

Evaluation of the effect of light curable fluoride varnish and silver diamine fluoride in preventing white spot lesions adjacent to orthodontic brackets: An *in vitro* study

Bonita T Mathew¹, Babukuttan Pillai², Sreejith Kumar G³

¹ Department of Orthodontics, Govt. Dental College Trivandrum, Kerala, India

² Associate Professor, Department of Orthodontics, Govt. Dental College Trivandrum, Kerala, India

³ Professor and Head, Department of Orthodontics, Govt. Dental College Kottayam, Kerala, India

Abstract

White spot lesions are one of the iatrogenic damages to enamel surface around brackets during orthodontic treatment. The prophylactic measures using Fluoride are absolutely necessary to prevent the adverse effects of the white spot lesions during orthodontic fixed appliance treatment. The article aims to evaluate the prevention of demineralisation and protective effect by remineralisation of Light Curable Fluoride Varnish (Vanish XT) and Silver Diamine Fluoride (SDF) against the white spot lesions over a time period of two months using extracted teeth allocated into three groups.

Keywords: White spot lesions, demineralisation, remineralisation, Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Analysis (EDX), Vanish –XT, Silver Diamine Fluoride (SDF)

Introduction

The presence of certain demineralized areas on enamel popularly called “White Spot Lesions” (WSLs) as a sequelae of orthodontic fixed appliance treatment is a very well-known concern among orthodontists [9]. These lesions develop as opaque white outlines around the bracket periphery and can be seen by naked eye. They can be the result of prolonged accumulation and retention of bacterial plaque around the bracket surfaces. Commonly involved sites are anterior teeth particularly lateral incisors and the cervical margins of banded teeth. Their severity can range from a slight mineral loss to frank cavitations with subsurface progression into dentin [1]. Various methods have been developed to minimize the incidence and severity of WSLs. Good oral hygiene regimen along with incorporation of fluoride in dentifrices, varnishes, are some of the methods to prevent WSLs [2]. In addition to preventive methods there has been a surge in the use of remineralisation products containing fluoride containing Light Curable Fluoride Varnishes and nanoparticle incorporated Silver Diamine Fluoride [4]. A varnish introduced by 3M ESPE named, “Vanish XT Extended contact” is a site specific, light cured durable coating that remains on the tooth for six months or longer, is moisture tolerant, without any need to pre dry the teeth, capable of delivering Calcium, Fluoride and Phosphate ions, creating a barrier against demineralisation and acid erosion and also helps to repair demineralised enamel adjacent to the coating. It is a resin modified glass ionomer material that gets recharged every time the patient brushes with Fluoride tooth paste and also releases more Fluoride over 24 hours than conventional varnish. It is possible to achieve a more acid-resistant mineral nucleation by the addition of low levels of functionalized TCP and 5% NaF which are its principle ingredients [10]. The effectiveness of Silver Diamine Fluoride (SDF) as a preventive and cariostatic agent has been proved since 1969. Its widespread usage has been in non-cooperative pediatric patients requiring complex treatments. The application of SDF results in significant reduction of salivary

Streptococcus mutans level (antibacterial action of Silver) at 0.12 micromole/ml [7]. Its antimicrobial property is due to the ability to penetrate bacterial cell wall, interrupting DNA replication and inhibiting cellular respiration. Studies on SDF (nanoparticle incorporated) also have shown remineralisation and bactericidal properties without staining with a remineralisation potential of up to 14.63% compared to 12.7% of Durophat varnish [8]. The ability of SDF to dissociate into Silver Phosphate and Calcium Fluoride compounds at low pH has been regarded to facilitate remineralisation [11]. Currently, a wide range of both macroscopic and microscopic methods for both *in vitro* and *in vivo* studies are available [12]. It is desirable that the assessment method be accurate, reproducible, easy to use and should validate mineral loss from the enamel. For microscopic *in vitro* evaluation, various methods polarized light microscopy and Scanning Electron Microscope have been used. An improvement on the Electron microscope has been the EDX analysis with Scanning Electron Microscope (SEM) which is a micro-analytical technique employed to estimate quantitatively the amounts of mineral in a given tooth sample [6]. The article aims to evaluate the effects of Vanish XT (Light Curable Fluoride Varnish) and Silver Diamine fluoride on enamel demineralization around the orthodontic brackets using Scanning Electron Microscope and Energy Dispersive X-ray analysis.

Materials and methods

The samples consisted of 45 extracted human premolars obtained from patients requiring therapeutic extraction for orthodontic treatment. The inclusion criteria for teeth selected were intact buccal enamel without developmental defects, not subjected to any pretreatment chemical agents, no physical damage due to extraction and any caries or WSLs. All the teeth were rinsed with normal saline and stored individually in thymol containing closed pre-labeled plastic containers. Each tooth surface was bonded with standard MBT brackets of 0.022” standard slot size. Acid etching with 37% phosphoric acid (Eazetch), followed by

water rinsing for 60 seconds to remove the etchant gel. A layer of Transbond XT primer (3M Unitek Transbond XT Light cure adhesive primer) was applied & then air dried. The same primer was applied to bracket base followed by Transbond XT (3M Unitek, Monrovia California, USA) application onto the bracket base. The samples were then kept in artificial saliva for 16 hours at room temperature. After rinsing with distilled water, the categorized samples were treated with respective agents. Rinsing was again done after application of the respective fluoride agents in study groups and allowing it to dry for 5 minutes. They were again kept in demineralising solution (2.2mM (CaCl₂), 2.2mM (NaH₂PO₄), 0.05 M acetic acid with the pH adjusted to 4.4 with 1 M KOH) at room temperature for 48 hours. All teeth were brushed with Fluoride containing toothpaste & put back in artificial saliva (containing 2.200 g/L gastric mucin, 0.381g/L NaCl, 0.213 g/L (CaCl₂)₂H₂O, 0.738 g/L K₂ (HPO₄)₃H₂O and 1.114 g/L KCl). for 12 hours. The surface characteristics and mineral content were assessed using SEM and EDX respectively after appropriate

tooth sectioning. The images obtained were photographed at 20 μ & 100 μ depth. At the end of the incubation period all the samples were evaluated by SEM- EDX analysis. The Ca, P, F contents were analyzed for all the three groups. Data obtained was subjected to statistical analysis. One-way Analysis of Variance (ANOVA) was used to differentiate between the mean and standard deviation among the groups and Post Hoc Bonferroni corrected test was used for comparison between two groups. The statistical significance level (p-value) was kept at p value ≤ 0.05.

Results

EDX analysis was used to determine calcium and phosphorus content (in weight %) of the samples. The mean Ca content of enamel in Control group was 32.56 +1.23, in the SDF group was 30.44 +2.96 and Vanish XT group was 47.98+4.07 groups showing that the Calcium Content is significantly higher in Vanish XT group as compared to Control and SDF group.

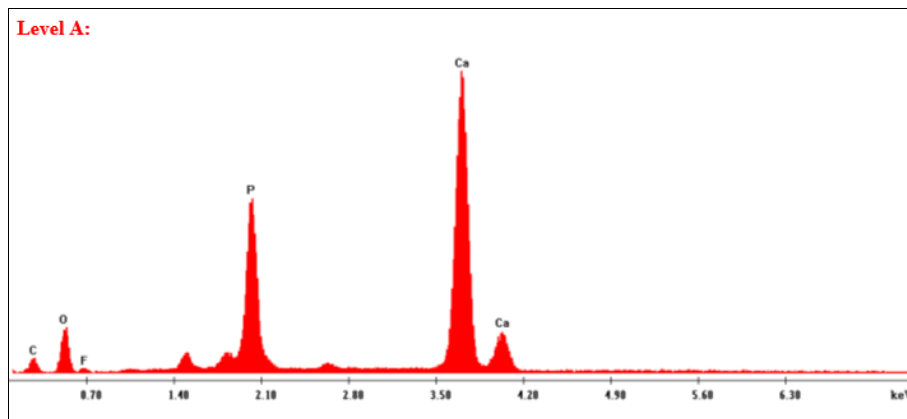


Fig 1: showing EDX spectrum of Vanish XT with spikes on Ca,P,O,C & F

Table 1: Descriptive statistics of the Calcium content in all three groups

	N	Calcium Content (EDX) (wt%)		p
		Mean	SD	
Control	15	32.56	1.23	<0.001
SDF	15	30.44	2.96	
Vanish XT	15	47.98	4.07	

Table 2: Post hoc Bonferroni corrected test for comparison between two group

Multiple comparison	Mean difference	se	p
Control VS SDF	2.12	1.09	0.059
Control VS Vanish XT	15.42	1.09	<0.001
SDF VS Vanish XT	17.54	1.09	<0.001

The Phosphorus content in the Control group was 17.23 +0.84, in the SDF group was 14.55+ 0.48 and Vanish XT group was 15.70 +1.08 denoting a significantly lower value in the Vanish XT group and SDF group as compared to Control group.

Table 3: descriptive statistics of Phosphorus content

sample	N	Phosphorus Content (EDX) (wt%)		p
		Mean	SD	
Control	15	17.23	0.84	<0.001
SDF	15	14.55	0.48	
Vanish XT	15	15.70	1.08	

Table 4: Post hoc Bonferroni corrected test

Multiple comparison	Mean difference	se	p
Control VS SDF	2.68	0.31	<0.001
Control VS Vanish XT	1.53	0.31	<0.001
SDF VS Vanish XT	-1.15	0.31	0.001

The mean Fluoride Content in the Control group obtained was 0.10 +0.07, in the SDF group, was 0.76+ 0.29 and Vanish XT group was 1.14+ 0.29 showing that Vanish XT group has significantly higher Fluoride Content (EDX) as compared to SDF group.

Table 5: Descriptive statistics of Fluoride content

	N	Fluoride Content (EDX) (wt%)		p
		Mean	SD	
Control	15	0.10	0.07	<0.001
SDF	15	0.76	0.29	
Vanish XT	15	1.14	0.29	

Table 6: Post hoc Bonferroni corrected test

Multiple comparison	Mean difference	se	p
Control VS SDF	0.66	0.09	<0.001
Control VS Vanish XT	1.04	0.09	<0.001
SDF VS Vanish XT	0.38	0.09	<0.001

Conclusion

1. SEM study of Vanish XT showed normal surface characteristics of enamel with Calcium Fluoride deposits.
2. SEM findings of SDF showed eroded washed away appearance along with dense granules of silver compounds on its surface.
3. EDX showed higher Calcium content in Vanish XT compared to SDF and control group & a lesser Phosphorus content group compared to SDF and control group.
4. Fluoride content is highest in Vanish XT followed by SDF and then control group.
5. Vanish XT has greater efficiency than SDF in reduction of white spot lesions.

A longer duration of study could determine the additional properties of both agents. *in vitro* simulation of oral microenvironment was done by using artificial saliva; however due to the absence of plaque and bacteria, obtaining a proper fermenting medium was impossible.

References

1. Bishara SE, Ostby AW. White spot lesions: formation, prevention, and treatment. *Semin Orthod*,2008;14(3):174-82.
2. Zachrisson BU, Heimgaard E, Ruyter IE, Mjör IA. Problems with sealants for bracket bonding. *Am J Orthod*,1979;75(6):641-9.
3. Banks PA, Richmond S. Enamel sealants: a clinical evaluation of their value during fixed appliance therapy. *Eur J Orthod*,1994;16(1):19-25.
4. Punyanirun K, Yospiboonwong T, Kunapinun T, Thanyasrisung P, Trairatvorakul C. Silver diamine fluoride remineralized artificial incipient caries in permanent teeth after bacterial pH-cycling *in vitro*. *J Dent*,2018;69:55-9.
5. Scarpelli BB, Punhagui MF, Hoepfner MG, Almeida RSC, Juliani FA, Guiraldo RD, *et al.* *In vitro* evaluation of the remineralizing potential and antimicrobial activity of a cariostatic agent with silver nanoparticles. *Braz Dent J*,2017;28(6):738-43.
6. Mohanty P, Padmanabhan S, Chitharanjan AB. An *in vitro* evaluation of remineralization potential of Novamin® on artificial enamel sub-surface lesions around orthodontic brackets using energy dispersive X-ray analysis (EDX). *J Clin Diagn Res*,2014;8(11):88-91.
7. Chatterjee R, Kleinberg I. Effect of orthodontic band placement on the chemical composition of human incisor tooth plaque. *Arch Oral Biol*,1979;24(2):97-100.
8. Chang HS, Walsh LJ, Freer TJ. Enamel demineralization during orthodontic treatment: aetiology and prevention. *Aust Dent J*,1997;42(5):322-327
9. Zachrisson BU, Zachrisson S. Caries incidence and orthodontic treatment with fixed appliances. *Eur J Oral Sci*,1971;79(2):183-92.
10. Gorelick L, Geiger AM, Gwinnett AJ. Incidence of white spot formation after bonding and banding. *Am J Orthod*,1982;81(2):93-8.
11. Mirzahi E. Enamel demineralization following orthodontic treatment. *Am J Orthod*,1982;(1):6-13.
12. Kaur T, Tripathi T, Rai P, Kanase A. SEM evaluation of enamel surface changes and enamel microhardness around orthodontic brackets after application of CO2 laser, Er,Cr laser, and fluoride varnish: an *in vivo* study. *J Clin Diagn Res*,2017;11:59-63.