# Glass Ionomers:
## Why, Where and How

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Composite resin is a suitable restorative material to restore an existing failed restoration, however it is unsuitable to restore a carious lesion due to the large amount of remineralizable dentin required to achieve a reliable adhesive base.

Glass ionomer cements (GIC) will adhere to caries affected dentin, minimizing the amount of tooth removal required to restore the tooth. Glass ionomer cement can be used as a restorative material in its own right or as a base for a composite resin overlay (sandwich restoration) where the remaining tooth structure is unsupported and requires a bonded composite to maintain its structural integrity.

For the following reasons glass ionomer cements are the material of choice for treating an active carious lesion:

- The weak bond strength of glass ionomer cement to sound and caries affected tooth structure does not affect the integrity of the restoration as there is not the polymerization shrinkage stress associated with composite resins.
- Glass ionomer cement, both auto and light cured will adhere to caries affected and infected dentin.
- Glass ionomer cements release fluoride ions at around 1 percent (above 5000 parts per million) that will effectively kill any cariogenic bacteria still present in the outer perimeter of a carious lesion.
- Glass ionomer cements protect the margins of a restoration from recurrent caries.

The fluoride release from glass ionomer cements over a sealed carious lesion will harden the carious dentin and encourage the formation of caries resistant arrested caries in any carious dentin present and change the carbonated apatite in affected dentin to fluor apatite creating a decay resistant base beneath the restoration.

### Rationale for Using GIC to Restore Dental Caries

A schematic diagram of a carious lesion prepared for a GIC restoration is shown in **Figure 1.** Note that it is possible to leave a thin layer of carious dentin as fluoride ions released from the GIC will penetrate into the carious dentin at a concentration that will kill any bacteria present.

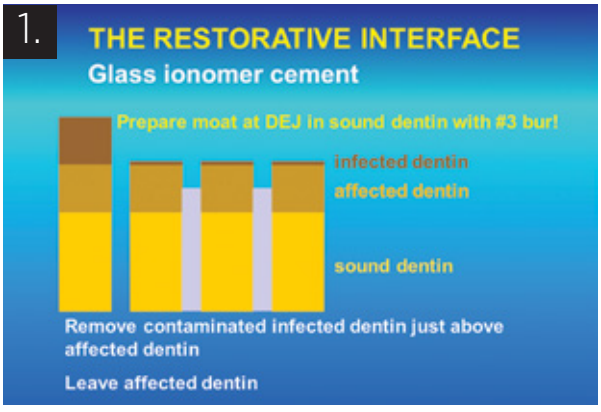
**Figure 2** shows schematically what happens when a GIC restoration is placed in such a prepared cavity. Strontium and fluoride move from the GIC into the infected and affected dentin to combine with calcium and phosphate ions from the dentinal tubular fluid to enable the formation of fluoride enriched arrested caries in the infected dentin and fluorapatite in the affected dentin **(Fig. 3)**.

**Figure 4** shows schematically the amount of tooth removal required for a GIC restoration compared to the amount of tooth removal required for a composite resin restoration in similar circumstances **(Fig. 5)**.

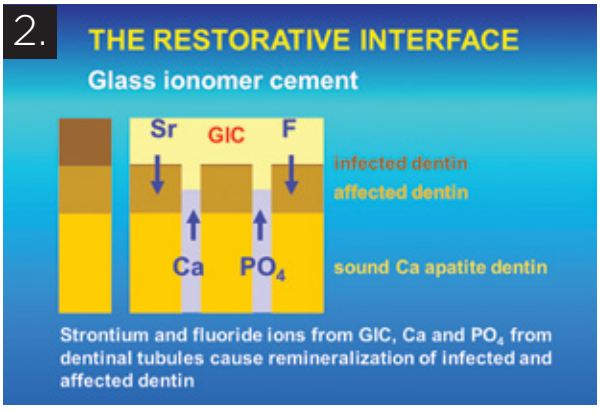
### Restoring A Carious Lesion With An Auto Cure Glass Ionomer Cement Or Resin Modified Glass Ionomer Cement

Auto cure GIC is preferable as a restorative material to Light cured GIC, or resin modified glass ionomer cement (RMGIC).

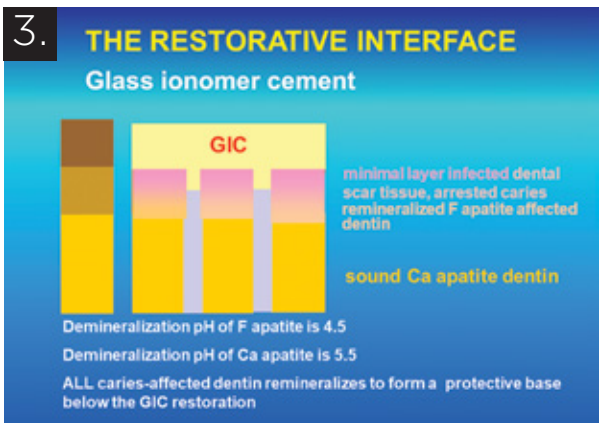
RMGICs have poor wear resistance on occlusal surfaces and in larger restorations the curing light does not penetrate to the base of the restoration (due to the high opacity). This leaves uncured HEMA within the RMGIC that will absorb



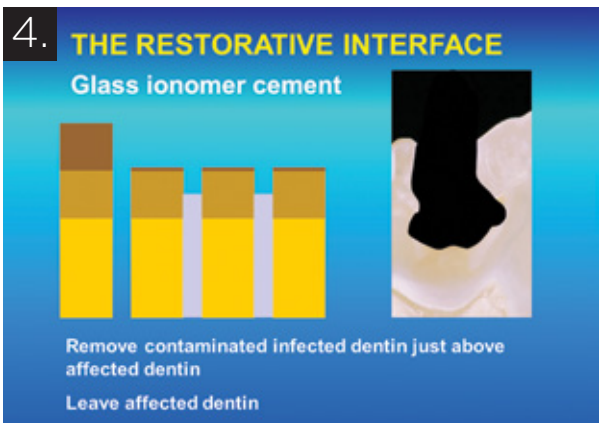

A schematic diagram of a carious lesion prepared for a GIC restoration, showing the amount of tooth removal required.



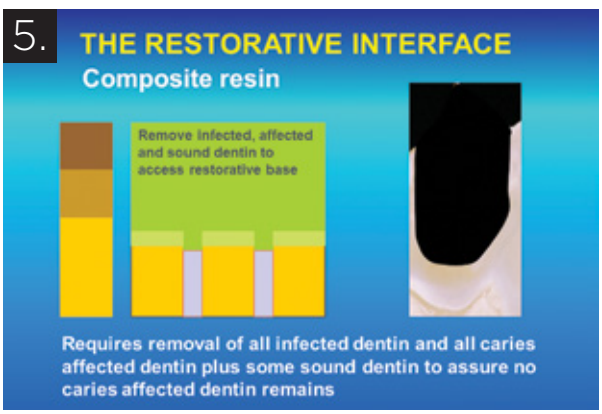

The remineralization process when a GIC restoration is placed over caries affected dentin.




The schematic outcome of a GIC restoration, remineralizing caries affected dentin.

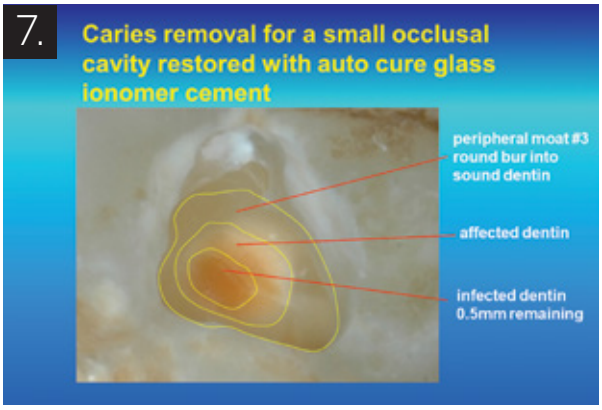



The amount of tooth removal required for a GIC restoration: leaving some infected dentin and all the affected dentin in the cavity preparation.




A cavity prepared for a composite resin restoration requiring removal of all infected and affected dentin to achieve a reliable adhesive base.


Two small occlusal carious lesions about to be prepared for GIC restorations.




How to identify the different types of carious affected dentin and how much to leave at the restorative base.


Cavity preparation prior to restoration placement.


Etching for five seconds with phosphoric acid removes hand piece oil and other contaminants from the cavity surface.


Oil from a high and slow speed handpiece is not removed by polyacrylic acid conditioning the tooth, potentially reducing the bond strength of the GIC.

moisture from the tooth into the material and may produce post- operative sensitivity.

## Restorative Technique

**Figure 6** shows two small occlusal carious lesions prepared for a GIC restoration. **Figure 7** shows the amount of caries to remove. At the perimeter of the preparation a moat is prepared with a #3 round bur just into sound dentin to secure a biological seal with the GIC restoration.

Further in from the perimeter of the preparation, the base consists of affected dentin (determined by the colour and hardness of the tissue). Since the collagen fibres remain intact this dentin will remineralize as fluorapatite as calcium and phosphate ions from the dentinal tubular fluid combine with the fluoride from the GIC.

In the centre of the preparation a thin layer of carious dentine, about .5mm thick remains directly above the pulpal tissues. Fluoride ions from the GIC will penetrate through the remaining caries at a concentration that will kill any bacteria present and assist with the formation of fluoride enhanced arrested caries **(Fig. 8)**.

After cavity preparation the tooth is etched for five seconds with 37% phosphoric acid to clean the cavity and remove any debris, including hand-piece oil from the restorative interface **(Fig. 9)**. Conditioning with polyacrylic acid does not remove handpiece oil; that if left behind, substantially reduces the bond strength of the GIC. **Figure 10** shows how oil from a high and slow speed handpiece can contaminate the tooth surface, a fact that appears to have been overlooked by the manufacturers of self-etching bonding agents.

Once the cavity has been washed and gently dried, the GIC can be placed, inserting the nozzle to the base of the cavity and filling the preparation from the base upwards to avoid air inclusions. High viscosity glass ionomer cements currently available will enable a clinician to pack the GIC into the cavity similarly to an amalgam restoration.


**GIC restorations on occlusal surfaces are recommended when there are no unsupported cusps present and the restoration does not encroach upon a centric stop**

Setting time of the GIC can be reduced by prior warming the capsule and/or applying a composite curing light over the restoration, as the energy released speeds up the chemical setting reaction of the GIC.

Once set, the restoration should be contoured to fit within the occlusal envelope. A layer of protective varnish is recommended by some manufacturers but clinically seems to have little effect on the success of the restoration.

GIC restorations on occlusal surfaces are recommended when there are no unsupported cusps present and the restoration does not encroach upon a centric stop **(Fig. 11).**

If either of these conditions are present, then a sandwich restoration is indicated with a composite resin overlay to protect the tooth from possible cusp fracture and excessive occlusal wear at the centric stop.

## Conclusions

Composite resin may be unsuitable as a restorative material for carious lesions due to the large amount of remineralizable tissue removal required when using these materials.

Auto cure glass ionomer cement enables a restorative dentist to leave small amounts of infected dentin within the cavity and all of the remineralizable affected dentin.

With the advent of pharmacological caries management, little if any carious dentin removal will be required, however GICs will continue as the first layer material of choice to replace any missing tooth structure using this restorative technique. **OH**

Oral Health welcomes this original article.

Geoff Knight is a general dentist from Melbourne, Australia with interests in aesthetic and minimal intervention dentistry. He has introduced a number of innovative clinical techniques and is named on several dental patents. Dr. Knight speaks internationally with a focus on highly efficient, minimally invasive dentistry. He has been State President of his Dental Association and has extensive political and economic experience within the profession. Dr. Knight's recreational pursuits include mountaineering, an interest that has taken him to a number of the highest peaks on several continents.