Introduction
Indirect bonding has been practiced for many years, beginning with the “clean base” method of Silverman, et al.,¹ and progressing to the “custom base” method of Thomas.² These techniques have in common the pre-positioning of appliances on a working model of the dentition and the use of a transfer tray to capture the appliances and convey them to the patient’s mouth. The custom base method offers the advantage of reducing the amount of excess adhesive flash by allowing the use of less highly filled adhesives.

Numerous advances have been made over the years, both in the areas of the transfer tray and the adhesive. Transfer tray innovations include application of transparent silicones³ and combinations with hard thermoformed material for improved placement accuracy.⁴ Adhesives have employed improved redox initiator packages to yield quick set times combined with the convenience of a no-mix application.⁵,⁶ Light cure adhesives have been employed to advantage for their controlled set time and compatibility with self etching primers.⁷,⁸ Recently, some practitioners have advocated the use of flowable light-cured restoratives such as Filtek™ Supreme Plus Flowable Restorative for indirect bonding.⁴,⁹,¹⁰ The moderate filler content of these products is credited with mitigating the effect of marginal voids.

In response to this interest in flowable restoratives, in 2008 3M Unitek introduced Transbond™ Supreme LV Low Viscosity Light Cure Indirect Bonding Adhesive (Figure 1). Syringe delivery via a 20 gauge needle tip helps ensure that the ideal amount of product is delivered in precisely the desired location. The adhesive contains a dimethacrylate polymer that modifies the rheology of the material and provides a “flow on demand” handling characteristic allowing the material to flow under pressure, yet hold its shape after placement until light cured. For indirect bonding, this means that it will not slump, run, or drift from the bracket base prior to placement in the patient’s mouth. This rheology control allows the adhesive to be moderately filled (65% by weight) with a combination of agglomerated and non-agglomerated nanoparticles, composed of the following:

- 75 nm diameter non-agglomerated/non-aggregated silica nanofiller
- 5-10 nm diameter non-agglomerated/non-aggregated zirconia nanofiller
- Loosely bound agglomerated zirconia/silica nanocluster, consisting of agglomerates of 5-20 nm primary zirconia/silica particles. The cluster particle size range is 0.6 to 1.4 microns.

To provide the strength associated with Transbond brand adhesives, its resin consists of the dimethacrylate monomers Bis-GMA, TEGDMA, and Bis-EMA.

Figure 1: Transbond™ Supreme LV Low Viscosity Light Cure Indirect Bonding Adhesive is delivered via a syringe.
Laboratory Findings
Figure 2 illustrates that the bond strength of Transbond™ Supreme LV Low Viscosity Light Cure Adhesive compares favorably with those of Transbond™ XT Light Cure Adhesive, our light-cured direct bonding adhesive, and Sondhi™ Rapid-Set Indirect Bonding Adhesive, our chemically-cured indirect bonding adhesive.

Figure 2: Bond strengths of Transbond™ Supreme LV Low Viscosity Light Cure Adhesive, Transbond™ XT Light Cure Adhesive, and Sondhi™ Rapid-Set Indirect Bonding Adhesives.

Figure 3 demonstrates that the bond strength of Transbond Supreme LV Low Viscosity Light Cure Adhesive is similar to that of Transbond XT Light Cure Adhesive at 5 and 30 minutes after illumination, meaning that the bonds will be sufficiently strong for archwire tie-in.

Figure 3: Development of bond strength after bonding.

Customer Evaluation
To validate the above laboratory studies, we solicited input from doctors who currently use an indirect bonding system. A total of 20 evaluators submitted their feedback. The criteria for inclusion into the study were:

1. >75% indirect bonding of new case starts
2. Use of a transparent or translucent tray system
3. Access to an orthodontic curing light

There were no restrictions placed on the type of adhesive used to create the custom base, the tray material, tooth preparation or curing light.

The evaluation consisted of two parts. The first queried the general impression of the light cure indirect bonding adhesive. The second tracked bond failures at the time of tray removal, within 24 hours of the bonding appointment and one week after the bonding appointment.

Demographics
Most evaluators used a two tray system with a soft inner tray and a hard outer tray. The majority of the brackets used in the evaluation were manufactured by 3M Unitek: Victory Series™ Brackets, SmartClip™ Self-Ligating Brackets, Clarity™ Metal-Reinforced Ceramic Brackets and Clarity™ SL Self-Ligating Brackets. Four of the evaluators used competitor brackets. The majority of custom bases were prepared from APC™ II Adhesive or Transbond XT Light Cure Adhesive.

Curing lights used include Ortholux™ LED Curing Light, ORTHO Lite™ Curing Light, and three competitor lights. Recommended cure time per the instructions for use was 10 seconds mesial and 10 seconds distal with the light guide position perpendicular to the bracket and in contact with the hard outer tray.

General Impressions
Six adhesive properties were surveyed with the following questions.

1. Dispensing properties
2. Flow properties
3. Consistency/viscosity
4. Shade
5. Working time
6. Flash removal
Failures in the posterior region are not unexpected due to the difficulty of maintaining a dry field and challenges presented by patient occlusion.

Summary

Transbond Supreme LV Low Viscosity Light Cure Adhesive is a new light-cured adhesive. Its combination of fillers and rheological modifiers makes it especially suited for indirect bonding. The positive outcomes in the laboratory setting, i.e., handling characteristics and bond strength, along with the positive feedback and low bond failure rate in the customer evaluation, demonstrate Transbond Supreme LV Adhesive's effectiveness for indirect bonding.

References


Clinical Findings

Bond failure was tracked at the time of tray removal, 24 hours after tray removal and within one week of the bonding appointment. As shown in Figure 5 the overall bond failure rate was quite low at 1.7% overall.

Bond failures tabulated by tooth are shown in Table 1. Upper and lowers were grouped, as were first and second molar and first and second bicuspid brackets. There are significantly more bond failures in the posterior region, bicuspid and back, as compared to the anterior region.

<table>
<thead>
<tr>
<th>Tooth</th>
<th>Molar</th>
<th>Bicuspid</th>
<th>Cusp</th>
<th>U Lateral</th>
<th>U Central</th>
<th>L Anterior</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Bond Failures</td>
<td>22</td>
<td>18</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 1.

The evaluators were asked to rate their level of agreement of each statement concerning Transbond™ Supreme LV Low Viscosity Light Cure Adhesive. Responses are illustrated in Figure 4.