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*Virginia Commonwealth University*

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School of Dentistry  
Department of Orthodontics  
Virginia Commonwealth University

This is to certify that the thesis prepared by Daniel J. Lill, DDS entitled IMPORTANCE OF PUMICE PROPHYLAXIS FOR ORTHODONTIC BONDING WITH SELF-ETCH PRIMER: AN *IN VIVO* STUDY has been approved by his committee as satisfactory completion of the thesis or dissertation requirement for the degree of Master of Science

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Dr. Steven J. Lindauer, Thesis Director, School of Dentistry Department of Orthodontics

---

Dr. Bhavna Shroff, Committee Member, School of Dentistry Department of Orthodontics

---

Dr. A. Omar Abubaker, Committee Member, School of Dentistry Department of Oral and Maxillofacial Surgery

---

Dr. Steven J. Lindauer, Chairman of the School of Dentistry Department of Orthodontics

---

Dr. Laurie Carter, Director of Advanced Dental Education, School of Dentistry

---

Dr. F. Douglas Boudinot, Dean of the School of Graduate Studies

March 7, 2005

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IMPORTANCE OF PUMICE PROPHYLAXIS FOR ORTHODONTIC BONDING  
WITH SELF-ETCH PRIMER: AN *IN VIVO* STUDY

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science at Virginia Commonwealth University.

by

DANIEL J. LILL

D.D.S., Virginia Commonwealth University, 2002

B.S., Pennsylvania State University, 1993

Director: STEVEN J. LINDAUER, D.M.D., M.D.Sc  
CHAIRMAN, DEPARTMENT OF ORTHODONTICS

Virginia Commonwealth University  
Richmond, Virginia  
June 2005

## Acknowledgement

Thank you to Dr. Steven J. Lindauer for his guidance and to my assistant Dawn Collins for her help with the project. I also offer my appreciation to Paul Morrison of 3M Unitek for generously donating the brackets and bonding supplies. Finally, I extend a special thank you to my wife Leslie for her continued support in one of my many endeavors and to my children Andrew and Jordan.

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## Abstract

### IMPORTANCE OF PUMICE PROPHYLAXIS FOR ORTHODONTIC BONDING WITH SELF-ETCH PRIMER: AN *IN VIVO* STUDY

By Daniel J. Lill, D.D.S.

A thesis submitted in partial fulfillment of the requirements for the degree of Master of  
Science at Virginia Commonwealth University.

Virginia Commonwealth University, 2005

Thesis Director: Steven J. Lindauer, D.M.D., M.D.Sc  
Chairman, Department of Orthodontics

Self-etching primers (SEP) have recently simplified the orthodontic bonding process and questions have arisen regarding their reliability and efficiency. The goal of this study was to assess the importance of a pumice prophylaxis prior to bonding with SEP (Transbond Plus, 3M Unitek, Monrovia, CA) in reducing bond failures. Thirty orthodontic patients volunteered to participate in this split-mouth prospective clinical trial. A pumice prophylaxis experimental group and a non-pumice control group of teeth were randomly assigned in a contralateral quadrant pattern within each patient. A total of 508 teeth were bonded and monitored over 3 months for bond failures. There were 35 total failures (6.9%) with 6 (2.4%) in the pumice group and 29 (11.4%) in the non-pumice group. Bond



failures were compared as a total number between groups and also as the number of patients who experienced bond failures with each method using Chi-square analysis. There were statistically significant differences both in the total number of bond failures ( $P < .001$ ) and in the number of patients with bond failures between groups ( $P < .01$ ). A significantly lower and clinically acceptable bond failure rate was demonstrated when using Transbond Plus SEP after pumice prophylaxis. This study produced strong evidence to suggest the need for pumice prophylaxis in orthodontic bonding when using SEP.

## Introduction

Efficient orthodontic treatment requires adequate bonding of orthodontic brackets to the enamel surfaces of teeth. Bond failures decrease efficiency of treatment resulting in prolonged time in treatment, increased chair time per visit and increased patient inconvenience. Buonocore<sup>1</sup> in 1955 first introduced direct bonding to the dental profession as a way to increase retention for pit and fissure acrylics. He used 85% phosphoric acid to etch enamel to improve retention. Bonding in orthodontics evolved into a system using a three-step process of preparing the tooth's enamel surface with 37% phosphoric acid etchant, followed by a priming agent, and then adhesive resin.

Recent advances in dental bonding chemistry have allowed the combination of the etchant and primer into one product called a self-etch primer (SEP) composed of methacrylated phosphoric acid esters. In the 1990's SEP was introduced to the orthodontic community as a way to save chair time during bonding. Questions about resultant bond strengths have been raised and studied both *in vitro* and *in vivo*.

Adequate clinical bond strengths in orthodontics have ranged from 5.9 to 7.9 MPa as reported by Reynolds and von Fraunhofer.<sup>2</sup> *In vitro* Studies have shown that bond strengths produced by SEP are generally clinically acceptable but somewhat lower when compared to the three-step process. Bishara et al<sup>3</sup> indicated that the use of SEP to bond orthodontic brackets to the enamel surface resulted in significantly lower ( $P = .004$ ), but

clinically acceptable, shear bond forces (7.1 +/- 4.4 MPa). Aljubouri et al<sup>4</sup> in 2003 also found the mean shear bond strength of brackets bonded with SEP to be significantly less than those bonded with a conventional two-stage etch and prime system *in vitro*.

Asgari et al<sup>5</sup> recently evaluated Transbond Plus SEP versus a traditional acid etch sequence *in vivo* and found that those brackets bonded with SEP had a significantly lower incidence of debond. They incorporated a pumice prophylaxis for all groups. Similarly, a recent *in vivo* study by Ireland et al<sup>6</sup> tested Transbond Plus SEP versus conventional etch but disregarded the pumice prophylaxis step for all groups. They found a significantly greater number of bond failures occurring within the SEP group.

According to manufacturer's recommendations, a pumice prophylaxis step should be incorporated prior to beginning the bonding process with SEP. This pre-treatment removes organic material including the acquired pellicle. Clinically, this step is often left out or disregarded as unimportant.

Previous studies have shown that for conventional acid etch systems this step is not significant. Lindauer et al<sup>7</sup> in 1997 tested the effect of pumice prophylaxis on the bond strength of orthodontic brackets *in vivo* and *in vitro* and found no difference with or without the use of pumice prophylaxis. Barry et al<sup>8</sup> in 1995 and Ireland et al<sup>9</sup> in 2002 similarly demonstrated that pumice prophylaxis had no effect on *in vivo* bond failure rates before using conventional etching with composite or resin modified glass ionomer for direct bonding. To date, though, no clinical studies have been performed testing the role of pumice pre-treatment on bond failure using SEP.

A study of this nature can be beneficial in determining whether or not pumice pre-treatment is warranted clinically because SEP results in a weaker bond *in vitro* and pumice pre-treatment may result in a cleaner enamel surface. Therefore the purpose of this study was to determine the clinical importance of the manufacturer's recommended pumice prophylaxis step on the *in vivo* bond failure rate when using Transbond APC (adhesive pre-coated, 3M Unitek, Monrovia, CA) brackets with the Transbond Plus SEP system. The null hypothesis was that there was no difference in bond failure rates between teeth that have had a pumice prophylaxis and those that have not when using the SEP system.

## Materials and Methods

Thirty patients from the Virginia Commonwealth University School of Dentistry Department of Orthodontics volunteered for the study. Institutional Review Board approval was granted and informed consent was obtained from each patient who volunteered to participate. The patients enrolled were scheduled to have maxillary and/or mandibular conventional fixed orthodontic appliances. An equal number of teeth on each side of the arch, with a minimum of 4 teeth per quadrant, was required. Teeth were excluded if they had decalcifications or restored labial surfaces. A split mouth design was developed with a pumice quadrant first randomly assigned using a fair coin toss. A bonding pattern was then established using the contralateral quadrant in the opposing arch as pumice and the remaining two contralateral opposing arch quadrants as non-pumice. The investigator was blinded to the coin toss and quadrant preparation, which were both done by the same assistant. All brackets were applied by the primary investigator to limit variability.

All quadrants were first cleaned with a toothbrush and toothpaste by the patient and rinsed. Subsequently, the chosen quadrants were cleaned with an oil-free pumice paste (First and Final, Reliance Orthodontic Products, Itasca, IL) for 3 seconds per tooth and rinsed with water and dried. After isolation, the SEP system (Transbond Plus SEP, 3M Unitek, Monrovia, CA) and bonding were carried out exactly the same in all quadrants per

manufacturer's instructions. The product was activated and checked for proper mix by visually looking for a yellow color to 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 well and the process was repeated for each tooth. A gentle burst of oil and moisture free air was directed to the primed tooth to disperse the primer leaving a shiny surface. If a tooth surface became contaminated, it was reprimed for 3 seconds with the SEP. A separate SEP packet was used for upper and lower arches. Metal Victory series APC (adhesive pre-coated, 3M Unitek, Monrovia, CA) brackets were bonded to the prepared enamel and cured with an Ortho Lite halogen arc light (3M Unitek, Monrovia, CA) for 3 seconds mesial and 3 seconds distal to the bracket after flash had been removed. A check for any occlusal interference was made and initial archwires were placed and secured with wire or elastomeric ligatures. Normal new patient instructions were given. Bond failures were defined as any bracket that was debonded after wire placement and occlusal check. These were tabulated in a logbook for each patient by quadrant over a 3 month period. Each debonded bracket was verified by the investigator and assistant and then recorded by patient name and failure location. Debonded brackets were rebonded and then removed from future counts. Chi square analysis was used to compare the number of bracket failures between groups and the number of patients in each group experiencing one or more bond failures.

## Results

508 teeth were bonded within the 30 patients. Pumice and non-pumice groups each contained 254 teeth. Overall, 35 bond failures occurred (6.9%). In the pumice group there were 6 failures (2.4%) and in the non-pumice group there were 29 (11.4%). Chi-square analysis was used to compare the groups. Table 1 illustrates the total number of bond failures recorded between the two groups. There was a significantly greater number of bond failures in the non-pumice group ( $P < .001$ ). Likewise Table 2 shows the number of patients who experienced one or more bond failures with each method. Each patient, as their own control, was broken down into pumice and non-pumice halves. The 6 bond failures that occurred in the pumice group were recorded among 5 patients and the 29 bond failures in the non-pumice group were spread among 16 patients. There was a significant difference in the number of patients with bond failures between groups ( $P < .01$ ).

Table 1: Bond failures between groups

	<i>Bond Failure</i>	<i>No Failure</i>	Total
<i>Pumice</i>	6	248	254
<i>Non-Pumice</i>	29	225	254
Total	35	473	508

Chi-square = 16.23;  $P < .001$

Table 2: Number of patients with bond failure

	<i>Bond Failure</i>	<i>No Failure</i>	Total
<i>Pumice Halves</i>	5	25	30
<i>Non-Pumice Halves</i>	16	14	30
Total	21	39	60

Chi-square test = 8.86; P < .01



## Discussion

This study evaluated the orthodontic bond failure rates *in vivo* for a SEP system with and without pumice prophylaxis. Relatively few clinical studies have been reported in the literature for SEP bond failure rates. Many *in vitro* studies show SEP shear bond strengths to be comparable with or less than those with conventional acid etching techniques.

Previous studies by Zachrisson,<sup>10</sup> O'Brien et al,<sup>11</sup> and Sunna and Rock<sup>12</sup> found clinical bond failure frequencies to vary between .5% and 16%. This study's low bond failure rate of 2.4% in the pumice group reflected the bracket application of a single operator in a blinded, well-controlled experiment. The non-pumice failure rate of 11.4% was in line with Ireland's previous study<sup>6</sup> conducted without pumice prophylaxis and further demonstrates the need to pretreat enamel when using SEP.

The bond failure rate in this study was nearly five times greater when pumice pretreatment was omitted. Similarly, three times as many patients had bond failures without pumice prophylaxis. Increased bond failures are inconvenient for patients and practitioners, are costly, and could lead to longer treatment times. Transbond Plus SEP, used as directed, performed better than when the recommended pumice prophylaxis step was omitted.

In a clinical report on chairside time comparing SEP to conventional etch methods, it was suggested that a time savings of 65% could be achieved with SEP.<sup>13</sup> Aljubouri et al<sup>14</sup> recently concluded that in a case requiring 20 brackets to be bonded, the average reduction in clinical chairside time would be around 8.5 minutes when compared with the

conventional two-stage etch and prime system. Conventional multi-step methods have been shown to work effectively but are susceptible to error at more stages than SEP.<sup>13</sup> The additional time needed to pumice and rinse the teeth prior to SEP is just over a minute and can be done by the assistant prior to the orthodontist's chairside arrival. Therefore actual doctor time is not increased by performing prophylaxis.

Costs of SEP, around \$3.00 per patient, have become more comparable with conventional methods. More importantly, the convenience of SEP cuts down the number of products needed in inventory and reduces susceptible contamination steps. The simplified bonding procedure is appreciated by orthodontic clinical staff and improves clinical cost-effectiveness.

The importance of the pumice prophylaxis step for assuring clinical success of the SEP bonding procedure may be due in part to SEP's inherently lower bond strength and technique specificity. A cleaner tooth surface may be required when using this method as compared to conventional acid etching techniques. Increasing popularity of SEP could lead to unnecessary bond failures if the manufacturer's recommended pumice pre-treatment step is omitted.

### Conclusions

The conclusions of this *in vivo*, split mouth design study were:

- There was a significant increase in the bond failure rate of brackets bonded with SEP if a pumice prophylaxis was omitted.
- Bond failure rates were low and well within an acceptable range when manufacturer's instructions were followed making SEP a suitable alternative to conventional acid-etch techniques for orthodontic bonding.
- Enamel pre-treatment with pumice is a necessary step when using the 3M Transbond Plus Self-Etching Primer system for orthodontic bonding.

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## VITA

Daniel J. Lill was born in Rochester, New York in 1971. He attended public school in Monroe County, New York and graduated in 1989 from Greece Arcadia High School. He received a Bachelor of Science from Pennsylvania State University in 1993 with a major in Premedicine. He proceeded to Virginia Commonwealth University (VCU) School of Dentistry and graduated in 2002 Summa Cum Laude with a Doctor of Dental Surgery degree. In 2003 he completed a postdoctoral certificate program in Advanced Education in General Dentistry (AEGD) at VCU. He is currently a postgraduate resident in the Orthodontics program at VCU and will receive a certificate in Orthodontics and a Master of Science degree. Upon graduation, Daniel will enter private practice in Virginia. He is married with a son and daughter.