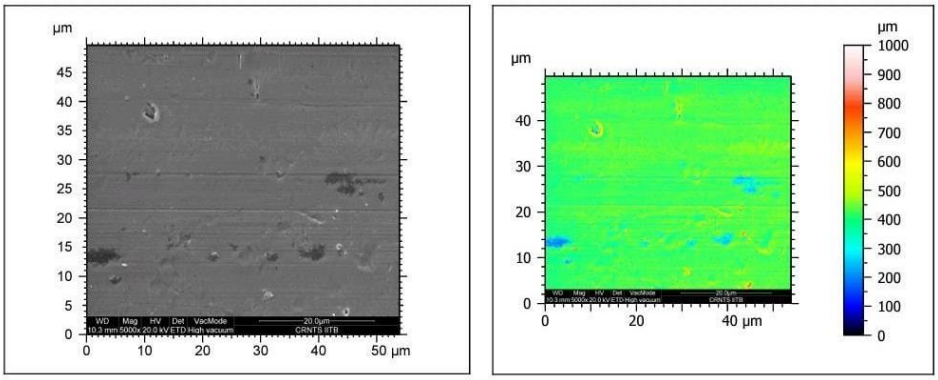
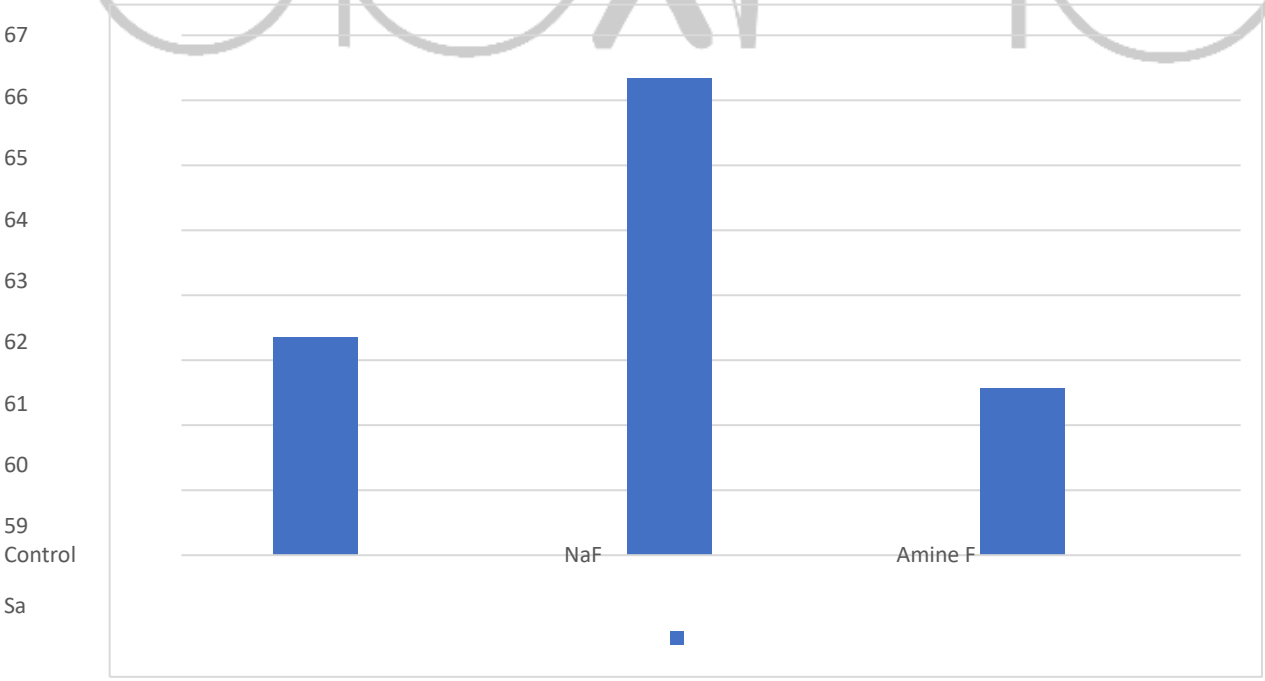


Figure 7: SEM results of Group III [Amine Fluoride based mouthrinses]



Graph 1: Scanning Electron Microscopy (Sa; linear)

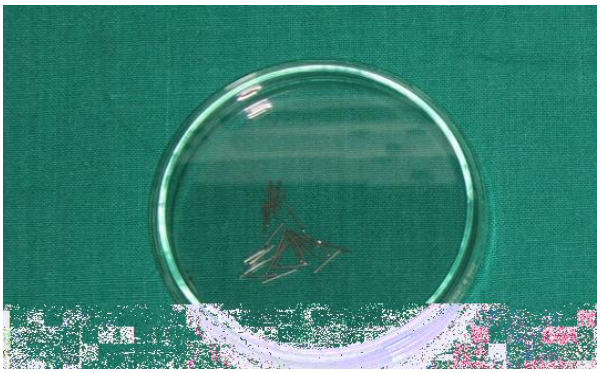


Figure 8: Group I (Control)

Figure 9: Group II (Sodium F^+ based)

Figure 10: Group III (Amine F^+ based)

Discussion

Fixed Orthodontic therapy dates its origin back to the late 1800's with the introduction of the E-Arch appliance by Dr. Edward Angle. Two centuries later along with the advent of various other fixed mechanotherapy's, there is still a major challenge of maintenance of oral hygiene. The presence of brackets, wires along with elastics increases the chances of food

retention and causes difficulty in brushing. This leads to a detrimental effect on the oral hygiene of the patient.[5]

To overcome this shortcoming of the fixed appliance therapy, fluoride mouthrinses are often recommended by the Orthodontist to the patient.

The fluoride reacts with the hydroxyapatite crystals of the enamel to form fluoridated hydroxyapatite which causes the structure of the tooth to be more stable.[6]

The introduction of NiTi alloys in 1970's caused a dynamic shift in the field of Orthodontics. With properties such as shape memory and super elasticity along with their ability to apply light continuous force, NiTi wires were preferred during the initial levelling and alignment stage as well as during the finishing stages of fixed appliance therapy.[7]

This led to the question of the effect of fluorides on NiTi archwires and this study was carried out to understand the effects of the various commercially available fluorides on NiTi archwires. A Scanning Electron Microscopy (SEM) test was done after the immersion of these wires in the three solutions.

Based on the results, least surface roughness was seen with Group III: Amflor Oral Rinse® **(**Amine fluoride, Group Pharmaceuticals Ltd) and the highest was seen with Group II: Proflo Anticavity mouth rinse (Sodium fluoride, Sandika Pharmaceuticals Ltd).

Introduction of fluoride mouthrinses during the fixed therapy treatment causes corrosion in both brackets and wires due to the dissolution of surface protective oxide layer by the Hydrofluoric acid (HF).[8]

According to a study by Chitra P et al, the amount of metal ions released showed an increase when orthodontic appliances were exposed to fluoride agents during the period of use. The element fluoride causes a breach in the protective titanium oxide later allowing for the corrosion process to begin. They concluded in the study that the amount of metal ions released due to the exposure of fluoride in the oral environment caused oxidative stresses thereby increasing the surface roughness of the NiTi wire.[9]

Another article published by Walker M et al, stated that Titanium-based alloys have high corrosion resistance because they form a thin, stable oxide layer. Nevertheless, fluoride prophylactic agents can cause corrosion and associated discoloration of titanium-based orthodontic wires. The results obtained from their tests were that unloading mechanical properties of Ni-Ti orthodontic wires were significantly decreased after exposure to the fluoride agents and they concluded that that using topical fluoride agents with Ni-Ti wire could decrease the functional unloading mechanical properties of the wire and contribute to prolonged orthodontic treatment.[10]

A study conducted by Ehrami E et al on the effect of two fluoride mouthwashes on the surface topography of the orthodontic wires concluded that surface roughness of Ni-Ti wires increased on exposure to fluoride agents.[11]

There is a direct co-relation of surface roughness and its effect on treatment mechanics. The lesser the surface roughness, lesser the frictional resistance, thus, facilitating faster tooth movement. [12]

According to the results obtained from our study, there was an increase in surface roughness with both the groups, i.e., the sodium fluoride group and the amine fluoride group. **Conclusion**

Thus the use of fluoride mouthwashes during the initial stages and finishing stages of orthodontic therapy is detrimental since there is an increase in friction between the bracket and arch-wire due to increased surface roughness.

Declaration of Conflicting Interest

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References

1.**Proffit WR, Fields Jr HW, Sarver DM.** *Contemporary Orthodontics. Elsevier Health Sciences; 2006.*

2.**Graber T, Lee W, Vanarsdall RL.** *Orthodontics: Current Principles and Techniques. Elsevier Health Sciences; 2011.*

3. **Wichelhaus A, Geserick M, Hibst R, Sander FG.** The effect of surface treatment and

clinical use on friction in NiTi orthodontic wires. *Dent Mater; 2005; 21(10): 938-45.*

4. **Mane P, Ganiger CR, Pawar R, Phaphe S, Ronad YA, Valekar S, Kanitkar AA.** Effect of fluoride on mechanical properties of NiTi and CuNiTi orthodontic archwires: An in-vitro study. *Dental Press J Orthod. 2021; 26(2): 1-20.*

5. **Naranjo AA, Triviño ML, Jaramillo A, Betancourth M, Botero JE.** Changes in the subgingival microbiota and periodontal parameters before and 3 months after bracket placement. *Am J Orthod Dentofac Orthop. 2006; 130(3): 275-91.*

6. **Simmer JP, Hardy NC, Chinoy AF, Bartlett JD, Hu JC.** How Fluoride Protects Dental Enamel from Demineralization. *J Int Soc Prev Community Dent. 2020; 10(2): 134-141*

7. **Andreasen GF, Hilleman TB.** An evaluation of 55 cobalt substituted nitinol wire for use in orthodontics. *J Am Dent Assoc.* 1971; 82(6): 1373–75.

8. **Geramy A, Hooshmand T, Etezadi T.** Effect of Sodium Fluoride Mouthwash on the

Frictional Resistance of Orthodontic Wires. *J Dent (Tehran). 2017; 14(5): 254-58.*

9. **Chitra P, Prashantha GS, Rao A.** Effect of fluoride agents on surface characteristics of

NiTi wires. An ex vivo investigation. *J Oral Biol Craniofac Res. 2020; 10(4): 435-40.*

10. **Walker MP, White RJ, Kula KS.** Effect of fluoride prophylactic agents on the mechanical properties of nickel-titanium-based orthodontic wires. *Am J Orthod Dentofacial Orthop. 2005; 127(6): 662-9.*

11. **Ehrami E, Omrani A, Feizbakhsh M.** Effects of Two Fluoride Mouthwashes on Surface

Topography and Frictional Resistance of Orthodontic Wires. *Front Dent. 2022; 19: 21.*

12. **Alavi S, Farahi A.** Effect of fluoride on friction between bracket and wire. *Den Res J. 2011; 8(1): 37-42.*