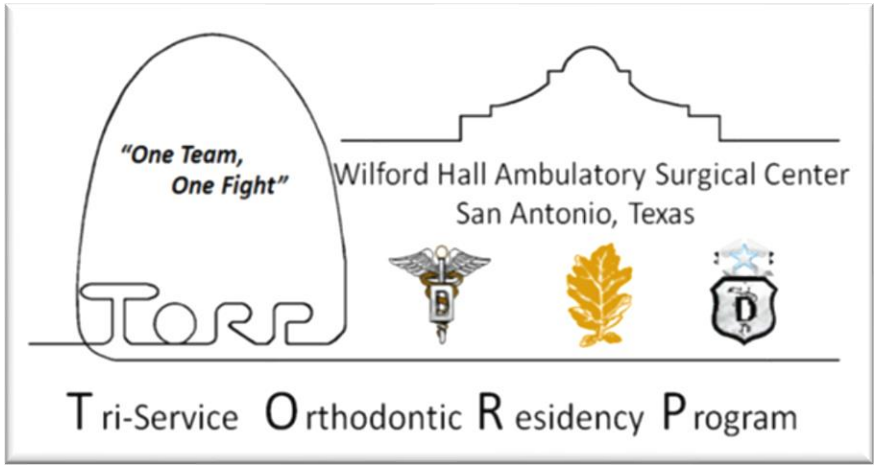


Shear Bond Strength: Opal Seal and Flash Free Brackets

Maj. Andrew P. Benfield, DMD, Resident, Air Force Postgraduate Dental School and Uniformed Services University of the Health Sciences Postgraduate Dental College

DISCLAIMER

The opinions or assertions contained herein are the private ones of the author(s) and are not to be construed as official or reflecting the view of the DoD or the USUHS.

Neither I nor any member of my family have a financial arrangement or affiliation with any corporate organization offering financial support or grant monies for this research, nor do I have a financial interest in any commercial product(s) or service(s) I will discuss in the presentation or publication.

Background and Purpose

- One of the risks associated with orthodontic treatment is the decalcification of enamel surrounding orthodontic brackets. In an effort to combat decalcification and subsequent caries during orthodontic treatment, many providers are turning to a micro-filled, fluoride releasing, bonding agent. Additionally, new flash free brackets have entered the market claiming to increase bond strength, decrease bonding time and decrease the amount of flash for bacteria to colonize. Many providers have begun using flash free brackets in conjunction with fluoride releasing bonding agents to decrease demineralization during treatment. The purpose of this study was to determine the effect on shear bond strength when using a fluoride releasing bonding agent with a flash free bracket system.

Materials and Methods

- This study was performed using bovine incisors. Two hundred fifty bovine incisors were procured and stored in distilled water prior to and throughout the protocol. Eighty teeth were chosen based on a set of inclusion criteria used to ensure suitability with the protocol design and adequate bonding environment. Teeth were excluded if there was evidence of coronal caries, enamel fractures or hypomineralization in the bonding area, gross staining extending into the bonding area, or less than eighty percent of the root remaining.

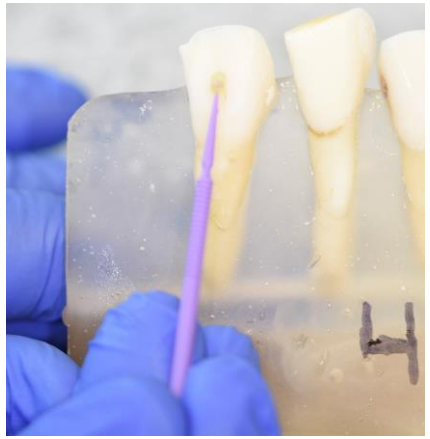
Materials and Methods

- Group 1 was comprised of sets one through four, twenty teeth in total, and was assigned for bonding with Transbond SEP and 3M Clarity Advanced ceramic brackets with APC Flash Free System.
- Group 2 was comprised of sets five through eight, twenty teeth in total, and was assigned bonding with Opal Seal and 3M Clarity Advanced ceramic brackets with APC Flash Free System.
- Group 3 was comprised of sets nine through twelve, twenty teeth in total, and was assigned bonding with Opal Seal and 3M Victory Series Low Profile brackets with APC Flash Free System.
- Group 4 was comprised of sets thirteen through sixteen, twenty teeth in total, and was assigned bonding with Transbond SEP and 3M Victory Series Low Profile brackets with APC Flash Free System.

Materials and Methods

- A standard protocol was used on all teeth for the initial steps of bonding. The facial surfaces of the teeth to be bonded were cleaned using pumice and rinsed thoroughly. Thirty-four percent phosphoric acid etchant gel (Caulk, Dentsply International) was then placed on the facial surfaces of each tooth and allowed to work for twenty seconds. The etched teeth were rinsed for ten seconds and dried thoroughly for fifteen seconds.

Materials and Methods



- Group 1 and Group 4
  - The facial surfaces of the teeth were painted with Transbond Self-Etching Primer for 3-5 seconds and then the primer was air thinned. One bracket, ceramic or metal respectively, with APC Flash Free System was placed on the facial surface of each tooth. The bracket was placed into its final position and fully seated. Each bracket was cured for a total of twelve seconds each, three seconds per side (incisal, gingival, mesial, distal).
- Group 2 and Group 3
  - The facial surfaces of the teeth were painted with Opal Seal using the provided syringe brush tip for 3-5 seconds and then the primer was air thinned. One bracket, either ceramic or metal respectively, with APC Flash Free System was placed on the facial surface of each tooth. The bracket was placed into its final position and fully seated. Each bracket was cured for a total of twelve seconds each, three seconds per side (incisal, gingival, mesial, distal).

Materials and Methods

- The bonded acrylic-tooth blocks were mounted in the Instron Universal Testing Machine holder and positioned such that the crosshead contacted the brackets along the superior tie wings to simulate intraoral shearing forces.
- The crosshead speed was set to 1 mm/min. When each test is initiated, the crosshead lowered until contact was made with the bracket. The load then increased until the bracket was debonded from the tooth. The load achieved for each test was recorded on computer software in units of newtons (N).
- Each measurement was then converted into megapascals (MPa). The shear bond strength of each of the eighty samples was then recorded and subjected to statistical analysis.

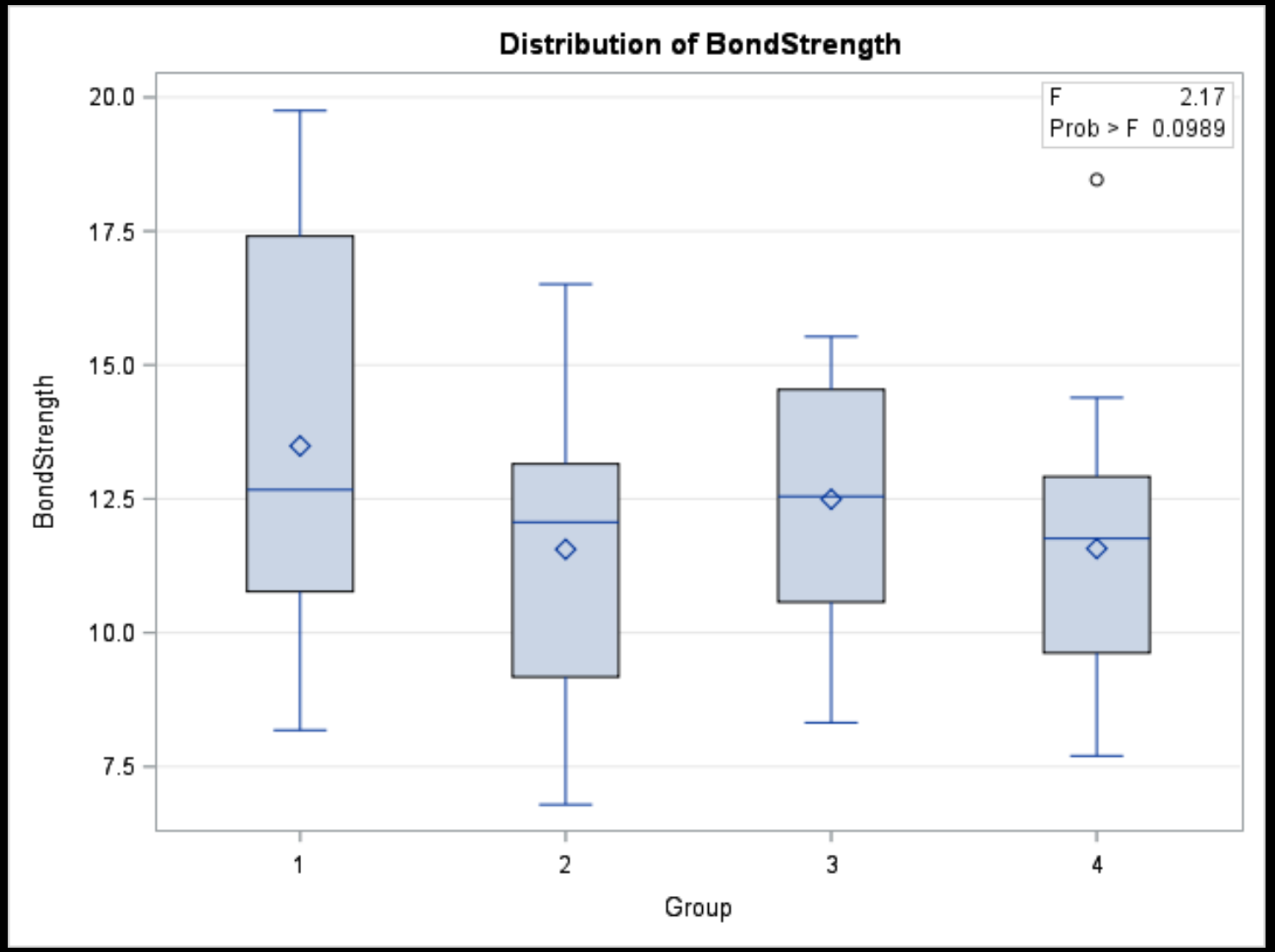
Results: Shear Bond Strength

The outcome data for Bond Strength was normally distributed according to Shapiro-Wilk test. A one-way analysis of variance (ANOVA) was performed to test the group difference. No significant group differences in Bond Strength was found ($F(3, 76) = 2.17$, $p = 0.099$).

Group	Mean	Std Dev
1: Clarity Transbond	13.49	3.55
2: Clarity OpalSeal	11.56	2.71
3: Victory OpalSeal	12.49	2.22
4: Victory Transbond	11.57	2.51

Results: Shear Bond Strength

- The box and whisker plot graph indicates all of the means are relatively close with groups 1 and 2 having some significant outliers and the medians being approximately 12.5 MPa for Groups 1-4.



Results: Adhesive Remnant Index (ARI)

- Next we evaluated ARI. ARI is a method to determine where the debond occurs. O'Brien, et al determined that the ARI score depended on many factors, including bracket base design and adhesive type, and not merely on the bond strengths at the interfaces. The index is useful in determining the percentage of bond failure sites by determining the amount of resin remaining on the tooth after debonding. According to Proffit, in an ideal debond situation the majority of the adhesive will remain on the tooth. This decreases the odds of enamel fracture during debond.

ARI Score	Definition	Type of Failure
0	0% adhesive on tooth surface (100% on bracket base)	Cohesive
1	<50% adhesive on tooth surface (>50% on bracket base)	Adhesive
2	>50% adhesive on tooth surface (<50% on bracket base)	Adhesive
3	100% adhesive on tooth surface with clear imprint of bracket base (0% adhesive on bracket base)	Cohesive

Results: Adehsive Remnant Index (ARI)

- The outcome data for ARI are ordinal data. Non-parametric test (Kruskal-Wallis Test) was performed to test the group differences. A Kruskal-Wallis Test showed that there was a statistically significant difference in rank for ARI among the groups. ARI scores for Groups 1 and 2 (Clarity) were greater than ones for Groups 3 and 4 (Victory). The median ARI of 3 with the Clarity brackets indicates that the median scores for the Clarity brackets were both at 3 meaning the majority of the adhesive remained on the tooth surface when compared to the Victory metal brackets.

Group	Median	25th Pctl	75th Pctl
1: Clarity Transbond	3.00	2.50	3.00
2: Clarity OpalSeal	3.00	3.00	3.00
3: Victory OpalSeal	2.00	1.00	2.00
4: Victory Transbond	1.50	1.00	2.00

Conclusion: Shear Bond Strength

There is no difference in shear bond strength of flash free brackets when using Opal Seal compared to flash free brackets without the use of Opal Seal. The results also indicate there is no difference in the amount of force required when debonding metal vs ceramic brackets with APC Flash Free systems. The outcomes indicate that there is no statistical difference when debonding brackets with the use of Opal Seal or Transbond Self-Etching Primer.

Conclusion: Adhesive Remnant Index (ARI)

- The results of the ARI were greater on average than what has been recorded in traditional shear bond strength studies of traditional twin brackets, which is consistent with the literature on APC Flash Free brackets. Research by Lee and Grunheid states that ARI is greater in flash free brackets when compared to traditional brackets, meaning they leave more composite on the tooth surface, thus protecting the underlying enamel.

Discussion

- A few of the limitations must be addressed due to their potential influence on the results of the study. The ceramic Clarity brackets fractured prior to debond from shearing forces. This could have caused an inadvertent increase in the ARI scores for the ceramic brackets due to the retention of both the fractured bracket and the composite on the tooth. This issue was not observed in the metal brackets. Future studies could examine the forces required to debond following the manufacturer's instructions, which could provide a more accurate representation of ARI during debond.