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Evaluation of the Efficacy of Fluoride Varnish on Enamel Demineralization in Orthodontic Patients: A Split-mouth Clinical Trial

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The incidence of white spot lesions in patients treated with fixed appliances is very common and can be seen as early as four weeks after band or bracket placement. Many methods can decrease or prevent white spot lesions: improving oral hygiene, modifying diet (low carbohydrate) and treating with topical fluoride. Most of these methods, however, rely on patient compliance, which is unreliable and therefore not compliant. The method thus selected is the application of fluoride varnish. The purpose of this study is to evaluate the short-term effect of a single-dose application of fluoride varnish on enamel demineralization adjacent to bonded brackets. Fifteen patients who needed at least two premolars extracted for orthodontic reasons were selected. In each patient, one premolar was considered the test tooth and the other the control. Brackets were bonded on both the premolars, but only the test teeth received fluoride varnish. The premolars were extracted after 90 days and buccolingual sections of the teeth were evaluated with polarized light microscopy. The mean depth of demineralization in each lesion was then measured.

Key words: White spots, fluoride varnish, enamel demineralization, polarised light microscope

INTRODUCTION

The demineralization of enamel adjacent to orthodontic brackets is a considerable clinical problem, jeopardizing the health and esthetics of the teeth. Orthodontic appliances facilitate the accumulation of dental plaque and make oral hygiene difficult. The duration of treatment and the intervals between appointments create opportunities for the development of decalcification. Formation of mature dental plaque on enamel surfaces of teeth and fermenting dietary carbohydrates by microorganisms lead to reduction of plaque pH to a critical point and mineral loss of enamel occurs as white spots (Hicks *et al.*, 2004; Gorton and Featherstone, 2003). The prevalence of white spot lesions in orthodontic patients has been reported between 2% and 96% (Schmit *et al.*, 2002; Heintze, 1999). Orthodontic materials and techniques to prevent decalcification during orthodontic treatment have been the focus of interest over the past few years.

Many methods can decrease or prevent white spot lesions: improving oral hygiene, modifying diet (low carbohydrate) and treating with topical fluoride. Most of these methods, rely on patient compliance, which is unreliable. Attempts have been made to use compliance-free methods (Todd *et al.*, 1999) Prevention of metabolic activity of plaque bacteria, forming fluoroapatite crystals and stimulating remineralization are some caries control potential of fluoride-releasing agents (Chadwick and Gordon, 1995) Of the various forms of fluoride products (systemic forms, gels, varnishes, toothpastes and mouth-rinses), varnishes are easy to use and do not depend on patient cooperation. Fluoride varnish adheres to the tooth surface in a thin layer and releases fluoride for a long time (Beltran-Aguilar *et al.*, 2000) explained that fluoride varnishes are safe and effective To use fluoride routinely, one needs to know the optimal form of application (compliance free), the optimal frequency (less time consuming) and the optimal concentration with minimal side effects.

The purpose of this study was to evaluate the short-term effect of a single-dose application of a high concentration fluoride varnish on enamel demineralization adjacent to bonded brackets.

MATERIALS AND METHODS

The study was designed as a split-mouth clinical trial. Informed consent was obtained from the patients older than 18 and parents of the younger subjects. A minimum of twelve subjects was adequate. Because of possible dropouts during study, a few more were included. The

subjects included twelve females and three males who were scheduled for extraction of at least 2 premolars as part of their orthodontic treatment.

The inclusion criteria were:

- Age less than 20 years because the highest incidence of caries occurs during the teenage years
- Premolars fully erupted and intact without visible defects on their buccal surfaces
- Moderate to good oral hygiene according to Silness and Loe (1964) with no history of allergies

In each patient, 1 premolar was the experimental tooth (fluoride varnish applied) and the other was the control (no varnish). The experimental and control teeth were alternately selected on the left and right. After cleaning the teeth with nonfluoride pumice, stainless steel standard brackets (3 M UNITEK GEMINI APC II, Germany) were bonded to the center of the teeth.

Patients received oral hygiene instructions and a tube of toothpaste containing 250 ppm of fluoride. After a week, the experimental teeth received high-concentration fluoride varnish (Bifluoride 12, 6% calcium fluoride and 6% sodium fluoride; VOOCO, CUXHAVEN, Germany). The varnish was applied around the bracket with a pallet of foam soaked in varnish and allowed to dry for 1 min according to the manufacturer's instructions. All patients were instructed not to brush the experimental teeth for 24 h according to the manufacturer's instructions. The brackets were removed 90 days after the fluoride varnish application and the teeth were then extracted. Their roots were cleaned with a scaler and stored in thymol 0.1% solution. The crowns were cut 1 mm apical to the cemento-enamel junction and embedded individually in molds of epoxy resin to prevent fracturing during thickness reduction.

A buccolingual section from each tooth was made in the middle of the crown with a hard-tissue microtome. Then, by hand grinding, the thickness of the sections was reduced to 50 to 70 μ m with progressively finer grades of silica carbide grinding paper.

The sections were evaluated with polarized light microscopy with water as the imbibed medium. Microphotographs of the gingival half of the buccal surface were taken with fixed magnification of 25 times. In each section, gingival, middle and occlusal areas of demineralized lesions were measured with a scale in the same magnification. This process were repeated three times at 1 week interval, in a blind situation. The mean of these three measurements was recorded as the mean depth of demineralization for that section. Intraclass correlation was calculated for random error. Findings were analyzed by paired t test after a normality test (Fig 1, 2).

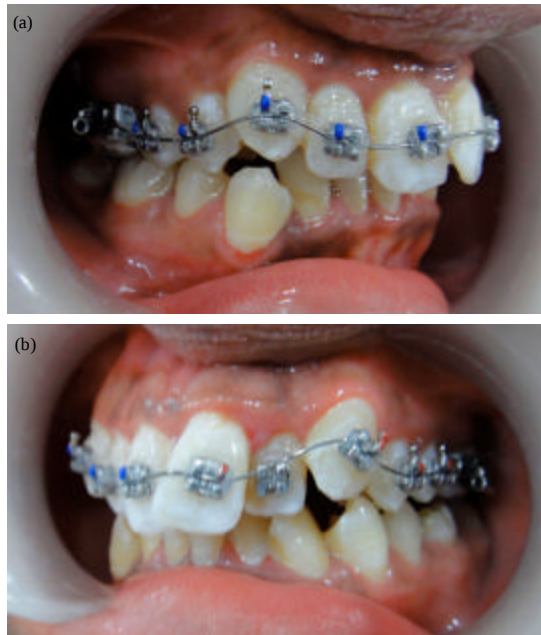


Fig. 1(a-b): Sample tooth with bracket engaged

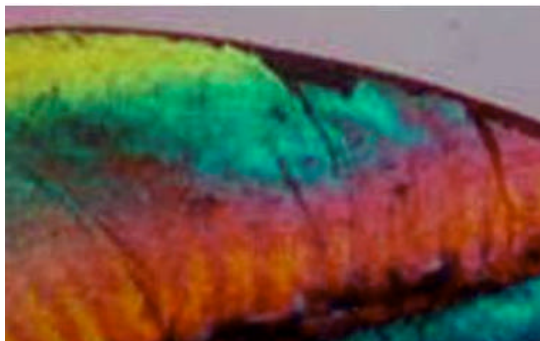


Fig. 2: Microphotograph of a section with demineralization

RESULTS AND DISCUSSION

The ages of the subjects ranged from 13 years 8 months to 19 years 7 months (mean, 16 years 3 months $\pm$ 1 year 2 months). Intraclass correlation for the repeated measurements was 0.988 (Table 1). The data were normally distributed according to the Kolmogorov-Smirnov test. The ranges of the mean depth of the lesions were 44.2 to 63.5 μ m in the experimental teeth and 85.1 to 103.7 μ m in the control teeth. The mean depths of demineralization for the 2 groups were 53.85 $\pm$ 5.7 and 94.4 $\pm$ 6.8 μ m, respectively. The mean difference was 40.55 $\pm$ 5.1 μ m

Table 1: Between-subjects effects and Intra-class correlations

Between-subjects effects					
Dependent variable response					
Source	Type III sum of squares	df	Mean square	F	Significance
Corrected model	33566.654*	29	1157.4708	248.384	0.000
Intercept	525452.416	1	525452.416	112758.029	0.000
Subject	33566.654	29	1157.4708	248.384	0.000
Error	279.643	60	4.660		
Total	558742.431	90			
Corrected total	33843.293	89			

*(adjusted $R^2 = .988$), Intra-class correlation = $1157.4708 - 4.660 = 0.988$
 $1157.4708 + (3-1) 4.629$

Table 2: Range and mean depth of demineralization with and without fluoride varnish

Sample group	N	Range (μ m)	Mean (μ m)	SD	Mean difference	p-value
Experimental teeth	15	44.2-63.5	53.85	5.7	40.55 $\pm$ 5.1	<.001
Control teeth	15	85.1-103.7	94.40	6.8		

Significant $p < .01$

(Table 2). Some amount of demineralization was observed on both the experimental and control teeth, but the teeth treated with a single dose of high-concentration fluoride varnish had significantly less demineralization, approximately 45%, than the control teeth ($p < 0.001$). No signs of hypersensitivity or toxic effect were observed.

The use of topical medicaments that can successfully prevent white spot lesion formation during orthodontic treatment are beneficial for patients at risk of developing such lesions. The use of topical fluoride in its various forms (toothpaste, mouthrinse, gels, varnishes, fluoride-releasing cements and elastomeric auxiliaries) has, to date, been the most commonly used caries preventive protocol during orthodontic treatment for at-risk patients, in addition to patient education and regular hygiene visits. The regular exposure of dental enamel to the various forms of topical fluoride has been found to have a greater effect in the prevention of enamel demineralization (Jeansonne and Feagin, 1979; O'Reilly and Featherstone, 1987).

In this study, our aim was to achieve the microscopic evaluation of the effect of fluoride varnish on enamel demineralization adjacent to bonded brackets. This study was feasible as it was similar to a routine clinical situation. From a clinical aspect, the study was not time consuming for it needed just a single application of fluoride varnish and the cost factor associated with repeated applications during treatment was also avoided. An advantage of varnish is its slow release over time so that repeated doses are not needed. A high concentration at repeated intervals might have toxic effects, although

(Ekstrand *et al.*, 1980) in their study on fluoride varnish (Duraphat), reported minimal risk of acute toxic reactions. The 3-month duration of this study permitted evaluation of demineralization of a single-dose fluoride varnish with high fluoride concentration *in vivo* without interfering with the treatment progress. Because both the experimental and the control teeth were in the same patient, confounding factors such as sex, oral hygiene, cooperation, tooth structure, fluoride uptake from other sources and composition of saliva were avoided. These results show that a single dose of fluoride varnish with a high concentration caused a significant reduction of the depth of the demineralized enamel during three months of orthodontic appliance wear.

Basdra *et al.* (1996) in an *in-vitro* study about the effect of fluoride-releasing bonding agents, reported that fluoride agents that release a high dose of fluoride initially (burst effect) would be more effective for increasing enamel resistance against decalcification.

It seems that high doses of fluoride are useful in inhibiting lesion formation and low doses are effective in remineralization and controlling the lesion progress (Seppa, 1983).

This study demonstrated an increase in the remineralization/demineralization ratio of enamel in the experimental group. Enamel lesions in all teeth indicated that fluoride cannot prevent their formation, but it did reduce their progression.

In this clinical study, the mean depth of demineralization in the test group was approximately 45% less than in the control group. Previous *in-vitro* studies reported reductions of more than 50% (Geiger *et al.*, 1992; Ogaard *et al.*, 1996).

As the oral environment has a variable pH and remineralization can occur without fluoride. Therefore, the results of *in-vivo* studies might be different from those of *in-vitro* studies.

CONCLUSION

With the limitations of any *in-vitro* study, the following clinical conclusions can be drawn:

- As patient compliance during orthodontic treatment is unreliable and variable, there is a need to implement compliance-free methods that are not time-consuming for reduction of enamel lesions
- One topical application of fluoride varnish with a high concentration can decrease enamel lesion depth adjacent to bonded brackets by about 45% for 3 months

- Although no sign of hypersensitivity or toxic effect was noted, it is advisable to use these high-dose varnishes for susceptible and uncooperative patients

REFERENCES

- Basdra, E.K., H. Huber and G. Komposch, 1996. Fluoride released from orthodontic bonding agents alters the enamel surface and inhibits enamel demineralization *in vitro*. Am. J. Orthod. Dentofacial Orthop., 109: 466-472.
- Beltran-Aguilar, E.D., J.W. Goldstein and S.A. Lockwood, 2000. Fluoride varnishes. A review of their clinical use, cariostatic mechanism, efficacy and safety. J. Am. Dent. Assoc., 131: 589-596.
- Chadwick, S.M. and P.H. Gordon, 1995. An investigation to estimate the fluoride uptake adjacent to a fluoride-releasing bonding agent. Br. J. Orthod., 22: 113-122.
- Ekstrand, J., G. Koch and L.G. Petersson, 1980. Plasma fluoride concentration and urinary fluoride excretion in children following application of the fluoride-containing varnish Duraphat. Caries Res., 14: 185-189.
- Geiger, A.M., L. Gorelick, A.J. Gwinnett and B.J. Benson, 1992. Reducing white spot lesions in orthodontic populations with fluoride rinsing. Am. J. Orthod. Dentofacial Orthop., 101: 403-407.
- Gorton, J. and J.D. Featherstone, 2003. *In vivo* inhibition of demineralization around orthodontic brackets. Am. J. Orthod. Dentofacial Orthop., 123: 10-14.
- Heintze, S.D., 1999. Oral Health for the Orthodontic Patient. Quintessence Publishing, London, ISBN: 9780867152951, pp: 2-9,94-97.
- Hicks, J., F. Garcia-Godoy and C. Flaitz, 2004. Biological factors in dental caries: Role of remineralization and fluoride in the dynamic process of demineralization and remineralization (part 3). J. Clin. Pediatr. Dent., 28: 203-214.
- Jeansonne, B.G. and F. Feagin, 1979. Fluoride action on acid resistance of unaltered human surface enamel. J. Oral. Pathol., 8: 207-212.
- O'Reilly, M.M. and J.D. Featherstone, 1987. Demineralization and remineralization around orthodontic appliances: an *in vivo* study. Am. J. Orthod. Dentofacial Orthop., 92: 33-403.
- Ogaard, B., H. Duschner, J. Ruben and J. Arends, 1996. Microradiography and confocal laser scanning microscopy applied to enamel lesions formed *in vivo* with and without fluoride varnish treatment. Eur. J. Oral. Sci., 104: 378-383.

- Schmit, J.L., R.N. Staley, J.S. Wefel, M. Kanellis, J.R. Jakobsen and P.J. Keenan, 2002. Effect of fluoride varnish on demineralization adjacent to brackets bonded with RMGI cement. *Am. J. Orthod. Dentofacial Orthop.*, 122: 125-134.
- Seppa, L., 1983. Effect of dental plaque on fluoride uptake by enamel from a sodium fluoride varnish *in vivo*. *Caries Res.*, 17: 71-75.
- Silness, J. and H. Loe, 1964. Periodontal disease in pregnancy. II. Correlation between oral hygiene and periodontal condition. *Acta Odontologica Scandinavica*, 22: 121-135.
- Todd, M.A., R.N. Staley, M.J. Kanellis, K.J. Donly and J.S. Wefel, 1999. Effect of a fluoride varnish on demineralization adjacent to orthodontic brackets. *Am. J. Orthod. Dentofacial Orthop.*, 116: 159-167.