Shear Bond Strengths Using an Indirect Technique with Different Light Sources

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Many orthodontists use indirect bonding for greater accuracy and efficiency of bracket placement.[1,2] Both clinical and laboratory studies have demonstrated that indirect systems produce bond strengths similar to those of directly bonded adhesives,[3-8] as well as comparable bond failure rates.[2] Indirect bonding has also been reported to create superior conditions for bracket removal.[4] Although it requires a laboratory procedure, indirect bonding involves less clinical chairtime than direct bonding.[9]

Only a few in vivo studies have investigated the clinical effectiveness of the increasingly popular high-speed curing lights, such as LED and xenon plasma arc units.[10,11] No clinical studies have examined the suitability of these light-curing units for indirect bonding. The present article describes a clinical comparison of the shear strengths of indirectly bonded orthodontic brackets using two high-speed curing units—an LED and a xenon plasma arc light—and a conventional halogen curing light.

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Methods

Thirty consecutive patients (13 male and 17 female) were indirectly bonded with the following technique. First, all available molars were separated and banded. All teeth mesial to the first molars were bonded indirectly, except for any teeth scheduled for extraction. Some patients had teeth that could not be bonded initially due to severe crowding. A total of 554 brackets were placed.

The laboratory procedures were all performed by a single individual. After the bands were cemented, alginate impressions were taken, and stone casts were poured within two hours. Bracket positions were marked, and a separating medium was applied to the casts. Twenty-four hours later, MBT Victory Series* brackets were bonded to the casts with Transbond XT* adhesive. The adhesive was cured for three seconds on the mesial and three seconds on the distal of each bracket with an Advance 3000 Plasma Arc Curing Light** (Fig. 1).

A .5mm soft, positive-pressure Tray-Rite*** tray was vacuum-formed over each cast with the brackets in place. After a silicone lubricant was applied, a 1mm hard Biocryl† sheet was vacuum-formed over the first tray. The two trays with the embedded brackets were removed from the casts and trimmed. The custom bracket pads were cleaned with rubbing alcohol to remove any residual separating medium. Each custom tray was then segmented at the midline, and the hard

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**TPC Advanced Technology, Inc., 17588 E. Rowland St., City of Industry, CA 91748.

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†Great Lakes Orthodontics, Ltd. P.O. Box 5111, Tonawanda, NY 14151.

outer tray was separated from the soft inner tray.

All bonding was also performed by a single practitioner. Each patient was randomly assigned to either Group 1 (LED and halogen curing lights) or Group 2 (plasma arc and halogen curing lights). Each patient's left and right sides were then randomly assigned to either the high-speed light or the halogen light.

The tooth surfaces to be bonded were etched for 30 seconds and rinsed, and OrthoSolo‡ primer was applied. Small amounts of Transbond adhesive and OrthoSolo primer were placed on the custom pad of each bracket immediately prior to intraoral bonding. The first quadrant to be bonded was selected randomly, followed by the two contralateral quadrants and finishing with the ipsilateral quadrant in the opposing arch.

After the inner tray with the brackets was placed on the teeth, the hard outer tray was positioned with moderate finger pressure. When the Ortholux XT* halogen light (Fig. 2) was used, the brackets were cured for 15 seconds each from the mesial and the distal. The Advance LED 1 Curing Light** (Fig. 3) was applied for 10 seconds per side, and the Advance 3000 Plasma Arc Curing Light for three seconds per side, both according to the manufacturer's recommendations. A stopwatch was used to time the interval from the placement of the first bonding tray to completion of light curing for the first and second quadrants bonded on each patient.

After bonding, none of the patients had the bite opened to disclude the teeth. Each patient was followed for three months, and any bracket failures were noted, regardless of the apparent cause of debonding. A three-month follow-up period was chosen because we felt that bond failures over a longer period would more likely be attributable to other factors, such as inappropriate diet and destructive habits rather than the bond-

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Fig. 1 Advance 3000 Plasma Arc Curing Light.

Fig. 2 Ortholux XT Visible Curing Light.

Fig. 3 Advance 1 LED Curing Light.

TABLE 1
BOND FAILURES AND BONDING TIMES

	No. Teeth Bonded	No. Bond Failures	No. Failures per Patient	Bonding Time (sec/bracket)
Halogen unit	278	9	0.30*	31.47**
LED unit	140	5	0.33*	21.40**
Plasma arc unit	136	4	0.27*	7.53**

*Differences not statistically significant ($p > .05$).
**Differences statistically significant at the .001 level.

ing technique. T-tests were conducted to assess statistical significance.

Results

Over the three-month observation period, a total of .6 bond failures per patient were recorded. Brackets bonded with the halogen unit failed at a rate of .3 per patient; those bonded with the LED unit failed at a rate of .33 per patient, and those bonded with the plasma arc light failed at a rate of .27 per patient. There was no significant difference among the three units with regard to bond failure (Table 1).

The difference in the speed of the three curing lights was observed clinically and substantiated statistically. The halogen light required 31.47 seconds per bracket, the LED 21.40 seconds per bracket, and the plasma arc light 7.53 seconds per bracket. The difference between each pair of the units was highly significant ($p < .001$).

Discussion

Previous studies have demonstrated similar bond strengths between conventional halogen lights and high-speed curing units, but such a comparison has never been reported with an indirect bonding technique. Light intensity is inversely proportional to the square of the distance from the light source. The dual trays used in indirect bonding not only increase the distance between the light and bracket, but may act as a filter to reduce the light intensity. While previous reports have found that direct and indirect techniques produce similar bond strengths[3-8] and bracket failure rates,[2] the present study also demonstrates that LED and plasma arc high-speed curing lights have comparable clinical effectiveness when used for indirect bonding.

To the practitioner, as well as to the patient in the chair, the time required for bonding is of the utmost importance, and is often cited as a major reason for switching to an indirect technique. *In this study, the conventional halogen light was found to require two minutes and 21 seconds more than an LED unit and a full eight minutes more than a plasma arc light to bond a complete complement of 20 brackets.* Although we conclude that orthodontic brackets can be bonded indirectly with any suitable light source without fear of compromising clinical bond strength, chairtime can be dramatically reduced with the use of high-speed curing devices.

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