Deep caries: A look at the latest restorative options.

By Dr Graham Craig

A common restorative situation faced by practitioners is how to handle deep caries in a tooth that is vital and does not have reversible pulpitis. There are now enough long-term clinical findings to provide very sound guidelines on the procedures to follow.

Traditional option: Remove all caries.

The traditional approach is to remove all caries. In such cases there is the possibility of a pulp exposure. If this occurs, the two main options are pulp capping or pulpectomy.

Pulp capping >>

Left: The presence of infected dentine chips introduced during a vital pulp exposure can be a factor in pulp capping failure. Even if done under ideal conditions, such as a mechanical exposure under rubber dam, the longer-term success rates of pulp capping are not encouraging.

As an example, the reported success rates after 9 to 10 years have ranged from 13% to 59%. Factors such as the size of the pulp exposure and bacterial leakage around an overlying restoration can affect the success of the procedure. However, another factor that can jeopardise a favourable outcome is the presence of dentine chips in the pulp. These are part of the grinding debris produced during the removal of the last layer of dentine. Bacteria embedded in the chips can thrive and proliferate and so act as sites for inflammation and abscess formation.

Comment:

The longer-term results with pulp capping suggest that alternative strategies may be more viable. The conditions favouring success, that is a vital exposure under rubber dam, may not be met in a tooth with deep caries. Infected dentine chips introduced into the pulp at the time of exposure have been cited as a source of eventual problems.

Dentine caries.

It is now realised that carious dentine contains more minerals than originally thought. These can be utilised in various repair processes.

Effect of sealing off decay.

Sealing off decay prevents other bacteria and nutrients reaching organisms in the caries.

With time the process just described can continue. The dentinal tubules at the base of the lesion can become occluded with deposited minerals and, in some instances, the pulpal ends capped with tertiary dentine.

The number of organisms in the caries can be reduced and the lesion can become harder, drier and darker.

Source www.dentaloutlook.com.au
**Traditional option: Remove all caries. (cont)**

**Pulpectomy >>**

Left: Carrying out a pulpectomy on a tooth with a vital pulp exposure does increase the complexity and expense of a case.

Moving straight into removing the pulp is a major step in increasing the complexity of the case.

**Comment:**
- Moving into a pulpectomy as a result of a vital pulp exposure represents a major increase in the complexity of a case. Non-pulp-invasive procedures can be a preferable first option.

**Stepwise excavation >>**

Left: The stepwise excavation technique can be used to prevent a pulp exposure.

There is now a multitude of clinical studies to show the efficacy of the stepwise excavation approach.

The reported success rates varied from 94 to 100 per cent.

**Technique:**
- [The procedure is carried out on vital teeth with no evidence of irreversible pulpitis].
- 1. Prepare cavity outline.

2. For occlusal lesions, remove sufficient caries to establish a 2 mm band of completely sound dentine immediately below the dentino-enamel junction.

For approximal surface lesions, prepare a lip of completely sound dentine just inside the dentino-enamel junction.

(These steps are mandatory to obtain a good seal of the interim restoration and so prevent bacterial leakage).

3. Remove some of the remaining carious dentine. The exact amount to be removed depends on the case. It is often to the point where a very slight firmness of the dentine >

In addition it places an additional financial load on the patient for the endodontic treatment itself and the subsequent restoration.

In teeth with multiple root canals, the accompanying complexity may even warrant the case being referred.

Endodontics is an option that, perhaps, can be kept in reserve if other more conservative non-pulp-invasive procedures do not succeed.

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**Comment:**
- Moving into a pulpectomy as a result of a vital pulp exposure represents a major increase in the complexity and expense of a case. Non-pulp-invasive procedures can be a preferable first option.

When the stepwise excavation method is used and the dentine caries is eventually removed, the colour of the remaining dentine can vary from yellow-light brown to dark brown-black. Examples of the colour range are shown above.

**Option: Leave some caries and re-enter at a later time.**

**Stepwise excavation procedure.**

Occlusal lesion.

**Stepwise excavation procedure.**

Approximal surface lesion.

The first stage of the stepwise excavation technique is to remove the superficial dentine caries, place a calcium hydroxide base and restore the tooth with a high-viscosity glass-ionomer cement.
Option: Leave some caries and re-enter at a later time. (cont)

Critical step if leaving caries in a cavity....

If leaving caries in a cavity, a lip or ‘moat’ of sound dentine must be prepared in the sites shown.

Stepwise excavation (cont) >>

- Technique: (cont)
  is experienced. However, if an exposure is considered imminent, excavation is stopped immediately.

4. Cover the remaining carious dentine with an easily removed material such as a setting, DyCal - type, calcium hydroxide material.

5. Restore the cavity with a suitable material such as a high-viscosity glass-ionomer cement.

6. After 6 to 12 months re-enter the site and remove the remaining caries.

7. Place a suitable base and restore the tooth.

- How it works:
  Removing some of the caries and sealing off the remainder from the oral environment makes the caries left behind less active.
  The seal provided by the interim restoration (i) prevents more oral bacteria reaching the lesion; and (ii) deprives the remaining bacteria of an outside source of nutrients.
  This allows time for the repair mechanisms of the dentine and pulp to operate.
  Minerals dissolved from the carious dentine can become deposited in the underlying dentinal tubules.
  Also, odontoblasts within these tubules may start laying down more peritubular (intratubular) dentine. These two processes may occur separately or together.
  At the pulpal end of the tubules tertiary (reparative) dentine may form. Its nature depends on the severity of the caries attack.
  Also there can be an increase in radiopacity within the body of the lesion. What processes are involved with this phenomenon are not fully understood.
  With time there is a reduction in the number of bacteria surviving in the remaining caries.
  After the interim restoration is placed the remaining caries becomes, harder, drier and darker.

- Point to watch when re-entering:
  When re-entry is carried out 6 to 12 months after placing the interim restoration it is advisable to proceed carefully. Overzealous cutting can remove the repaired area at the base of the lesion.
  Keep in mind that with a successful result, the cavity floor may be medium hard rather than fully hard. In such circumstances trying to reach fully hard dentine can result in a pulp exposure.
Option: Leave some caries and no re-entry.

Leave and seal >>

Another option is to leave caries at the base of a cavity. There are studies showing that as long as the overlying restoration (or sealant) stays completely intact with no leakage the underlying caries does not progress. 13 - 16

A recent 10-year study of 13 restorations placed over residual caries found that where the marginal seal remained intact:

1. Lesion depth remained unchanged or decreased under 12 of the 13 restorations.
2. Tertiary dentine was observed under 10 of the 13 restorations.
3. Overall there was an increase in radiodensity of the lesions.

Tip:

Caries detector dyes are not recommended when treating deep carious lesions. Firstly, they do not differentiate between non-infected and infected dentine. Secondly, they have the major disadvantage of selectively staining the dentino-enamel junction area. This means an operator may go chasing ‘caries’ in dentine that is completely sound. Thirdly, a major problem can arise if a caries detector dye is used close to the pulp. It may result in a preventable pulp exposure. This is a result of the material selectively staining completely sound dentine adjacent to the pulp. 19

Deciding whether to leave some caries or re-enter later.

There are a number of factors that may influence an operator’s decision as to whether to leave some caries in a cavity or re-enter at a later stage. >

Patient age >>

If the tooth in question is a young permanent tooth that is to remain in the mouth, and not subsequently be removed for orthodontic reasons, then re-entry may be the preferred option. By re-entry and placing a suitable base material, such as glass-ionomer cement, it provides an additional protective zone against any bacterial leakage if the overlying restoration becomes lost or defective at any stage.

Excluding various economic factors, some of the aspects to take into consideration are set out below:

A common situation where the stepwise excavation approach can save root canal treatment is with previously undiagnosed large occlusal lesions in first and second permanent molars. In the case of older patients the need for re-entry into a lesion may be less: especially where the placement of a well-sealed restoration is possible.

Young permanent molar teeth.

In young permanent molar teeth with deep caries a stepwise excavation technique may be preferable to a no-re-entry approach. Usually re-entry is made after 6 to 12 months and the remaining caries removed. A base is placed and the tooth restored.
Deciding whether to leave some caries or re-enter later. (cont)

Lesion location >>

**Practitioners may be** far more comfortable leaving caries at the base of an occlusal lesion in contrast to an approximal-surface one.

In the latter case, the proximity of the residual caries to the gingival margin may be a cause for concern. The enamel in this area is comparatively thin.

Secondary caries or bacterial leakage has less distance to travel to reach the residual caries than would be the case in an occlusal situation.

Patient’s caries activity >>

**In a patient** with a high caries activity, it may be decided to opt for re-entry as a precaution against new lesions, secondary caries or bacterial leakage reaching the residual-caries site.

Concern about viability of remaining organisms >>

**An operator** may be more comfortable about not re-entering a lesion and leaving residual caries if he or she knew the remaining bacteria had been completely destroyed.

Whilst sealing off the residual caries from the source of nutrients will reduce bacterial numbers, there are some that may remain viable.

To date treatments with ozone or 1% chlorhexidine have been shown to have no immediate anti-microbial effects. Whether other treatments, such as with metal fluorides, prove to be more effective has not yet been established.

Misinterpretation of situation by other practitioners >>

**An underlying factor for not leaving residual caries and re-entering a lesion maybe the concern about untoward comments if the patient is seen at another practice.**

In light of such possibilities, it reinforces the importance of informing the patient, or patient’s parents, of the purpose of the approach. Apart from noting the procedure in the patient’s records, a simple written explanation should be given to the patient at the time of treatment. It also provides the appropriate protection against any subsequent mis-understanding.
It has been known for over 30 years that the deeper layers of carious dentine are capable of being re-calcified after a restoration has been placed. For this to happen, it appears necessary for the top (probably infected) layer of the carious dentine to be removed first.

A recent study looked at residual carious dentine under restorations that had been in place for 10 years. It was found that the carious dentine had become more radiopaque over time suggesting some form of re-mineralisation. The mechanism by which this re-mineralisation takes place has not as yet been established.

The case shown below was seen in a private practice setting. Over a period of 14 months the residual carious dentine under the restoration in the lower second molar seems to have mineralised.

Initially, the superficial layer of carious dentine was removed and a safety lip of sound dentine was prepared just inside the dentino-enamel junction to a depth of 2 mm. The remaining caries was treated with silver fluoride followed by potassium iodide, an auto-cure GIC base placed and the cavity restored with resin composite.

The same practitioner found a similar result on another molar tooth with a deep occlusal cavity in another patient. In that instance ozone (HealOzone • Kavo) was used to treat residual carious dentine prior to placing a GIC base and a resin-composite restoration.

Whilst the above observations do not in any way constitute a scientific study, they suggest something interesting may have happened. The possibility exists that the techniques used to treat the carious dentine surface may have inactivated organisms in the outer infected layer. This in turn may have allowed some form of re-mineralisation to take place.

* Case report and photos courtesy Dr Geoffrey Knight.
Example materials for interim restorations.  

**Fuji IX (GC Corp)**

- **Uses:** Occlusal and approximo-occlusal cavities.
- **Materials:** High viscosity, auto-cure glass-ionomer cements.
- **Composition:** Fuji IX has a strontium fluoro-alumino-silicate glass filler and Ketac Molar has a calcium lanthanum fluoro-alumino-silicate glass filler.
- **Handling:** Both are high viscosity materials and for bulk placement applying pressure via a gloved finger helps ensure proper adaptation.
- **Advantages:** Both materials have a long track record of clinical use, particularly with ART techniques. A study with Fuji IX showed that, even after 6 years, the material still performed well with no marginal breakdown or secondary caries. The only problem was some dissolution of the material adjacent to the contact area.
- **Disadvantage:** Because of the aesthetics of the materials, there may not be a marked contrast with adjacent tooth structure to aid in removal when required.

**Summary:** Two proven high-viscosity materials. May not provide the same contrast with tooth structure as other materials to aid in removal at the end of the 6- to 12-month treatment period.

**Ketac Molar (3M Espe)**

- **Uses:** Occlusal cavities not involving an occlusal stop.
- **Material:** Low viscosity, chemically-set glass-ionomer cement.
- **Composition:** Has a strontium fluoro-alumino-silicate glass filler and a trace of iron oxide.
- **Handling:** Placement is straightforward when using the dispenser gun. Has the option of accelerated setting by exposing the material to a curing light.
- **Advantages:** Pink colour of material allows ready identification and differentiation from adjacent tooth structure.
- **Disadvantages:** Material is not as heavily filled as the high viscosity materials so physical properties may place a limit on its usefulness in some situations. Wear may be a problem if subjected to masticatory forces over a period of time.

**Summary:** May be a useful material for shorter-term interim restorations in occlusal cavities. Pink colour helps differentiate material from adjacent tooth structure.

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**Fuji VII (pink) (GC Corp)**

- **Uses:** Occlusal cavities not involving an occlusal stop.
- **Material:** Low viscosity, chemically-set glass-ionomer cement.
- **Composition:** Has a strontium fluoro-alumino-silicate glass filler and a trace of iron oxide.
- **Handling:** Placement is straightforward when using the dispenser gun. Has the option of accelerated setting by exposing the material to a curing light.
- **Advantages:** Pink colour of material allows ready identification and differentiation from adjacent tooth structure.
- **Disadvantages:** Material is not as heavily filled as the high viscosity materials so physical properties may place a limit on its usefulness in some situations. Wear may be a problem if subjected to masticatory forces over a period of time.

**Summary:** May be a useful material for shorter-term interim restorations in occlusal cavities. Pink colour helps differentiate material from adjacent tooth structure.
### ChemFil Rock (Dentsply)

**Uses:** Occlusal and approximo-occlusal cavities.

**Material:** High viscosity, auto-cure glass-ionomer cement.

**Composition:** The product differs from other auto-cure glass-ionomer cements in that its filler particles are reported to be a zinc fluoro-alumino-silicate glass. (Other materials in this category use either a strontium fluoro-alumino-silicate glass or a calcium lanthanum fluoro-alumino-silicate glass as the filler).

**Handling:** An initial assessment is that the material is easy to place in bulk, is not sticky and has an adequate working time of around 1.5 minutes. Trimming and contouring can be commenced by about 6 minutes.

**Advantage:** Material is opaque and so gives a good contrast to tooth structure. This should facilitate removal at the appropriate time and minimise any inadvertent over-cutting of adjacent tooth structure.

**Disadvantage:** It is a new material and independent clinical and laboratory reports are not yet available.

**Summary:** If clinical and laboratory testing prove to be positive, this material could set the standard for interim restorations in situations where a stepwise excavation technique is being used.

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### IRM (Dentsply)

**Uses:** Occlusal cavities.

**Material:** Reinforced zinc oxide eugenol.

**Composition:** Zinc oxide eugenol with polymer reinforcement.

**Handling:** For optimum longevity the material must be mixed to a very thick consistency. The tendency is to stop mixing too early. Whilst mixing, the bolus of material must be continually pushed down into fresh powder and that incorporated in the mix.

**Advantages:** Zinc oxide eugenol has good anti-microbial activity against *Streptococcus mutans* and has shown the potential to remineralise carious dentine.

**Disadvantages:** Physical properties questionable for longer-term interim restorations involving approximal surfaces.

**Summary:** Another useful material for occlusal restorations where re-entry is planned in 6 to 12 months.

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**Note:** The materials shown above and on the previous page are examples of items that may be used for interim restorations. The list is not, in any way, intended to be exhaustive.
main points

• **The stepwise excavation technique** has been shown to be a viable way of preserving pulp vitality in teeth with deep carious lesions.

• **When using the technique** it is desirable not to re-enter and remove the residual caries in under 6 to 12 months.

• **As an alternative** to the above, if it is decided to immediately restore the tooth and deliberately leave caries behind, it is essential that the caries be completely sealed off.

• **Factors such as** the patient’s age and location of the lesion have to be considered in deciding whether or not a ‘no re-entry’ approach is adopted.

• **Whether a stepwise excavation** or a ‘no re-entry’ approach is adopted, it is essential that the residual caries be sealed off as stated above. For occlusal lesions this requires a lip of completely sound dentine, 2 mm wide, immediately apical to the dentino-enamel junction. For approximal surface lesions it requires a lip of completely sound dentine just inside the dentino-enamel junction.

Tip: If placing an interim restoration

1. **Inform patient of the purpose of the interim restoration.**
   - It allows nature’s defence mechanisms to work and start to repair and seal off the decay.
   - In the longer term it can save time and money by preventing the need for root canal treatment.

2. **Provide patient with written information.**
   - To reinforce the information given in the surgery it is advisable to provide the patient with a simple written description of the procedure used and its purpose.
   - This helps avoid any misunderstandings at a later date.

3. **Charge the full restoration fee. No ‘fund fee’ only.**
   - Done properly an interim restoration requires care and time. Charging the full fee places a worth on the procedure in the patient’s (and operator’s) mind. If a subsequent interim restoration is required make any fee adjustments, if necessary, at that stage.
References. >>


The various zones in carious dentine.

- Zone of bacterial invasion
- Zone of demineralisation
- Translucent zone (sclerotic dentine)
- Reparative dentine