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Evaluation of fluoride varnish and its comparison with pumice prophylaxis using self-etching primer in orthodontic bonding—an *in vivo* study

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SUMMARY The aim of this study was to evaluate the use of fluoride varnish as a prophylaxis method with self etching primer (SEP) and its comparison with pumice before orthodontic bonding. Thirty seven orthodontic patients participated in a prospective clinical trial. A split mouth technique was used in each patient, one quadrant was assigned to fluoride varnish and the contralateral quadrant to pumice prophylaxis. A total of 684 teeth were bonded with SEP (Transbond plus; 3M Unitek) and monitored for 6 months for bond failures. A total of 42 (6.1%) failures were recorded, 9 (2.6%) in the pumice group and 33 (9.6%) in the fluoride varnish group. Chi-square analysis was used to compare the number of bracket failures between the pumice and fluoride varnish groups and the number of patients in each group experiencing at least one bond failure. Statistically significant differences were found both in total number of bond failures ($P < 0.001$) and in the number of patients with bond failures ($P < 0.05$) between both groups. A significantly lower and clinically acceptable bond failure rate was observed with Transbond Plus self etching primer after pumice prophylaxis.

Introduction

The acid etch technique (Buonocore, 1955) using 37 per cent phosphoric acid etchant followed by priming and then adhesive resin has been used for years in orthodontic bonding. Recent advances in dental bonding chemistry have produced a combination of etchant and primer in one product called self-etching primer (SEP) composed of methacrylated phosphoric acid esters which reduces chair-side time during bonding (Fortin *et al.*, 1994; Van Meerbeek *et al.*, 1994; Swift *et al.*, 1996). However, questions about resultant bond strength have been raised and studied both *in vitro* and *in vivo*.

Adequate clinical bond strength in orthodontics ranges from 5.9 to 7.9 MPa (Reynolds and Von Fraunhofer, 1976). An *in vitro* study showed that the mean shear bond strength of brackets bonded with SEP was clinically acceptable but lower when compared with conventional three-step process (Aljubouri *et al.*, 2003). Bishara *et al.* (2001) demonstrated significantly weaker ($P = 0.004$) shear bond strength with SEP than when phosphoric acid and the primer were used separately with a conventional adhesive system. However, the SEP still produced laboratory bond strengths (7.1 ± 4.4 MPa) considered to be clinically acceptable for orthodontic bracket bonding.

An *in vivo* study by Ireland *et al.* (2003) tested Transbond Plus SEP versus conventional etch but disregarded the pumice prophylaxis step for all groups. They found significantly more bond failures in the SEP groups than conventional etch patients when enamel pre-treatment was done before bonding. Asgari *et al.* (2002) evaluated Transbond plus SEP (3M Unitek, Monrovia, California, USA) versus traditional acid etch sequence *in vivo* and found that brackets bonded with SEP had significantly ($P = 0.037$) lower incidence to debond. They incorporated pumice prophylaxis for all groups. According to the manufacturer's recommendations, a pumice prophylaxis step should be incorporated before beginning the bonding process with SEP. This pre-treatment removes organic material including acquired pellicle.

It was reported that the application of fluoride varnish before or even at the time of bracket placement did not alter the bond strength of orthodontic brackets to tooth enamel (Todd *et al.*, 1999). Kimura *et al.* (2004) investigated the relationship between the shear bond strength of orthodontic brackets to enamel with or without fluoride varnish, by using either conventional or SEP systems. They concluded that application of fluoride varnish does not affect the bond strength of orthodontic brackets to enamel with conventional or SEP systems.

Fluoride ions encourage the formation of calcium fluoride and fluorapatite. This reaction enhances remineralization of etched enamel making it more resistant to demineralization. Fluoride varnishes have been shown to increase contact time with tooth enamel allowing greater uptake of fluoride ions in to enamel (Thornton *et al.*, 1986). Bishara *et al.* (1989) found no difference in tensile bond strength between

orthodontic brackets bonded to enamel etched with 37 per cent phosphoric acid for 1 minute and treated with 2 or 4 per cent sodium fluoride and specimens not treated with sodium fluoride. Also topical fluoride application should be done before etching in bonding procedure and not after etching because fluorides fill in inter-prismatic spaces created by etching, hence bonding capacity of adhesives is reduced.

The purpose of this study was to determine the bond failure rate using fluoride varnish and pumice prophylaxis before bonding with a SEP. The null hypothesis was that there would be no difference in bond failure rates using either fluoride varnish or pumice prophylaxis with SEP system.

Materials and methods

Thirty-seven patients scheduled to undergo treatment at Department of Orthodontics, S.G.T Dental College, Budhera, Gurgaon, volunteered for the study. Informed consent was obtained from each patient who participated in the study. A total of 684 teeth were bonded from both the maxillary and mandibular arches with 342 teeth in each arch. These patients underwent conventional fixed orthodontic appliance therapy. An equal number of teeth on each side of arch, with a minimum of four teeth per quadrant were included. Teeth that had decalcification or restored labial surfaces were excluded. A split-mouth technique was used with the pumice quadrants in the upper right and lower left side and the fluoride varnish on contralateral upper left and lower right quadrants. All brackets were placed by the same investigator to limit variability.

Initially, the teeth were cleaned with a toothbrush and toothpaste by the patient and rinsed. Group 1 comprised patients where pumice prophylaxis was used. Upper right and lower left quadrants were cleaned with oil-free pumice paste (Reliance Orthodontic Products, Itasca) for 5 seconds per tooth, rinsed with water, and dried. Group 2 comprised patients where fluoride varnish was used. For the upper left and lower right quadrants, fluoride varnish (Septodont, France) containing 5 per cent sodium fluoride was applied according to manufacturer's instructions.

After isolation, the SEP system (Transbond plus; 3M Unitek) was applied to the teeth, having ensured proper mixing by looking for the yellow colour of the primer. For each tooth, the applicator was used to rub the enamel to be bonded for 3 seconds. The applicator was returned to the reservoir and the same procedure was repeated for each tooth. When all teeth were primed, oil- and moisture-free air was delivered gently for 1–2 seconds to dry the primer into a thin film. If a tooth surface became contaminated, it was reprimed for 3 seconds with SEP. Ormco (California, USA) brackets with a 022″ slot were bonded to prepared enamel and cured with a Ortho lite halogen arc light (Densply QHL75, Caulk, Milford, Delaware, USA) for 10 seconds mesially and 10 seconds distally after flash had been removed. A check for occlusal interference was made. All the patients of both groups had same initial NiTi archwires of round 0.014″ in diameter (3M Unitek) followed by levelling NiTi wires of 0.016″ in diameter (3M Unitek). All the wires were secured with elastomeric modules. Each patient was given the follow-up instructions.

A bond failure was defined as any bracket that debonded after wire placement and occlusal check. These were tabulated in a logbook for each patient for each quadrant over a 6 months period. Each debonded bracket was verified by the investigator and recorded by patient's name and failure location. Debonded brackets were rebonded and removed from future account. Chi-square analysis was used to compare the number of bracket failures between the pumice and fluoride varnish groups and the number of patients in each group experiencing at least one bond failure.

Results

In 37 patients, 684 teeth were bonded. Both pumice and fluoride varnish groups included 342 teeth each. Overall, 40 bond failures occurred (5.8 per cent). More bond failures occurred in maxilla (24) than the mandible (16) and were more common in maxillary lateral incisor, premolars, and mandibular premolars. Chi-square analysis was used to compare the number of failures between groups.

Table 1 denotes the total number of bond failures in both groups. In the pumice group, there were 9 failures (2.6 per cent) and in the fluoride varnish group, there were 31 failures (9.6 per cent). There were significantly more bond failures in the fluoride varnish group ($P < 0.001$).

Table 2 shows the number of patients who experienced at least one bond failure with each method. Nine bond failures in the pumice group were recorded in 8 patients and 31

Table 1 Bond failures compared in the two groups.

Group	Failure	Successful	Total	Failure %
Pumice	9	333	342	2.6
Fluoride varnish	31	311	342	9.06
Total	40	644	684	5.8

Chi-square = 14.611; $P < 0.001$.

Table 2 Number of patients with bond failures.

Group	Failure	Successful	Total
Pumice	8	29	37
Fluoride varnish	16	21	37
Total	24	50	74

Chi-square = 4.89; $P < 0.05$.

bond failures in the fluoride group were seen in 16 patients. All 8 patients who experienced bond failures in the pumiced teeth also had fluoride varnish bond failures. There was a significant difference in the number of patients with bond failures between groups ($P < 0.05$).

Discussion

The hypothesis that there would be no difference in bond failure rate between fluoride varnish and pumice group before bonding with the SEP was not accepted. The results of this study suggest that use of fluoride varnish caused more bond failures with the SEP system.

The significance of fluoride on bonding was originally questioned because prophylaxis paste containing fluoride was used to clean teeth before bonding. Clean tooth surfaces have a higher surface energy that is amenable to bonding (Craig, 2002), but fluoride on the surface can lower the surface energy of the adherent, decreasing the ability of the adhesive to spread. However, the bond strength appears to be unaffected when fluoridated paste is used (Powers and Messersmith, 2001).

In an *in vitro* study by Garcia-Godoy (1993), the mean shear bond strength of brackets etched with 0.5 per cent NaF solution for 60 seconds was greater than with conventional etching. The present *in vivo* study contradicts these findings. The fluoride varnish group showed bond failure rate of 9.06 per cent, which was statistically significantly higher than the pumice group. Hence, further *in vivo* studies using different fluoride varnishes should be performed with SEP system.

In the present study, the bond failure rate in pumice group was 2.6 per cent, which is in agreement with studies done by Lill *et al.* (2008) who observed 2.7 per cent bond failures in their study in pumice quadrants. The bond failures occurred mainly in maxillary and mandibular premolars. Factors that could alter bond failures include contaminants, such as saliva, and the contents of some pastes, such as fluorides, oils, or other agents (Legler *et al.*, 1989). Furthermore, the stress distribution at the bracket-adhesive interface is not homogenous (Katona and Chen, 1994). Clinically, the overall failure rate for brackets bonded directly to enamel has been reported to range from 4 to 30 per cent (Mizrahi, 1983). The bond failure in this study was nearly three times greater when fluoride varnish was used. Similarly, twice the number of patients had bond failures using fluoride varnish.

Bherwani *et al.* (2008) observed 17.87 per cent bond failure rates which was based on tooth position in dental arch, sagittal occlusal relationship, and gender of patients. Wenger *et al.* (2008) demonstrated an overall bond failure rate of 1.26 per cent on comparing an Orthosolo group (0.72 per cent) and Transbond XT group (0.54 per cent)

It has been reported that SEPs can be more tolerant of salivary contamination than adhesive systems that do not contain hydrophilic primer (Vargas *et al.*, 1994). It is thought that hydrophilicity of the self-etching system might allow its diffusion through the salivary film. Fritz *et al.* (1998) also determined that adverse effects of salivary contamination of etched enamel were also greatly reduced if the saliva was rinsed away or blotted dry. They also determined that any contamination of the already cured adhesive layer seriously compromised the bond, regardless of how the contaminant was removed or altered, and that the entire bonding procedure should be repeated to ensure adequate adhesion. The aspect of salivary contamination on orthodontic bracket bond strength with self-etching systems has not been thoroughly investigated but should be pursued in future.

When deciding on the suitability of an etching and priming system, each clinician must weigh the time saved in bonding and debonding. As far as chair-side time is concerned, White (2001) suggested that a time saving of 65 per cent could be achieved using SEP. Aljubouri *et al.* (2004) concluded that for a patient requiring 20 brackets to be bonded, the average reduction in clinical chair time would be 8.5 minutes when compared with a conventional two-stage etch and primer system. The additional time needed to pumice and rinse the teeth before SEP is just over a minute and can be done by an assistant before the orthodontist's chair-side arrival. Therefore, actual doctor's time is not affected at all.

Pandis and Eliades (2005) suggested that a clean surface was more important for SEP because the chalky appearance of enamel that results from traditional etching which otherwise indicates a well-prepared surface is not visible clinically using SEP. Due to lower inherent bond strength and technique sensitivity, the prophylaxis step is important for SEP to ensure clinical success. Since bond failures are inconvenient for patient and clinician, costly, and lead to longer treatment times, these findings suggest that pumice prophylaxis works better before bonding with SEP than fluoride varnish.

Conclusions

The null hypothesis that there was no difference in bond failure rates with SEP using pumice Prophylaxis or fluoride varnish was rejected. The conclusions of this *in vivo* split-mouth study were as follows:

1. There was a significant increase in bond failure rate of brackets bonded with the SEP system when fluoride varnish was used.
2. Bond failure was low and well within a clinically acceptable range when pumice prophylaxis was used before bonding with the SEP.

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