

Curing Efficiency of a Photo- and Dual-Cured Resin Cement Polymerized Through 2 Ceramics and a Resin Composite

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Purpose: The influence of the curing mode (dual vs light) and of the photopolymerization through ceramic or resin composite on the degree of remaining carbon bonds was investigated via infrared spectroscopic analysis for 1 resin cement (Calibra, Caulk/Dentsply). **Materials and Methods:** The 0.5-mm cement layer was photopolymerized for 40 s through the 2-mm-thick ceramic Empress 2 (Ivoclar) and Vitadur Alpha (Vident) and the laboratory-processed resin composite Sinfony (3M/ESPE). **Results:** The dual-cured system polymerized better than the light mode. Photopolymerization of the resin cement through the translucent materials reduced its curing efficiency in both curing modes. The resin composite induced a more negative effect than the 2 ceramics tested. **Conclusion:** The curing mode and photopolymerization of dual-cured resin cements through esthetic restorative materials affects the degree of remaining double carbon bonds. *Int J Prosthodont* 2006; 19:34–36.

Resin cements are used to bond inlays, onlays, veneers, crowns, and fixed partial dentures made of ceramic and laboratory-processed resin composite materials. The purpose of the study was to determine the influence of the curing mode (dual vs light) and the prosthetic material (photopolymerization through 2 ceramic and 1 resin composite) on the degree of remaining double carbon bonds (RBD) in a resin cement.

Materials and Methods

One resin cement (Calibra, Caulk/Dentsply), available in both light- and dual-cured formulations, was evaluated. The lithium disilicate pressable-core ceramic Empress 2 (Ivoclar Vivadent), the feldspathic dentin porcelain Vitadur Alpha (Vident), and the laboratory-processed dentin resin composite Sinfony (3M/ESPE)

were selected for the preparation of rectangular blocks 12 mm long, 6 mm wide, and 2 mm high. All materials were selected in the A3 shade.

Silicon molds of the same length and width were fabricated with a 0.5-mm recess that was used for the preparation of the cement specimens. After the pastes were mixed, the dual-curing cement was inserted into the mold (0.5 mm thickness), covered with the block material, and exposed to photopolymerization for 40 s through the block, via a halogen light-curing unit (Optilux 540, Demetron/Kerr) (Fig 1). The same procedure was followed to prepare specimens using a paste of the resin cement (light-curing mode).

Both combinations of curing mode (dual, light) plus the 3 block materials (Empress 2, Vitadur Alpha, and Sinfony) resulted in 6 different groups for testing ($n = 3$ samples in each group). Additionally, 3 specimens of each mode were subjected to direct photopolymerization and 3 specimens remained without photopolymerization. Infrared spectroscopic analysis (micro-mid-infrared spectroscopy and Fourier transform infrared spectroscopy) was used after 48 hours of dry and dark storage of the specimens to record the degree of RDB. The results were analyzed by 2-way analysis of variance and Ryan-Einot-Gabriel-Walsh test for multiple comparisons of means ($P < .05$).

Additionally, the percent difference between the RDB obtained through each block material and that of direct photopolymerization analogue (% change in RDB) were calculated.

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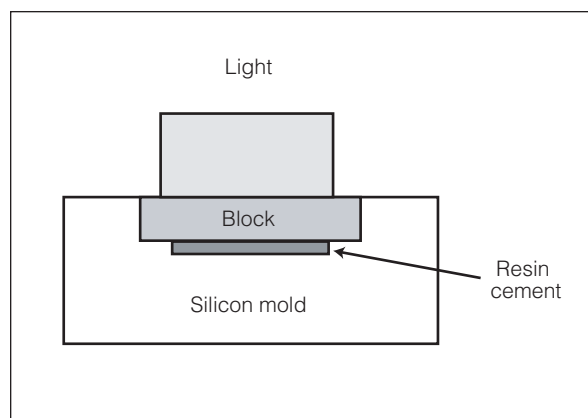


Fig 1 Schematic presentation of the setup used for the photopolymerization of resin cements through the block materials.

Table 1 Percent of Remaining RDB (Mean Values and SDs) of the Cement Calibra Polymerized Through 3 Different Block Materials and After Direct (No Block) Polymerization by Dual Curing or Light Curing

Curing mode	Empress 2	Vitadur Alpha	Sinfony	No block
Dual curing	51.03 (1.6) ^B [18.5]	52.06 (1.6) ^B [21.8]	58.97 (1.9) ^C [43.6]	43.08 (0.8) ^A
Light curing	60.80 (3.5) ^C [15.7]	60.80 (1.4) ^C [15.7]	67.2 (2.9) ^D [27.9]	52.53 (0.9) ^B

Groups with different letters were significantly different ($P < .05$). Bracketed numbers represent the percent of remaining C = C (change in RDB) difference in each block group relative to the direct photopolymerization analogue.

Results

The percent RDB in the dual-cured and light-cured cements, obtained through all block materials and after direct photopolymerization, and the percent change in RDBs calculated are presented in Table 1. A significant difference was detected between the dual-cured and light-cured cements when photopolymerized with the same block material.

When the cement was used in the light-curing mode without a block, RDB increased 22% more than with the dual-curing mode. The intervention of ceramic or resin composite block increased the RDB values for all modes from 16% to 44%. The resin composite induced the most negative effect on both curing modes compared to the 2 ceramic materials tested.

Discussion

The amine catalyst system of the chemical and dual-cured resin cements may cause a color shift to yellow, which is considered a major disadvantage.¹ Therefore,

manufacturers have developed products that can be used with and without chemical component. The dual-cured Calibra (combination of light-activated and chemically activated pastes) polymerized better than the light-cured mode in the present study. Generally, the dual-curing resin products exhibit higher monomer conversion than the light-polymerized resins.^{2,3} The additional catalyst seems to further induce the polymerization reaction.

Our results show the same trend in RDB values of Calibra polymerized with no block material seen by Caughman et al.² They found a 21% increase in RDB when no catalyst was used, although higher absolute RDB values have been recorded. The use of a light source with higher intensity than the unit applied in the current study may be responsible for the observed difference.

Polymerization was poorer with the laboratory-processed resin composite Sinfony than with the ceramics Empress 2 and Vitadur Alpha. Apparently, composite scatters light more than the ceramic materials, as a result of the difference in refractive index be-

tween the inorganic fillers and the organic matrix.⁴ Although higher opacity has been measured for Empress 2 than for the feldspathic porcelain Vitadur Alpha,⁵ a difference in RDB values was not observed in this investigation.

Conclusion

The dual-cured system resulted in lower RDB compared to the light mode. Photopolymerization of the resin cement through ceramic or resin composite blocks negatively affected the curing efficiency, regardless of the curing mode. The resin composite Sinfony gave higher RDB than the ceramic materials Empress 2 and Vitadur Alpha.

References

1. Noie F, O'Keefe KL, Powers JM. Color stability of resin cements after accelerated aging. *Int J Prosthodont* 1995;8:51-55.
2. Caughman WF, Chan DCN, Rueggeberg FA. Curing potential of dual-polymerizable resin cements in simulated clinical situations. *J Prosthet Dent* 2001;86:101-106.
3. Jung H, Friedl KH, Hiller KA, Haller A, Schmalz G. Curing efficiency of different polymerization methods through ceramic restorations. *Clin Oral Investig* 2001;5:156-161.
4. Enami N, Sjö Dahl M, Söderholm KJM. How filler properties, filler fraction, sample thickness and light source affect light attenuation in particulate filled resin composites. *Dent Mater* 2005;21:721-730.
5. Heffernan MJ, Aquilino SA, Diaz-Arnold AM, Haselton DR, Stanford CM, Vargas MA. Relative translucency of six all-ceramic systems. Part I: Core materials. *J Prosthet Dent* 2002;88:4-9.

Literature Abstract

A prospective clinical study of bone augmentation techniques at immediate implants

The efficacy of combinations of membranes and autogenous bone grafts at immediate implants were compared in this prospective study. Sixty-two consecutively treated patients (29 males, 33 females) each received an immediate implant for a single tooth replacement at a maxillary anterior or premolar site. Dimensions of the peri-implant defect at the implant collar were measured as follows: vertical defect height (VDH, measured from the most apical extent of the defect to the coronal aspect of the implant collar), horizontal defect depth (HDD, measured bucco lingually from the most buccal extent of the implant collar to the labial bone crest) and horizontal defect width (HDW, measured mesio-distally at the most labial extent of the implant collar). Each implant randomly received 1 of 5 augmentation treatments and were submerged with connective tissue grafts: Group 1 (n = 12), expanded polytetrafluoroethylene membrane only; Group 2 (n = 11), resorbable polylactide/polyglycolide copolymer membrane only; Group 3 (n = 13), resorbable membrane and autogenous bone graft; Group 4 (n = 14), autogenous bone graft only; and Group 5 (n = 12), no membrane and no bone graft control. Wound closure was achieved by the use of connective grafts harvested from the palate. At re-entry after 6 months, all groups showed significant reduction in VDH, HDD, and HDW. Comparisons between groups showed no significant differences for VDH (mean 75.4%) and HDD (mean 77%) reduction. Significant differences were observed between groups for HDW reduction (range, 34.1% to 67.3%), with membrane-treated Groups 1, 2, and 3 showing the greatest reduction. In the presence of dehiscence defects of the labial plate, HDW reduction of 66.6% was achieved with membrane use compared with 37.7% without membranes. Over 50% more labial plate resorption occurred in the presence of a dehiscence defect irrespective of the augmentation treatment used. The results indicate that VDH and HDD reduction at defects adjacent to immediate implants may be achieved without the use of membranes and/or bone grafts. The authors concluded that where the labial plate is damaged, significant resorption of the labial plate occurs irrespective of membrane and/or bone graft use and may have negative esthetic implications. In these situations, the use of barrier membrane and bone grafts or substitutes with slower resorption rates merits further investigations.

Chen ST, Darby IB, Adams GG, Reynolds EC. *Clin Oral Implants Res* 2005;16:176-184. **References:** 53. **Reprints:** Dr Stephen Chen c/o Ms K Fletcher 'Centre for Oral Health Science' School of Dental Science, The University of Melbourne, 711 Elizabeth Street, Melbourne, Vic 3000, Australia. Fax: +61 3 9341 2036. E-mail: schen@mira.net—Tee-Khin Neo, Singapore

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