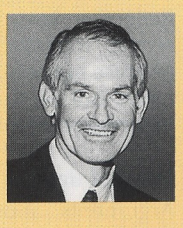

Compiled by Geoffrey M. Knight

The dentine restorative interface

Changes in the patterns of dental disease and restorative technologies pose questions as to how dentists should address the dentine restorative interface. Arguments about leaving carious dentine and where tooth removal should end generate new challenges in removing caries and restoring teeth.

Fusayama has differentiated dentine at the caries interface into infected and affected dentine.

Infected dentine is the amorphous mass of broken down collagen, infected with bacteria that once formed the structural organic matrix of dentine.

Affected dentine is the demineralized but still remaining structural collagen matrix, free from bacterial contamination, that is capable of remineralizing under favourable conditions (Fig. 1). According to Fusayama, the width of the softened affected dentine can extend up to 1 mm in depth, making a substantial contribution to protecting pulpal tissue from exposure.

Examination of the dentine restorative interface within this concept raises a number of questions, namely:

- What is the optimal adhesive system to use with affected dentine?
- What is the optimal restorative material to place against affected dentine?
- How to clinically detect the infected/affected dentine interface?
- Should infected dentine be removed or left to form a lining, and if so how should it be conditioned?
- What is the optimal technique for removing infected tooth structure so that the infected/affected interface remains clearly defined?

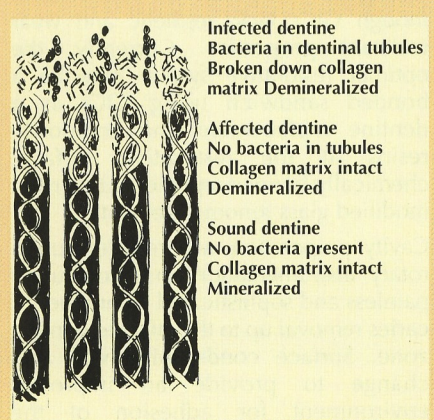

Fig. 1.

Adhesive systems

There is a growing divergence between the use of mechanically bonded resin adhesion and chemically bonded glass ionomer cements. The concept of a highly stressed mechanical bond to an active biological surface is hard to comprehend and defies biological principles. Clinical trials on resin bonding systems demonstrate increasing failure rates after three years.

Glass ionomer cement (GIC) bonds to dentine by an ionic bond that, although weaker than the mechanical resin bond, is theoretically capable of reconstituting itself after failure. GICs also bond well to sclerotic dentine. There is a lack of research examining mechanical resin bonds to the hybrid zone of partially demineralized affected dentine.

Restorative materials

Composite resins are aesthetic materials with a good resistance to occlusal wear. They are best suited in the oral environment if bonded directly to enamel or an intermediary lining material.

Glass ionomer cements bond chemically to dentine. They release calcium and hydroxide ions that facilitate remineralization of the affected dentine and the presence of fluoride ions enable remineralization to occur at a pH of 4.5 instead of the normal 5.5 (Figs. 2 and 3).

Furthermore, GICs act as a buffer to falls in oral pH and will break down in preference to tooth structure in an acid environment, similarly to the sacrificial anode on an outboard motor.

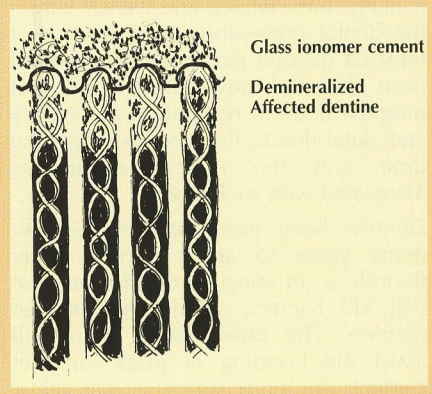

Fig. 2.

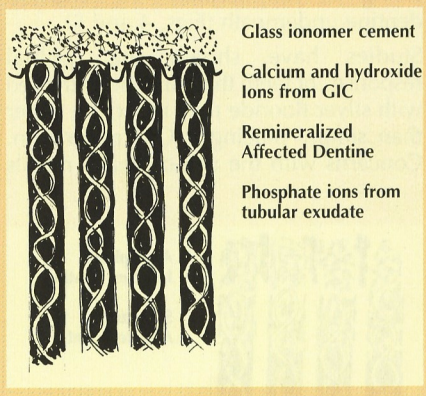

Fig. 3.

Caries detection

Traditionally caries have been detected using a sharp probe or excavator and determining the relative softness of the dentine. This relatively crude technique tends to result in the unnecessary removal of affected dentine potentially capable of remineralization.

Caries detector dye has been a useful addition to diagnosing caries although after the initial application the penetration of dye into the dentinal tubules may give a practitioner a false positive result, again leading to excess tooth removal. Dentists should be wary of advertisements for plain food dyes, as accurate detection dyes contain a number of proprietary additives and are pH sensitive.

Reflective laser caries detectors are a recent introduction that show great promise not only as a means of detecting caries but as a way of monitoring the progression of a lesion over time.

Infected dentine as a lining material

Arguments about removing infected dentine, especially if a pulpal exposure is likely, have waxed and waned within the dental profession. Suggestions that infected dentine that has been isolated from the oral environment will not progress under a restoration are largely anecdotal due to the long experimental time and the ethical constraints associated with such studies.

Dentists have used fluoride salts for many years to arrest caries. Silver fluoride is an effective disinfectant that will kill bacteria within the infected dentine. The precipitated silver will assist the bonding of glass ionomer cements to tooth structure and allow ions from the GIC to pass through the lining to remineralize the affected dentine underneath (Figs. 4 and 5).

Studies have shown that pulpal responses of teeth that have been treated with silver fluoride may in fact be better than simply placing a GIC restoration. Concerns with the use of heavy metals in the mouth and potentially toxic levels of fluoride release have caused treatment modalities of this type to be approached with caution. A further constraint is the black staining that occurs in a GIC restoration in silver fluoride treated teeth.

The use of silver salts may be indicated in an environment where a practitioner is unable to differentiate the carious/sound tooth interface in deep lesions where aesthetics is not a major concern in the final restoration.

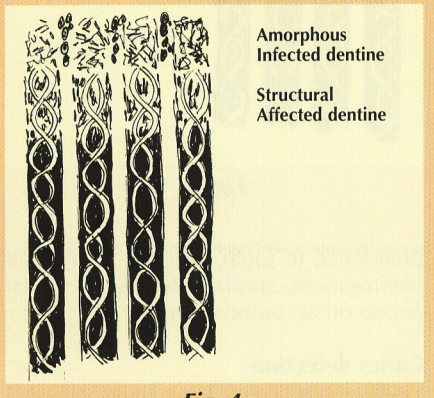

Fig. 4.

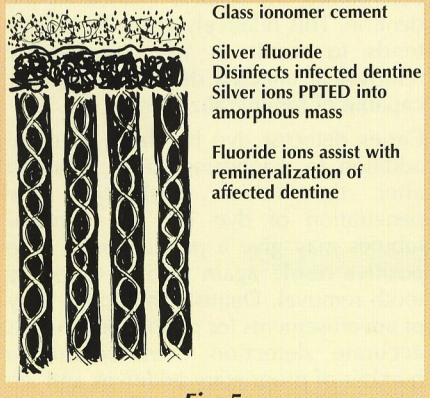

Fig. 5.

Cavity preparation techniques

Cavity preparation techniques fall into a number of categories:

- Mechanical removal using burs or hand instruments.
- Chemical removal.
- Mechanically assisted chemical removal.
- Laser removal.
- Particle abrasion.

Mechanical removal

Mechanical removal of carious dentine using rotary instruments remains the most popular and possibly the most efficient means of tooth preparation. Apart from patient discomfort, the main disadvantage of this technique is the inability to accurately differentiate the infected/affected tooth interface. Most teeth that have been prepared with rotary instruments have too much remineralizable tooth structure removed. Further disadvantages of engine removal are the potential to cause microfractures within the tooth and possible pulp damage caused by friction overheating.

The removal of infected dentine with sharp hand excavators will enable a more accurate diagnosis of the restorative interface. The technique is particularly applicable to ART dentistry where rotary instruments are not available.

Chemical removal

A variety of caries dissolving solutions have been marketed to the dental profession. The most recent, Carisolv, is basically a buffered sodium hypochlorite solution. The benefit of Carisolv is the ability to remove caries relatively painlessly without destroying the affected dentine. The main disadvantages are that it is a time consuming procedure and the material costs are prohibitive, adding substantially to the clinical expenses of placing a restoration.

Mechanically assisted chemical removal

Kavo has developed a number of diamond coated abrasive tips that can be attached to the Soniflex scaler. Air scalers have a greater oscillation range than ultrasonic scalers making them more effective for cutting tooth tissue. The SONICparo attachment tips are particularly suitable for removing residual carious dentine. Used in conjunction with Carisolv solution or even an EDTA gel enables a significantly more efficient removal of carious dentine than with the hand instruments supplied in the Carisolv kit.

Laser removal

The use of lasers in dentistry as tooth-cutting instruments has been hampered by the high costs and the relatively slow procedure involved in carious removal. As technology reduces equipment costs and improves efficiency lasers may well become the preferred technique of tooth removal due to their relatively painless and precise application.

Particle abrasion

Particle abrasion is particularly suitable for preparation of small lesions and opening up enamel to expose the carious dentine below. The resilience of dentine is such that particle abrasion with aluminium oxide is not suitable for preparation beyond the dentine enamel junction for larger cavities. Manufacturers are looking for alternative abrasives that may enable the efficient removal of infected dentine.

Future directions

It is likely that in the future restorative materials will become more biologically compatible with tooth structure and have increasing therapeutic properties.

At present glass ionomer cements are biologically superior to resins even though GICs lack aesthetic and wear resistant properties. Currently, the optimal restorative system may be a bonded sandwich using GICs as a dentine replacement and composite resins at the restorative surface, chemically bonded together with a resin modified glass ionomer cement.

Cavity preparation will rely less upon rotary instrumentation and more upon painless and sophisticated techniques of caries removal up to the affected dentine zone. Surface conditioning will also change to provide an improved environment for adhesion of the restorative material to tooth structure.