Shear Bond Strength With Indirect Bonding Variables: Tray Thickness and Material

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INTRODUCTION

Bonding of orthodontic brackets can be completed either directly, or indirectly. Indirect bonding is the process of positioning brackets on patient casts, then using a transfer tray to replicate bracket position intraorally. Direct bonding is simply placing brackets on teeth intraorally.

Benefits of indirect bonding:

- 360º visualization
- No time constraints
- Contamination reduced
- Adequate bond strength
- Reduced chair time for doctor and patient

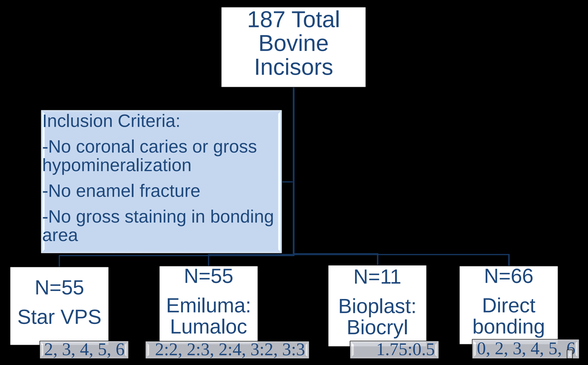
Costs of indirect bonding

- Additional steps
- Tray fabrication/material cost

OBJECTIVE & HYPOTHESIS

The aim of this laboratory study was to determine the Shear Bond Strength (SBS) of orthodontic brackets, when attached to teeth using different methods of bonding. Direct bonding was compared to 3 different methods of indirect bonding at different thicknesses.
Null Hypothesis: Varying the thickness and material of the transfer tray will have no impact on SBS.
Specific Hypothesis: Thickness and material of the transfer tray will impact SBS. Specifically, a thicker tray, and a more opaque tray will yield lower SBS.

MATERIALS AND METHODS



All brackets were debonded with the Instron Universal Testing machine and shear bond strength was recorded for each bracket, along with type of bond failure.

What is indirect bonding?

Results

Risk of too high bond strength

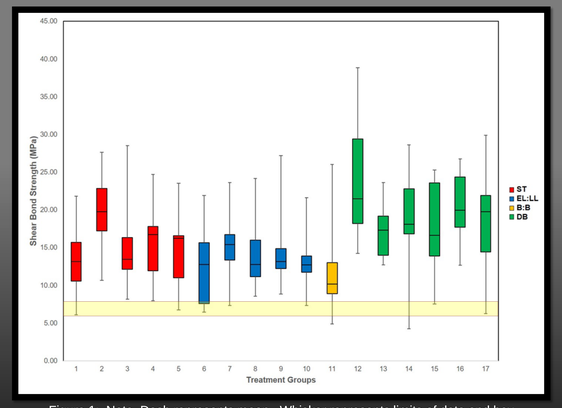


Figure 1: Note. Dash represents mean. Whisker represents limits of data and box represents 25th to 75th percentile. Yellow box represents Ideal SBS.

RESULTS

One-Way ANOVA results indicated a significant difference in the mean shear bond strength between the 17 groups ($p<.0001$). The Multiple Comparisons procedure showed direct bonding (with light cure touching the bracket) to be superior to most indirect bonding groups, but not all.

No statistical differences were found between any treatment groups that were in the same strata (material), which suggest that thickness of material does not impact shear bond strength.

Adhesive Remnant Index (ARI) describes type of bond failure. Inverse correlation between ARI and SBS, meaning higher SBS was related to a lower ARI score and lower SBS was related to higher ARI score.

DISCUSSION

The ideal transfer tray should be easily fabricated and sufficiently rigid to index intraorally. Trays should yield sufficient bond strengths to consistently bond brackets to teeth without debonding during treatment, yet allow bracket removal without tooth damage when treatment is complete.
According to Reynolds, orthodontic adhesives should have SBS of 5.9 to 7.8 MPa. In this study, treatment groups ranged from 12.0-23.6 MPa. This would result in reduced bracket failure during treatment, but may put the teeth at higher risk of enamel fracture during bracket removal.
In Contemporary Orthodontics, Proffit states that bond failure preferably occurs at the bracket-adhesive interface to avoid tooth damage, resulting in an ARI score of 3. This study ranged from ARI of 0.5-1.6, putting teeth at higher risk of damage at removal. The higher the ARI score (scale is 0-3), the better.

CONCLUSION

All treatment groups yielded shear bond strengths exceeding Reynolds published ideals of 5.9-7.8 MPa. While there were statistical differences between some treatment groups, these differences did not represent clinically significant differences.

Practitioners may select indirect transfer tray materials based on provider preferences for fabrication and handling characteristics of the materials.

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