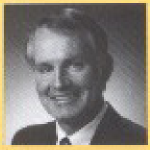
AESTHETIC UPDATE



Compiled by Geoffrey M. Knight

The 'co-cured' bonding technique

The introduction of resin modified glass ionomer cement restorative materials has created a new direction in adhesive dentistry. This material exhibits the clinical properties of glass ionomer cements with a light-cured mode that overcomes the frustrating time lag associated with waiting for the cement to set.

Resin modified glass ionomer cements have found wide acceptance for use as non load bearing restoratives and have been shown to adhere more predictably to dentine than resin based bonding systems.

Composite resins are also enjoying increased use, although polymerization shrinkage, particularly at the restorative interface, remains an ongoing clinical problem.

Early in 1991, two increments of composite resin and resin modified glass ionomer cement, sitting on a bracket table, were accidentally photo initiated for two seconds. The composite resin was observed to have hardened whilst the resin modified glass ionomer cement remained malleable.

This observation led to the idea of bonding composite resin to tooth structure using a resin modified glass ionomer cement as an intermediary adhesive agent. Upon photo initiation, the composite resin will cure before the resin modified glass ionomer cement, allowing the composite to undergo initial polymerization shrinkage prior to adhering, by the glass ionomer cement, to the tooth surface, creating a less stressful environment at the restorative interface. **This is the basis of the 'co-cured' technique.**

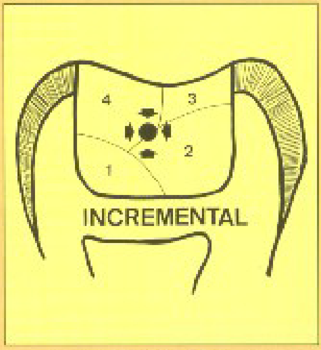


Diagram 1

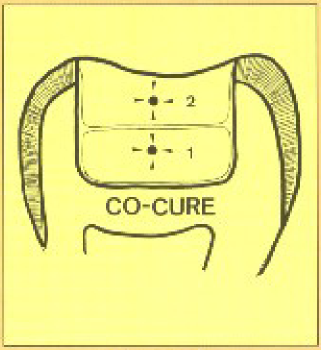
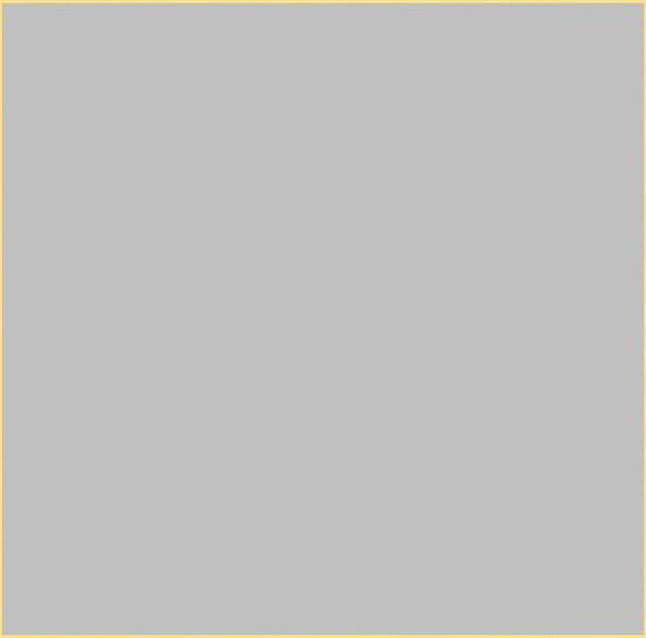


Diagram 2



Another problem with composite resin is that 40 per cent of polymerization shrinkage occurs after photo initiation. Clinically, this means that composite resin restorations should be limited to a maximum thickness of 2 mm, for even if a restoration is built up using small increments, the final mass of resin will undergo shrinkage as an integral unit creating internal stress within it (Diagram 1).

This problem may be overcome by smearing a layer of resin modified glass ionomer cement between increments of composite resin during placement of the restoration. Separation of the composite resin in this way will reduce internal stress within the restoration as each layer of resin undergoes further polymerization shrinkage as a separate entity (Diagram 2).

A scanning electron microscope shows a co-cured restoration that had been placed in an extracted molar tooth. The thickness of resin modified glass ionomer cement at the margins was in the range of 25 microns (Fig 1). The sharpest probe is about 40 microns and there was evidence of bonding between the resin modified glass ionomer cement and composite resin (Fig 2).

Fracture Resistance tests carried out at the Australian Bureau of Dental Standards showed that on extracted human teeth, a 'co-cured' restoration was 50 per cent stronger than a restoration using a glass ionomer cement-composite resin sandwich (Fig 3).

When some transparent materials are subject to stress and viewed between crossed polarized light, colorful birefringent patterns result. This leads to the possibility of identifying marginal stress that may have resulted within a composite resin due to polymerization shrinkage when bonded to a fixed surface.

Specimens of enamel and dentine were prepared and composite resin was bonded to them firstly using a resin based bonding system and then a resin modified glass ionomer cement, co-cured as an intermediary, between the composite and tooth.

When the enamel surfaces of the two specimens were observed in polarized light, there was a distinct region of birefringence within the composite resin at the restorative interface of the resin based bonding specimen (Fig 4). The composite that had been co-cured with the resin modified glass ionomer cement showed no birefringence at the restorative interface (Fig 5).

Similarly when the dentine surfaces were compared, there was distinct birefringence within the composite resin along the interface and associated with the slight penetation of the resin based bond into the dentinal tubules (Fig 6). No evidence of birefringence was observed at the interface of the composite resin that had been bonded using the co-cured technique (Fig 7).

Resin modified glass ionomer cements suitable for co-cure bonding are Fuji II LC (GC)*, Vitremer (3M)† and Photac-Fil (ESPE)‡. GC have recently released a further resin modified glass ionomer cement universal bonding system called Fuji Bond LC (GC)§ that carries specific instructions for use with the co-cured technique.

Clinical technique

After cavity preparation the surface of the tooth may be conditioned with either polyacrylic acid or a five second application of 37 per cent phosphoric acid to remove the smear layer and lightly etch the enamel surface.

One drop of Fuji Bond LC (GC) liquid is added to one scoop of powder and mixed with a micro brush into a smooth paste. Using the same brush, the glass ionomer cement is smeared in a thin layer over the base and dentine walls of the preparation.

*Halas Dental Pty Ltd, Waterloo NSW.
†3M Australia Pty Ltd, Pennant Hills NSW.
‡ESPE Australia Pty Ltd, Alexandria NSW.
§Halas Dental Pty Ltd, Waterloo NSW.

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Key
R Composite Resin
G Resin Modified Glass Ionomer Cement
E Enamel
D Dentine

Fig 1. The restorative interface showing a 25 micron thick layer of resin modified glass ionomer cement between enamel and composite resin.

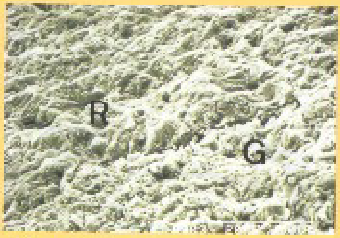

Fig 2. The interface within a restoration, between composite resin and resin modified glass ionomer cement.

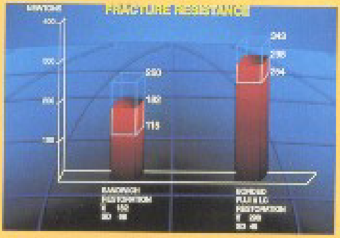

Fig 3. Graph showing that co-cured restorations have 50 per cent greater fracture resistance when compared to standard glass ionomer cement-composite resin sandwich restorations.

Fig 4. Cross section viewed under polarized light of composite resin bonded to dental enamel with a resin based adhesive system magnified by 80x. Note the region of birefringence within the composite resin along the full length of the restorative interface.

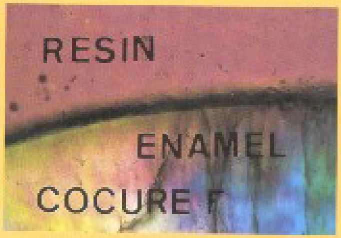

Fig 5. Cross section viewed under polarized light of composite resin bonded to dental enamel by the co-cured technique using resin modified glass ionomer cement as a bonding intermediary magnified by 80x. Note that there is no evidence of birefringence within the composite resin at the restorative interface.

Fig 6. Cross section viewed under polarized light of composite resin bonded to dentine by a resin based adhesive system magnified by 80x. Note the birefringence within the composite resin at the interface and associated with the penetration of the bond into the dentinal tubules.

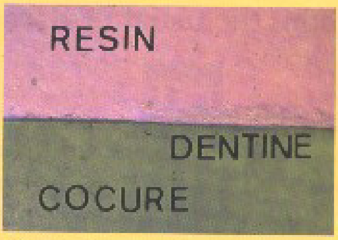

Fig 7. Cross section of composite resin bonded to dentine by the co-cured technique using resin modified glass ionomer cement as a bonding intermediary magnified by 80x. Note that there is no evidence of birefringence within the composite resin at the restorative interface.

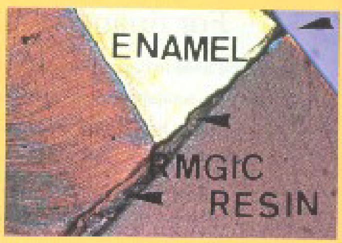

Fig 8. Microscopic appearance of a restorative margin after burnishing the composite resin to minimize the thickness of resin modified glass ionomer cement.

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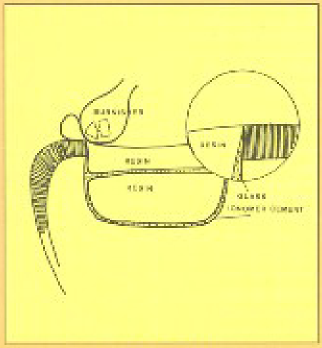

Diagram 3

An increment of composite resin, less than 2 mm thick, is puddled into the glass ionomer, displacing all but a thin layer of cement between the tooth and composite resin.

Both composite resin and resin modified glass ionomer cement are simultaneously photo initiated.

A further layer of resin modified glass ionomer cement is smeared over the hardened composite resin and the walls of the cavity, including the enamel margins. (Diagram 2). An increment of composite resin is placed to fill the cavity and burnished towards the margins with a ball burnisher. It is important to burnish the composite resin in this way in order to minimize the thickness of the glass ionomer cement at the restorative margins (Diagram 3, Fig. 8).

The composite resin and glass ionomer cement are now co-cured.

The restoration can be contoured and finished using standard techniques. Care is required not to overheat and dehydrate the thin layer of resin modified glass ionomer cement at the restorative interface.

The co-cured system is being used by increasing numbers of Australian dentists since 1991. The long term usage and confirmed clinical success of resin modified glass ionomer cement lining materials supports the viability of this technique that is both time efficient and easy to use. Furthermore, when compared to resin based bonding systems, the anecdotal experience of many practitioners has been a substantial reduction in the amount of post operative sensitivity and restoration fracture.

Acknowledgments

The author wishes to thank Associate Professor John Clement, Oral Medicine and Surgery Research Group, School of Dental Science, University of Melbourne, for making some of the laboratory facilities of the Dental School available to carry out this study, Mr Dennis Rowler whose technical assistance made it possible and, while the opinions expressed are those of the author, Dr Joe Palamara for his help with interpretation of the material. □

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